Mapping the Evolving Landscape of Child-Computer Interaction Research: Structures and Processes of Knowledge (Re)Production

Tiarnach Mc Dermott

Wolfson College

University of Oxford

A thesis submitted for the degree of

Doctor of Philosophy in Education

Hilary 2023

Acknowledgements

These may be amongst the last words I write as part of this thesis, but none of those which came before (and follow throughout this document) would ever have come to be without the support of a great many amazing people. To the following, my sincerest gratitude and ceaseless appreciation:

Dr James Robson, *Professor Lars-Erik Malmberg*, and *Dr Niall Winters*, my supervisors, for their guidance and expertise in navigating this journey and its innumerable obstacles;

Professor Sonali Nag, *Dr Jenni Ingram*, *Professor Harry Daniels*, *Professor Jill Porter*, *Dr Ariel Lindorff*, and *Professor Alis Oancea*, for the opportunities to develop they graciously afforded;

Catherine Scutt, *Jackie Bridges*, *Kyra Smith*, *Boda Sedlacek*, and *Department of Education professional services staff*, for their patience in answering inane queries;

The *Economic and Social Research Council* and *Grand Union Doctoral Training Partnership*, *Dr David Mills*, *Professor Alexander Betts*, *Kate Gear*, and *Alan McKechnie*, for supporting this study;

Members of the *Child-Computer Interaction community*, particularly those who participated in the present study, for their time and insight;

Staff and students at *St John's NS* and *Faughart CNS* for their understanding and accommodation;

Clíodhna, *Paul*, and *Dearbhla*; *Ciarán*, *Stephen, and Cathy*; *Seán*, *John*, *Josh*, *Louise*, *Brenda*, *Aisling*, *David*, *Martin*, *Michael*, *Shaun*, and *Stephen*; *Anay*, *Eddy*, and *Kyle*; *Aya* and *Gregor*; *Rose*, *Tim* and *June*; *Ira* and *Roman*; *Ernesto*, *Sofia*, *Mattho*, *Kate*, *Bridget*, *Sophia*, and *Ilan*; *Matthew* and *Robbie*; and many more besides who have ensured the journey was tolerable;

Aoibhinn, *Saoirse*, *Liadain*, and *Oisin*, my siblings, for their immeasurable patience and thoughtfulness;

Sadie and *Seamais*, my parents, for their unconditional support and encouragement.

For Teddy and Margaret, Michael and Mary

Table of Contents

List of Abbreviations

API	Application Programming Interface
CCI	Child-Computer Interaction
CTM	Correlated Topic Model
CUREC	Central University Research Ethics Committee
DPIA	Data Protection Impact Assessment
DPS	Data Protection Screening
DREC	Departmental Research Ethics Committee
FG	Focus Group
GDPR	General Data Protection Regulation
HCI	Human-Computer Interaction
HDBSCAN	Hierarchical Density-Based Spatial Clustering of Applications with Noise
ICO	Information Compliance Office
IDC	Interaction Design and Children
IJCCI	International Journal of Child-Computer Interaction
IxD	Interaction Design
LDA	Latent Dirichlet Allocation
MMR	Mixed Methods Research
OFG	Online Focus Group
QUAL	Qualitative Research Phase
QUANT	Quantitative Research Phase
RWMD	Relaxed Word Mover’s Distance
SKAD	Sociology of Knowledge Approach to Discourse
STM	Structural Topic Model
TA	Thematic Analysis
tf-idf	Term Frequency-Inverse Document Frequency
TM	Topic Model
t-SNE	t-Stochastic Neighbour Embedding
w2v	word2vec
WMD	Word Mover’s Distance (WMD)

List of Figures

List of Tables

Abstract

Implementing an iterative sequential mixed methods design (Quantitative → Qualitative → Quantitative) framed within a sociology of knowledge approach to discourse, this study offers an account of the structure of the field of Child-Computer Interaction (CCI), its development over time, and the practices through which researchers have (re)structured knowledge comprising the field.

Thematic structure of knowledge within the field, and its evolution over time, is quantified through implementation of a Correlated Topic Model (CTM), an automated inductive content analysis method, in analysing 4,771 CCI research papers published between 2003 and 2021. Detailed understanding of practices through which researchers (re)structure knowledge within the field, including factors influencing these practices, is obtained through thematic analysis of online workshops involving prominent contributors to the field (n=7). Strategic practices utilised by researchers in negotiating tensions impeding integration of novel concepts in the field are investigated through analysis of semantic features of retrieved papers using linear and negative binomial regression models.

Contributing an extensive mapping, results portray the field of CCI as a varied research landscape, comprising 48 major themes of study, which has evolved dynamically over time. Research priorities throughout the field have been subject to influence from a range of endogenous and exogenous factors which researchers actively negotiate through research and publication practices. Tacitly structuring research practices, these factors have broadly sustained a technology-driven, novelty-dominated paradigm throughout the field which has failed to substantively progress cumulative knowledge. Through strategic negotiation of persistent tensions arising as consequence of these factors, researchers have nonetheless affected structural change within the field, contributing to a shift towards a user needs-driven agenda and progression of knowledge therein. Findings demonstrate that the field of CCI is proceeding through an intermediary phase in maturation, forming an increasingly distinct disciplinary shape and identity through the cumulative structuring effect of community members' continued negotiation of tensions.

Chapter One: Introduction

1.1. Context

Child-Computer Interaction (CCI) is a multidisciplinary field of scientific investigation which concerns the design, evaluation, and implementation of interactive computational and communication technologies intended for children's use, and phenomena surrounding children's interaction therewith (Hourcade, 2015; Read & Bekker, 2011; Read & Markopoulos, 2013). CCI research seeks to further understanding of children's relationships and interactions with technology, and provide methods, tools, and techniques facilitating design of technologies which support children in their development and wellbeing (Lehnert et al., 2021; Smith et al., 2013). In doing so, the field is informed by, and combines, insights, theories, and methods of inquiry derived from a diverse range of scientific disciplines and fields, including computer science, developmental psychology, learning science, interaction design, and media studies (Read & Markopoulos, 2013; Tsvyatkova & Storni, 2019).

Throughout the two decades since the formalisation of CCI as a distinct field with the establishment of the specialised annual conference series *Interaction Design and Children* (IDC) in 2002, the field of CCI has been characterised by sustained, steady growth (Giannakos, Papamitsiou, et al., 2020; Lehnert et al., 2021), developing and maturing established research themes therein and extending the purview of the community to accommodate the continuously expanding breadth, and changing role, of technology in children's lives (see Brooke et al., 2020; Ofcom, 2022; and Rideout & Robb, 2020). As the field of CCI matures and defines a distinct identity, developing and extending beyond foundations derived from the various fields from which it initially arose and settling into well-established structures and methodologies, concerns and anxieties have arisen within the community regarding the "disciplinary shape" (Reeves, 2015) of the field and the coherence and adequacy of knowledge generated therein (Barendregt et al., 2017; Frauenberger, 2016; Höök & Löwgren, 2012). Consequently, regarded as having reached a critical juncture in development analogous to "adolescence" (Antle & Hourcade, 2022), researchers (e.g., Antle & Hourcade, 2022; Kawas et al.,

2020) have advocated for conscious engagement of the Child-Computer Interaction community in these processes of maturation and identity formation through purposeful reflection upon the development of the field (i.e., where has the field come from?), and engagement in critical dialogue concerning the state of the field at present (i.e., where is the field currently?) and the actions and decisions which will dictate the field's direction (i.e., where is the field going?).

The present study engages in such reflection upon, and critical dialogue concerning, Child-Computer Interaction research through investigation of the structure of knowledge comprising the field and the processes and practices through which researchers, in contributing to the field, have (re)structured this knowledge over time. Implementing an iterative sequential mixed methods design framed within a conceptual framework based on the *sociology of knowledge approach to discourse* (SKAD; Keller, 2011), the current study explores the thematic structure of knowledge constituting the field of Child-Computer Interaction, and its development over time, through quantitative text analysis of relevant research papers, and examines researchers' experiences of processes and practices through which such knowledge has been (re)produced through a series of qualitative workshops. In so doing, this study contributes an empirically grounded account of the current state of the field of Child-Computer Interaction, elaborates processes and practices which have shaped development therein, and provides insights and recommendations informing the continued progression of the field.

1.2. Aims and Research Questions

This study aims to investigate the structure of knowledge within the field of Child-Computer Interaction, and the research practices and processes through which such knowledge has been (re)structured throughout the field's development. In pursuing these aims, the current study specifically seeks to: (a) map the thematic structure of the field of CCI, and the evolution thereof; (b) identify factors influencing research practices related to the field; and (c) examine researchers' negotiation of such factors in contributing to knowledge in the field of CCI. Operationalising these aims and objectives, the study is guided by, and addresses, the following overarching research question and associated sub-questions:

1. How have research practices shaped knowledge developed within the field of Child-Computer Interaction throughout the period 2003 to 2021?
    1.1. What major themes of study were addressed in the field of Child-Computer Interaction during the period 2003 to 2021?
    1.2. How have major themes of study in Child-Computer Interaction changed in prominence within research throughout the field's development?
    1.3. How have major themes of study been combined within Child-Computer Interaction research during the period 2003 to 2021?
    1.4. What factors have influenced trends in research priorities within Child-Computer Interaction throughout the field's development?
    1.5. How have norms and structures associated with the field of Child-Computer Interaction influenced research and publication practices therein?
    1.6. How do researchers negotiate norms and structures associated with the field of Child-Computer Interaction in producing novel knowledge in the field?

1.3. Structure of the Thesis

The present chapter, ***Chapter One*** provides an ***introduction*** to the study, briefly establishing the context of the study, identifying the primary aims and research questions guiding the study, and outlining the structure of, and progression of the argument throughout, the thesis. ***Chapter Two*** provides a ***review of literature*** which frames and situates the study within the context of extant Child-Computer Interaction research, critically reviewing overviews and analyses of knowledge and processes of knowledge construction within the field of Child-Computer Interaction and the related field Human-Computer Interaction (HCI). ***Chapter Three*** expounds the ***conceptual framework*** implemented in the current study. The theoretical underpinnings, assertions, and affordances of the *sociology of knowledge approach to discourse* (SKAD) advanced by Keller (2005, 2006, 2011, 2018) upon which the proposed conceptual framework draws are discussed. The chapter concludes with an elaboration of the conceptual framework, which articulates a dialectic relationship between the field of Child-Computer Interaction and researchers contributing thereto, applied throughout the present study. ***Chapter Four*** outlines the ***research design and methodology*** informed by both the research aims and questions stated in ***Chapter One*** and the conceptual framework presented in ***Chapter Three***. This chapter begins by introducing the mixed methods research design, paradigmatic stance, and criteria to assess rigour adopted. The iterative sequential mixed methods design (Tashakkori et al., 2020) implemented, comprising three distinct, sequential phases (QUAN → QUAL → QUAN), is described. Data collection and analysis methods, as well as criteria to assess rigour, related to respective quantitative and qualitative phases of the mixed methods design are detailed. The chapter concludes by addressing ethical considerations and principles guiding the research design and practices.

Results of data analyses comprising respective phases of the study are presented sequentially in individual chapters (Chapters Five, Six, and Seven). ***Chapter Five*** presents a ***mapping of the thematic landscape of Child-Computer Interaction*** generated through Correlated Topic Modelling (CTM; Blei & Lafferty, 2007) of an extensive corpus of published research papers obtained from Elsevier's Scopus database (i.e., Phase 1). Results of analyses of the prominence of, and interaction between, major themes of study throughout research in the field, as well as trends over time therein, are detailed, providing an overview of the structure of knowledge comprising the field of Child-Computer Interaction and the development thereof over time. ***Chapter Six*** details ***processes of knowledge (re)construction within Child-Computer Interaction***, identified based on thematic analysis of Child-Computer Interaction researchers' perspectives and experiences obtained through a series of online workshops (i.e., Phase 2), which may explain the structure of the field, and trends therein, observed in results of Phase 1 (i.e., ***Chapter Five***). In so doing, results convey insights regarding practices through which researchers have shaped and (re)structured the field of Child-Computer Interaction, including endogenous and exogenous factors influencing these practices, and thereby facilitates empirical scrutiny of the relationship between researchers and the field posited within the conceptual framework (***Chapter Three***). ***Chapter Seven*** reports results of regression models which, analysing semantic features of published research papers, empirically test the efficacy of proposed ***strategies for knowledge innovation in Child-Computer Interaction*** employed by researchers in pursuing publication and integration of innovative contributions within the field (i.e., Phase 3). Proposed strategies, arising from the results of Phase 2 (***Chapter Six***), and associated hypotheses are supported by a supplementary review of literature related to innovation in scientific fields presented in ***Appendix I***. In addition to indicating the generalisability and practical efficacy of hypothesised strategies within the field of Child-Computer Interaction, results provide further insights regarding the posited reciprocally structured and structuring relationship and interaction between researchers and the field.

Chapter Eight presents ***discussion*** which, integrating results of respective phases of the mixed methods research design implemented (i.e., ***Chapter Five***, ***Chapter Six***, and ***Chapter Seven***) and contextualising these results within the relevant literature (***Chapter Two*** and ***Appendix I***) and conceptual framework (***Chapter Three***), addresses research questions. ***Chapter Nine*** provides a ***conclusion*** to the study, summarising substantive findings, discussing the study's contributions, acknowledging limitations of the study, and offering recommendations for future research.

Chapter Two: Review of Literature

Although a relatively young field, a burgeoning body of literature examines the development and structure of knowledge comprising the field of Child-Computer Interaction research. This chapter frames the current study within the context of such Child-Computer Interaction literature as well as, where relevant, literature pertaining to neighbouring and related fields (e.g., Human-Computer Interaction), defining the field and presenting a critical review of extant literature, analysing methodological approaches utilised and identifying current gaps therein.

2.1. Field of Child-Computer Interaction

Recent decades have witnessed the prompt and pervasive proliferation of interactive computational and communication technologies throughout many aspects of daily life, to the extent that, as Martens et al. (2018) assert, "[e]verywhere there are children, there are screens, and child-computer interaction is ubiquitous" (p. 1; see Brooke et al., 2020; Ofcom, 2021, 2022; Rideout, 2017; Rideout & Robb, 2020 for empirical evidence). As interaction with technology has become ubiquitous throughout children's lives, a broad body of research explicitly investigating, and concerned with advancing understanding of, children's relationships with interactive technologies, the design of interactive technologies for children, and the wider impact of technology on children and society has emerged (Antle & Hourcade, 2022; Hourcade, 2015; Markopoulos et al., 2008; Read & Markopoulos, 2013). Such research collectively constitutes the field of Child-Computer Interaction (CCI).

Child-Computer Interaction (CCI) is a multidisciplinary field of scientific investigation which concerns the design, evaluation, and implementation of interactive computational and communication technologies intended for children's use, as well as phenomena surrounding children's interaction therewith and societal implications of such interaction[1] (Antle & Frauenberger, 2020; Hourcade, 2015; Read & Bekker, 2011; Read & Markopoulos, 2013). CCI research seeks to further understanding of children's relationships and interactions with technology, and provide methods, tools, and techniques facilitating design of technologies which support children in their development and wellbeing (Lehnert et al., 2021; Smith et al., 2013) . In doing so, the field is informed by, and combines, insights, theories, and methods of enquiry derived from a diverse range of disciplines and fields, including computer science, developmental psychology, learning science, interaction design, and media studies (Read & Markopoulos, 2013; Tsvyatkova & Storni, 2019).

Research explicitly concerned with phenomena related to child-computer interaction predates recognition of CCI as a distinct field of study, with the potential of computational technologies for children recognised as early as the 1960s in the work of pioneering researchers such as Seymour Papert, Marvin Minsky, and Alan Kay which explored the design and use of computer systems for children. Early research examined children's interaction with mainstream technologies initially developed for adult use, and in so doing identified the necessity of adaption of interactive technologies, design methodologies, and methods of enquiry developed in the field of Human-Computer Interaction (HCI) to accommodate the differing developmental needs and capabilities of children (Read & Markopoulos, 2013). Subsequent research affirming and elaborating upon these assertions produced throughout the 1980s and 1990s, including seminal works by key proponents such as Papert (1980), Kafai (1998), Druin (1999; Druin & Solomon, 1996), and Rogers and Scaife (Rogers et al., 2002), incorporated contributions from fields beyond HCI (e.g., education, developmental psychology, computer science), investigated novel interaction technologies for children, and developed appropriate research and design methodologies. The growing presence of

[1] In the context of Child-Computer Interaction, children of interest were initially those between 5 and 12 years old, but, although studies (see Yarosh et al., 2011; Kawas et al., 2020) indicate that children in this age range remain the primary subjects of research, the field has since extended to include toddlers and adolescents within its remit (Giannakos, Papamitsiou, et al., 2020; Read & Bekker, 2011; Van Mechelen, Baykal, et al., 2020).

child-computer interaction related interests and publications appearing at Human-Computer Interaction conferences (e.g., Druin, 1996) consequently coalesced with the establishment of a specialised annual conference series entitled *Interaction Design and Children* (IDC) in 2002, intended to serve as an annual venue for "the latest research findings, innovative methodologies and new technologies in the areas of inclusive child-centered design, learning and interaction"[2] (M. Bekker & Markopoulos, 2003; Markopoulos et al., 2008; Read & Bekker, 2011). Further research infrastructure was developed with the initiation of a dedicated journal in 2013, the *International Journal of Child-Computer Interaction* (IJCCI), which serves as a forum in which high-quality Child-Computer Interaction and Interaction Design related research may be disseminated (Read & Hourcade, 2013; Read & Markopoulos, 2013). Throughout the past two decades, "IDC has served as the annual conference gathering for CCI researchers (although works and activities are also taking place in other, usually HCI and learning/education events) and IJCCI has served as the explicit journal of the field (although CCI related works are published in other, usually HCI and learning journals)" (Giannakos et al., 2022, p. 2). Establishment and development of these dedicated venues has, over the past two decades, acted to cohere, and thereby formalise, Child-Computer Interaction as a distinct field and associated community.

Thus, emerging from "pockets of work, mainly driven from interests in technology use within education and schools", the field of Child-Computer Interaction has, in recent years, developed and defined itself as an "identifiable community within the HCI space which is beginning a process of maturing into its own discipline with its own associated methods and solutions" (Read & Bekker, 2011, p. 163). CCI has been distinguished from the broader field of HCI by a number of key differences which pose theoretical and methodological implications and thereby necessitate a specialised area of study, including the rate of change (e.g., physical and cognitive development) in children, the frequent involvement of adults in children's interactions with technology, the contexts in which children

[2] Interaction Design and Children 2022 call for papers (https://idc.acm.org/2022/)

interact with technologies, and the underlying cultural and societal values and assumptions regarding what is appropriate and beneficial for children (Read & Bekker, 2011). Notwithstanding such distinctions, however, researchers (e.g., Giannakos et al., 2022; Read et al., 2008, 2011) maintain that, as "the community matures and as methods and processes are refined, and become situated, there is an urgent need to start to develop a theory around CCI that can be used with some confidence by the research community" (Read et al., 2011, p. 689), with movement towards definition of the field considered overdue.

Throughout the two decades since the formalisation of the field of Child-Computer Interaction with the establishment of the IDC conference, the field has been characterised by sustained, steady growth (see Giannakos, Papamitsiou, et al., 2020; Lehnert et al., 2021), building upon established research themes and extending the purview of the community to accommodate the expanding breadth, and changing role, of technology in children's lives (Antle & Hourcade, 2022; Giannakos et al., 2022; Giannakos, Horn, & Rubegni, 2020). As Antle and Hourcade (2022) assert, having matured from a young, largely technology-driven field, characterized by exploratory research, to one which has settled into well-established structures and methodologies, CCI has now reached a critical point in development analogous to adolescence, "still finding its way" (Markopoulos et al., 2008, p. 79) as it extends beyond foundations derived from the various fields from which it initially arose and continues to form a distinct identity, establishing research priorities, practices, and norms. Consequently, researchers (e.g., Antle & Hourcade, 2022; Giannakos et al., 2022; Kawas et al., 2020) have advocated for conscious engagement of the CCI community in these processes of maturation and identity formation through purposeful reflection upon the development of the field (i.e., where has the field come from?), and engagement in critical dialogue concerning the state of the field at present (i.e., where is the field currently?) and the actions and decisions which will dictate the field's direction (i.e., where is the field going?).

2.2. Mappings of the Child-Computer Interaction Landscape

Child-Computer Interaction, as a community, demonstrates a commitment to regular discussions (i.e., workshops and panels at relevant conferences, such as IDC and the ACM Conference on Human Factors in Computing Systems [CHI]) regarding advancements, developments, and future directions in research (Giannakos et al., 2022; Read et al., 2011) and "an established tradition of and appreciation for literature reviews to analyze current trends and guide future developments of the field" (Lehnert et al., 2021, p. 6; e.g., special issue of IJCCI on review articles in CCI research, Giannakos et al., 2022). As the field of CCI evolves and matures, and child-relevant technology advances, researchers (Giannakos, Papamitsiou, et al., 2020; Kawas et al., 2020) argue the acute need for continued, regular systematic mapping – whereby the field is held 'still' in order to identify and represent various themes, methods, and tools therein, and the relationships therebetween (Sanders, 2008) – of, and reflection upon, intellectual progress therein, initiating and informing constructive and critical dialogue within the community concerning the current state and identity of the field and its future direction. Throughout the field's development as a distinct, identifiable community, numerous studies have undertaken such efforts to examine the structure of and progress in, and thereby offer an interpretable representation and overview of, the CCI research landscape through review and systematic mapping of various areas therein and dimensions thereof (Giannakos, Papamitsiou, et al., 2020; Read & Bekker, 2011). Such review of, and reflection upon, the state of, and progress in, a field of research commonly parallels the growth of a field and may be indicative of attainment of a certain level of maturity – indeed, accrual of a sizeable corpus of research within the field is a prerequisite to any such reflection (Daenekindt & Huisman, 2020).

Studies have characterised various aspects of the field of Child-Computer Interaction and summarised progress therein, identifying recurrent patterns and trends in the thematic structure of research in the field (Giannakos, Papamitsiou, et al., 2020; Hourcade, 2015; Korte, 2020; Read & Markopoulos, 2013), as well as research and design methods, techniques, and tools utilised (Jensen & Skov, 2005; Lehnert et al., 2021; Tsvyatkova & Storni, 2019); values and motivations espoused (Kawas et al., 2020; Van Mechelen et al., 2021; Yarosh et al., 2011); ethics (Van Mechelen, Baykal, et al., 2020) and criticality practised (Iivari et al., 2021); and levels of knowledge produced (Barendregt et al., 2017) therein. Moreover, a considerable number of recent reviews of literature have sought to synthesize, criticise, define, and reflect upon respective areas of study which comprise the CCI field, including design of technology for and with developmentally diverse children (Benton & Johnson, 2015; Börjesson et al., 2015; Spiel et al., 2019), interactive technologies supporting developmentally diverse children (Boucenna et al., 2014; Shahid et al., 2021), programming and coding in early-childhood education (Macrides et al., 2021; Papadakis, 2021), augmented reality in programming education (Theodoropoulos & Lepouras, 2021), tangible user interfaces and interaction (Baykal et al., 2018; Zaman et al., 2012), gestural interactions (Torres-Carrión et al., 2019), sensing technologies (K. Sharma & Giannakos, 2021), social and educational robotics (Bakala et al., 2021; Dawe et al., 2019; Kyriazopoulos et al., 2021), educational technology for young children (Hsin et al., 2014; Verbruggen et al., 2021), augmented reality in education (Law & Heintz, 2021; Oranç & Küntay, 2019), game-based learning (Flynn et al., 2021; Hainey et al., 2016; Pellas et al., 2021), making and the Maker Movement (Papavlasopoulou et al., 2017), and cybersecurity awareness (Quayyum et al., 2021).

Amongst the earliest of these overviews of research to be published in a dedicated Child-Computer Interaction venue (IDC), exhibiting an explicit focus on research in the emerging field, was that of Jensen and Skov (2005), which sought to provide a "snapshot of current and previous research conducted within [the] discipline to highlight how the research has been carried out" (p. 80) and support the further development of a community of researchers within the nascent field. Jensen and Skov's (2005) review comprised of a survey of research methods applied in papers concerning children's technology design published in IDC proceedings and selected journals between 1996 and 2004, classifying 105 papers on a two-dimensional matrix defined by research methods (e.g., case studies, field studies, lab experiments, surveys) and research purposes (understand, engineer, re-engineer, evaluate, and describe). Results demonstrated a bias in research towards the development, or engineering, of prototypes as applied research and evaluation of developed products, with many papers presenting novel design solutions followed by controlled, systematic evaluation studies intended to assess the efficacy of the engineered solution. Jensen and Skov (2005) identified common issues or shortcomings related to the application of methods in reviewed papers, including improper adaption for children, failure to adequately consider the needs of participating children, and limited reporting of research purposes.

Extending and expanding upon Jensen and Skov's (2005) earlier work – as well as that of Tsvyatkova and Storni (2019) – Lehnert et al. (2021), through a systematic review of 272 full papers published across a selection of relevant venues (based on those identified by Jensen & Skov, 2005) from 2005 to 2020, sought to develop an integrated understanding of empirical methodologies applied within the Child-Computer Interaction field and, therethrough, provide guidance for future studies in the field and support methodological advancement. Whereas Tsvyatkova and Storni (2019) reviewed only those methods, techniques, and tools intended for use with neurotypical children, Lehnert et al. (2021) argued the need to extend such methodological discussion to a broader group of children, including developmentally diverse children and children from 0 to 18 years old, thereby reflecting the community's interest in, and commitments to, inclusion (Börjesson et al., 2015). Lehnert et al. (2021) found that almost a quarter (24.7%) of reviewed papers involved children from specific developmentally diverse groups, the most frequently represented group being children on the autism spectrum (7% of papers). Similar to Jensen and Skov (2005), results indicated a preference for conducting field studies and evaluation of products at a single point in time. The most commonly studied product categories included interactive games, professional software, and applications and mobile phones, with a noted recent increase in studies considering newer technologies such as virtual and augmented reality and wearables. A clear effort to develop and employ a wide variety of creative design methods which actively engage children in deign processes was observed, particularly in the development of new techniques and tools. However, Lehnert et al. (2021) echoed previously expressed concerns regarding methodological (e.g., Jensen & Skov, 2005) and, in particular, ethical procedures (e.g., Van Mechelen, Baykal, et al., 2020) when involving children in research and design processes, noting that the majority of papers failed to provide clear information related to informed consent or report whether ethical approval for the study had been received.

In a seminal study, Yarosh et al. (2011) undertook an analysis of full papers published in the proceedings of the IDC conference between 2002 and 2010, examining values expressed by the Child-Computer Interaction community therein. The authors conducted a content analysis of 137 papers, investigating and classifying the types of contributions papers made, behaviours and qualities they sought to support amongst children, audiences for whom designs were generated, roles participating children fulfilled, theories and models informing research, criteria informing design decisions, and values expressed in papers. This content analysis was supplemented with a survey of paper first authors (*n* = 40). Through explicitly examining the values held by the community, Yarosh et al. (2011) sought to provide a means by which community members could define the community's culture, conduct informed research, and reflect upon research and design practices, offering a lens to foreground core values inherent in research in the field. Results demonstrated that CCI researchers sought to devise, implement and evaluate new research methods for the design and evaluation of technologies with children, were passionate about the design of novel technologies for various aspects of children's lives, and exhibited a consistent, conscious commitment to positioning children in central roles in designing and testing new technology. Similar to Jensen and Skov's (2005) earlier finding, Yarosh et al. (2011) identified a broad proportion of papers (43%) as presenting the design (and often evaluation) of novel systems for children, with such work, authors admitted, at times exploring emerging technological opportunities for the sake of novelty. Yarosh et al. (2011) note a predominance of research focusing on children between the ages of 6 and 12 years old, suggesting that investigation, and addressing, the needs of preschool children and adolescents may provide future avenues for insight and innovation.

Kawas et al. (2020), in a recent replication and extension of Yarosh et al.'s (2011) earlier work, conducted a content analysis of full papers published in the proceedings of the IDC conference between 2011 and 2019 (220 papers) and surveyed paper first authors (*n* = 44) in order to examine the values expressed by, and ethical considerations central to, the Child-Computer Interaction community. Building upon the findings of Yarosh et al., (2011), Kawas et al. (2020) also identified trends in research over the period 2002 to 2019 through analysis of correlation between the prevalence of values amongst papers and year of publication – however, a number of these analyses may have been underpowered due to the limited numbers of papers assigned to certain categories each year, and consequently may have been insufficiently sensitive to detect trends or may have inflated apparent trends (i.e., effect size or magnitude), with statistical significance unreported. Kawas et al. (2020) identified various developments in the field since Yarosh et al.'s (2011) previous analysis, including greater emphasis on empirical knowledge contributions over novel artefacts, which declined in prevalence amongst papers throughout the period of interest (r = -.51), a broadening range and disciplinary diversity of theories informing research, and continued commitment to inclusivity and diversity (e.g., design for special needs, r =.28) – although, Kawas et al. (2020) note opportunities to extend research to include broader marginalised communities (e.g., children from diverse ethnic groups). In response to opportunities in CCI research identified by Yarosh et al. (2011), Kawas et al. (2020) found that IDC papers published between 2011 and 2019 broadened the scope of investigation to include a wider range of ages (i.e., children younger than 5 and older than 12), exhibited greater attentiveness to children's broader socio-cultural systems, and more often explicitly discussed theories and models in which research was grounded and values which drove the work.

Whilst such studies, in systematically reviewing and representing various aspects of the research landscape, have generated illuminating insights regarding the structure and development of the Child-Computer Interaction field, these analyses generally exhibit limited scope as consequence of methodological limitations. Due to inherent demands associated with traditional qualitative methods, such as close reading and manual coding, employed within these studies, particularly related to time and substantive domain knowledge required (Quinn et al., 2010), these studies are, by practical necessity, constrained, considering limited portions of the field. Often limited to consideration of research published in the field's primary publication venues (i.e., IDC and IJCCI), these reviews may omit a considerable volume of contributions to the field published elsewhere and consequently produce representations of the field which reflect priorities and trends associated with specific venues rather than those evident throughout the broader field. Moreover, overviews and representations produced through application of such methods may be implicitly influenced by researchers' perceptions, preferences, and various disciplinary forces, and thus generate representations of the field biased by the researchers' own position therein (Daenekindt & Huisman, 2020; DiMaggio et al., 2013).

Consequently, in order to obtain a broad, veracious overview of the Child-Computer Interaction field, researchers (e.g., Giannakos, Papamitsiou, et al., 2020; Iivari et al., 2021) have advocated the application of large-scale analysis methods which facilitate inductive identification of systematic patterns within heterogenous text corpora. In addition to accommodating analysis of broad selections of research papers, such inductive approaches facilitate analysis which eschews subjective depictions of the field of research, permitting "researchers to discover the structure of the corpus *before* imposing their priors on the analysis" (DiMaggio et al., 2013, p. 577, emphasis in original), thereby mitigating researcher biases and producing more objective representations of the field.

In a recent study, Giannakos, Papamitsiou, et al. (2020) employed such a large-scale, inductive analysis approach, in the form of co-word analysis of article keywords, in order to construct an intellectual map of the Child-Computer Interaction field as manifested in articles published in the field's primary venues, the IDC conference and IJCCI, between 2003 and 2018 (n = 1059). Co-word analysis facilitates mapping of relationships between words in a set of texts and subsequent identification of patterns and trends based on co-occurrence patterns of pairs of words. Giannakos, Papamitsiou, et al.'s (2020) implementation of co-word analysis, seeking to quantify the conceptual structure and thematic landscape of the field of CCI, is premised on the dual assumptions that author-assigned keywords provide an adequate, and accurate, summary of content, and that co-occurrence of terms within articles reflect a linkage or interaction between these terms which may be indicative of a specific research theme (Y. Liu et al., 2014). Results of co-word analysis conducted on frequently employed keywords in the field (n = 53; i.e., keywords occurring in at least 11 articles) revealed a diverse distribution of research themes, identifying 14 major themes evident throughout the period of interest, of which a number – *participatory design*, *tangibles*, *coding*, *design*, *making*, and *education* – were found to represent areas of particular focus throughout research, demonstrating a high degree of 'coreness' (i.e., interaction with different topics) and 'constraint' (i.e., interaction with otherwise isolated or peripheral topics). Separate clustering analyses conducted for the periods of 2003 to 2012 and 2013 to 2018 (i.e., before and after IJCCI began) to investigate progress in the thematic landscape of the field demonstrated an apparent shift in the community's research interests over time, such that research concerning *tangibles* diminished and research addressing topics such as *participatory design*, *coding*, *autism*, and *education* gained prominence.

Whilst Giannakos, Papamitsiou, et al.'s (2020) application of a large-scale, inductive analysis method, co-word analysis of article keywords, accommodated systematic analysis of a sizeable, diverse corpus of Child-Computer Interaction research, this methodology nonetheless entails a number of notable limitations - in particular, implicit assumptions related to author keywords upon which the analysis is premised. Within such an analysis, author-assigned keywords are assumed to adequately, and accurately, represent the content of articles – however, authors do not apply a consistent approach in assigning keywords. As such, the extent to which author-assigned keywords may be considered representative of the content of articles in their entirety is questionable. Indeed, Giannakos, Papamitsiou, et al. (2020) note that researchers in the CCI community, contrary to guidance in reporting standards (see Levitt et al., 2018), seldom assign keywords describing pertinent details related to studies' populations, methodologies, technologies, and application areas. Additionally, the limited number of keywords associated with each article, as well as the limited number of keywords throughout the corpus retained for analysis (n = 53), may not sufficiently represent the thematic content, or capture the network of interactions and relationships therein, addressed throughout a heterogenous, multidisciplinary field of investigation such as that of CCI research. Furthermore, analysis of keywords prevents distinction of the differential extent to which inferred themes are addressed within papers – that is, all keywords associated with a paper are given equal weight, intimating an equal proportion of thematic content addressed in a paper is dedicated to each keyword or theme – inhibiting nuanced analysis of the prominence of research themes and their interaction within research. Although Giannakos, Papamitsiou, et al. (2020) illustrate differences in the thematic landscape of the field as represented within articles published during the periods 2003 to 2012 and 2013 to 2018 (i.e., before and after the establishment of the IJCCI respectively) through comparison of results of separate clustering analyses, investigation of trends and change in the field based on such broad, discrete time periods fails to afford the ability to trace trajectories of change in the thematic landscape of the field and thus impedes a more granular analysis of the field's dynamic evolution and progress. Additionally, whilst considering a substantial number of papers published in the "flagship venues of CCI" (p. 15), Giannakos, Papamitsiou, et al. (2020) excluded CCI research published in "neighbouring" conferences and journals, producing an overview of the field which may reflect biases associated with these venues (e.g., IDC conferences have, thus far, been hosted in either North America or Europe, possibly inhibiting regular participation of CCI researchers from other continents).

Evidently, therefore, there is a need, in seeking to adequately map and represent the thematic structure of the CCI research landscape, for application of an analysis method which, in addition to facilitating large-scale, inductive analysis, accommodates analysis of paper content beyond keywords, abstracting thematic information therefrom. One such analysis method, extensively applied throughout a diverse range of disciplines and fields – including recent studies concerning fields which are related to, and neighbour CCI, such as Human-Computer Interaction (Gurcan, Cagiltay, et al., 2021), E-Learning (Gurcan, Ozyurt, et al., 2021), and Educational Technology (Chen et al., 2020) – as a means by which to inductively analyse content of large corpora of scholarly literature and, in so doing, generate an overview thereof which provides "an empirical point of entry for in-depth and intensive human analysis" (Gill et al., 2017, p. 1671), is that of topic modelling (Blei et al., 2003; Blei & Lafferty, 2009).

Topic models refer to a family of computational content analysis methods which facilitate inductive mapping of the underlying thematic structure of large, unstructured text corpora through decomposition of data into multiple hidden (i.e., latent) dimensions (i.e., themes or topics). Premised on the natural assumption that document content comprises a combination of a subset of themes common throughout the corpus addressed to varying extents, topic models discern latent semantic themes evident within the corpus based on probabilistic patterns of term (i.e., word or multi-word phrase) co-occurrence (Blei & Lafferty, 2007, 2009; see **Section 4.4.2** for further detail).

Gurcan, Cagiltay, et al. (2021), in a recent study investigating the research themes and developmental stages of the field of Human-Computer Interaction (HCI), applied topic modelling in analysing the semantic content of 41,720 HCI journal articles – here, article titles, abstracts, and keywords – published between 1957 and 2018. Implementing a Latent Dirichlet Allocation (LDA; see **Section 4.4.2**) topic model, 21 major topics of study which represent a range of research interests and meaningfully describe research in the field of HCI over the course of its development were identified. Notably, however, this number of topics was determined to be optimal through review of outputs generated by candidate models fitted for a range of values ($K \in \{15,16 \dots 65\}$) without consideration of model diagnostic metrics – thus, the level of granularity (i.e., number of topics) at which the field was analysed, and subsequently portrayed, reflects the authors' subjective interpretation, and may consequently offer a limited or distorted depiction. Amongst the most prominent topics of study identified throughout research in the field of HCI during this period were those interpreted to relate to *user interface design* (10.2% of corpus semantic content), *intelligent decision systems* (7.9%), *machine control systems* (7.1%), and *online social communication* (6.8%). Through consideration of trends in the prevalence of inferred themes throughout the field during the period of interest, Gurcan, Cagiltay, et al. (2021) sought to extend this derived overview of the field beyond a 'snapshot' and provide a ‘panoramic view’ capable of illustrating the developmental stages of the field. Based on identified trends in topics of study over time, the authors propose “a systematic taxonomy exhibiting the evolution of [the] HCI field” (p. 277) consisting of three distinct developmental phases: the *Legacy Systems Age* (1959-1989), *Internet Age* (1989-2009), and *Pervasive Age* (2009-2019). These developmental stages demonstrate close relation to developments in computer systems over time, with research interests in the field transitioning from machine-oriented systems to human-oriented systems and progressing towards content-aware adaptive systems. Gurcan, Cagiltay, et al. (2021) thus, through content analysis of research in the field via topic modelling, convey an extensive overview of the field of Human-Computer Interaction, providing a greater understanding of the development and current state of HCI as a diverse, dynamic field of study and offering insight regarding the field’s future direction.

A considerable range of studies have reviewed the field of Child-Computer Interaction, presenting overviews of the current state of the field, and the development thereof, produced through an assortment of methods. Reviews (e.g., Giannakos, Papamitsiou, et al., 2020; Kawas et al., 2020) depict the field as diverse, addressing a broad array of themes of study, including topics related to specific technologies and application domains, particular user groups, theories, and methods, and dynamic, with research interests and priorities evolving throughout the field’s development. Whilst informative, such studies generally provide constrained representations of the field as consequence of methodological limitations, whereby methods utilised fail to accommodate one (or more) of the following forms of analysis: (a) large-scale; (b) inductive; or (c) content-related (Daenekindt & Huisman, 2020). Therefore, in order to support necessary reflection upon progress in, and critical dialogue concerning current state and future direction of, the field of Child-Computer Interaction, there remains a need for an extensive, empirically grounded mapping of the field. Topic modelling, overcoming the challenges and limitations encountered in previous studies, provides a means by which such a mapping of the field may be obtained.

2.3. Knowledge Construction in Child-Computer Interaction Research

Throughout recent years, an ongoing discussion has emerged within the Child-Computer Interaction community, reminiscent of established dialogue in neighbouring communities such as Human-Computer Interaction and Interaction Design, concerning the development of CCI as a field of research, or scientific community (Barendregt et al., 2017; Giannakos, Papamitsiou, et al., 2020). Reeves (2015) proposes that anxieties regarding status as an academic object, commonly centred around "disciplinary shape and how that shape relates to 'science'" (p. 73), may be characteristic of all 'new' research communities, with progression of aspects (or the entirety) of the field towards scientific disciplinarity perceived as addressing, or offering resolution to, these anxieties. Anxieties frequently contributing to discussion regarding the status of research communities such as CCI include concerns related to perceived *incoherence*, whereby the field demonstrates limited shared commitment to a certain set of problems or approaches through which such problems ought to be addressed, and *inadequacy*, whereby the field is (intellectually) inadequate when compared to established fields or disciplines and has yet to gain widespread respect or recognition amongst scientific communities, of the field (Reeves, 2015).

Discussion concerning the development, and status, of Child-Computer Interaction as a field of research, similar to dialogue in neighbouring fields, has unfolded along "multiple, interwoven threads" (Frauenberger, 2016, p. 342), prominent amongst which are the epistemology of the field – concerning the ways in which knowledge is produced and argued for, and thereby interwoven with concepts of rigour – and definition of the field as a scientific discipline – concerning the extent to which knowledge produced is cumulative, replicable, generalisable, and theoretically-informed, and practices and foci are stable and sustainable (Frauenberger, 2016; Reeves, 2015). Discourse within the CCI community addressing these threads has primarily concerned the construction of knowledge though design-oriented practices, traditionally a dominant approach to knowledge construction within the field (Barendregt et al., 2017; Höök & Löwgren, 2012), the (scientific) qualities of knowledge constructed therethrough, and consequences of such knowledge for the (scientific or academic) status of the community.

In response to perceived instability of the scientific foundations upon which the related field of Human-Computer Interaction developed as a tradition, the community, Frauenberger (2016) claims, sought to position methods and processes from design practices as a legitimate method of scientific enquiry (i.e., Research through Design [RtD]; Gaver, 2012; Zimmerman et al., 2007, 2010). Within the HCI field, the dominant approach to knowledge construction is “to design innovative interactive schemes and evaluate them empirically through more or less rigorous use studies” (Höök & Löwgren, 2012, p. 1), with the broad intentions of presenting a particular example of innovative designs (i.e., *instances*) and contributing to generalised understanding of human-computer interaction (i.e., *theories*). In addition to knowledge pertaining to particular instances (i.e., artefacts or situations) or theories, Höök and colleagues (Höök, Dalsgaard, et al., 2015; Höök & Löwgren, 2012) propose that design-oriented research practices may construct *intermediate-level* knowledge, of which there is a variety of forms (e.g., guidelines, *strong concepts*), which is “more abstracted than particular instances, yet does not aspire to the generality of theory” (Höök & Löwgren, 2012, p. 2). Child-Computer Interaction, inheriting, or paralleling development of, knowledge construction processes associated with HCI, similarly demonstrates prominence of, and concerns regarding, design-oriented research practices as an approach to knowledge construction (Barendregt et al., 2017; Yarosh et al., 2011).

Although argued to create opportunities for constructing knowledge more abstracted than particular instances (i.e., intermediate-level knowledge and theories), design-oriented research practices demonstrate a tendency within the CCI (and HCI) community to produce, and describe experiences and heuristics related to, novel solutions (i.e., paradigms, techniques, applications, or artefacts; Wakkary et al., 2015; Whittaker et al., 2000) and thereby typically contribute highly contextualised, situated knowledge related to particular artefacts or situations (i.e., *instances*).

Specific, novel design instances, variously described as *radical inventions* (Whittaker et al., 2000) (Whittaker et al., 2000) and *ultimate particulars* (Stolterman, 2008), are generally communicated to the Child-Computer Interaction community through *artefact-centred* (Barendregt et al., 2017) papers, which describe the design and evaluation of the particular technological artefact.

Investigating the prevalence of artefact-centred papers presented at the IDC conference, a primary venue of the Child-Computer Interaction community, through content analysis of 260 full papers published in proceedings from 2003 to 2016, Barendregt et al. (2017) found a considerable portion (42%) of papers reviewed presented the design and evaluation of artefacts (i.e., artefact-centred). Similarly, in Yarosh et al. (2011) earlier review of IDC full papers published between 2002 and 2010, 43% of papers were identified as focusing on the design, and often evaluation, of novel artefacts (i.e., systems or innovations) for children, with 8% of papers reviewed indicating technological novelty as sufficient, in itself, to warrant further investigation and authors surveyed admitting that their work, on occasion, explored emerging technologies for the sake of novelty. Notably, Kawas et al. (2020), in a more recent review of IDC full papers published between 2011 and 2019, found a substantial decrease in the proportion of papers contributing novel artefacts (23%), suggesting a declining trend in the tendency to produce artefact-centred contributions as the field of CCI develops, and identified an increase in research informed by theories from a diverse set of disciplinary sources. It ought to be noted, however, that these studies have exclusively considered research published in the proceedings of the IDC conference, which, given explicit interests in Interaction Design (IxD), may be more receptive to, or place greater emphasis upon, research concerning novel technology design than other publication venues associated with the field (e.g., IJCCI). Barendregt et al. (2017) suggest that the field's proclivity for undertaking such artefact-centred research is, in part, attributable to a tendency to pursue, and capitalise on, emerging technological developments, whereby researchers explore the possibilities afforded by technological advancements as they emerge at the expense of existing, established technologies (Giannakos, Horn, & Rubegni, 2020). Thus, design (and evaluation) of artefacts appears to be "where the action is" (Card et al., 1983,

p. 8) in Child-Computer Interaction, with research focusing on, and describing, the design and evaluation of novel solutions which “push the technology envelope” (Whittaker et al., 2000, p. 77).

Whilst design-oriented practices constitute a prominent paradigm of enquiry within Child-Computer Interaction, with design processes argued to generate insights of a particular kind and “bring about distinct ways of knowing” (Höök, Bardzell, et al., 2015, p. 34) amongst researchers engaged therein, Höök, Bardzell, et al. (2015) note that contributions to the field produced therethrough may appear as a “string of designs, one after another” (p. 34), which fail to generate knowledge which meaningfully builds upon prior insights or contribute to development of generalisable theories (Gaver, 2012; Stolterman, 2008). Gaver (2012) asserts that theories produced through such research are typically “provisional, contingent, and aspirational” (p. 937). Reduced generalisability, or extensibility, of knowledge constructed through design-oriented practices within the field of CCI may be evident in the lower impact of artefact-centred papers, with Barendregt et al. (2017) identifying significantly lower impact, as measured by citation count, of artefact-centred papers reviewed relative to other kinds of papers ($t_{(258)} = 2.17$, $p = 0.03$). Although CCI research increasingly demonstrates grounding (to varying degrees) in, and explicit reference to (see Kawas et al., 2020; Yarosh et al., 2011), theories, Kawas et al. (2020) indicate that theory seldom constitutes the primary contribution of CCI research papers (5% of IDC papers) and Giannakos, Papamitsiou, et al. (2020) observe an absence of common author assigned keywords related to theory or intermediate-level knowledge amongst CCI research papers, contending that the apparent paucity of research contributing to the development of intermediate-level knowledge and theory may hinder progress, and the achievement of cohesiveness and universality, in the field.

Although Barendregt et al. (2017) acknowledge the value of exploring the design space through design-oriented, and artefact-centred, research, which may generate innovative technology designs, demonstrate the value of designed artefacts for various groups of children, and inspire further research, designs and artefacts produced therethrough are nonetheless regarded as largely “unique, stand-alone products occurring as separate points in the vast design space of possible interactive products and systems aimed at children" (p. 7). Whilst design and investigation of novel technologies is pivotal to progression of Child-Computer Interaction, researchers have cautioned that, in constantly "striking off in new directions" (Whittaker et al., 2000, p. 7) analogous to "nomads chasing water and grasslands" (Y. Liu et al., 2014, p. 3560) and in so doing failing to build upon existing knowledge or contribute generalisable knowledge which others may subsequently develop, such research practices are likely to impede accumulation of knowledge within the community and consolidation of the field.

Emphasis on novel designs (i.e., artefact-centred research), Whittaker et al. (2000) suggest, comes at the expense of establishing, and maintaining, common research foci within the community. A lack of common foci in the community impedes development of cumulative knowledge, and consequently produces limited systematic information (i.e., body of robust knowledge) related to various major themes or problems, such that "there is no clear consensus about user tasks, no commonly held view of outstanding issues and problems, and no accepted success metrics" (Whittaker et al., 2000, p. 79), with focus on real, shared problems, comparison of results, and identification of favourable (rather than merely different) solutions consequently challenging. Despite a lack of cumulative knowledge, however, the community is "encouraged to try out even more radical solutions without pausing to do the analysis and investigation required to gain systematic understanding" (Whittaker et al., 2000, pp. 80–81), continually opening up, but failing to 'settle' through further study, new 'conceptual territory'. Thus, in pursuing novel designs, or radical inventions, without sufficient preceding empirical analysis or appropriate theoretical grounding, the community may propose novel solutions to issues which do not constitute major problems and, in so doing, neglect major problems experienced by children and fail to achieve the 'critical mass' of knowledge required for theory development (Whittaker et al., 2000).

Studies (e.g., Blackwell, 2015; Y. Liu et al., 2014) of Human-Computer Interaction research have identified such a lack of convergence and dearth of accumulated knowledge within the field, observing that "when a new technology comes along it seems researchers start from scratch leading to relatively isolated research themes" (Y. Liu et al., 2014, p. 3560) which are underdeveloped, producing fragmentation within the field. Notably, however, applying a similar approach to that which Y. Liu et al. (2014) employed in mapping the field of HCI, Giannakos, Papamitsiou, et al. (2020) identified evidence within CCI of a number of internally coherent, central themes derived from well-established (i.e., accumulated) knowledge applicable to various areas of study in the field (i.e., generalisable), including themes of study related to *coding*, *making*, *education*, *play*, and *child-robot interaction*. Thus, despite evident prevalence of design-oriented practices in CCI research (see Barendregt et al., 2017; Kawas et al., 2020; Yarosh et al., 2011), several common, underlying themes have formed, intimating that research within the field, including that presented as artefact-centred, may, in addition to engaging with isolated and underdeveloped themes, frequently contribute to theory or intermediate-level knowledge related to these broad areas.

Apparent limited uniformity of theory, method, and instrument apparent in Child-Computer Interaction is regarded as unsettling, prompting aforementioned anxieties amongst the community, when compared to formal accounts of established (scientific) fields or disciplines (Reeves, 2015). Therefore, whilst "first-order knowledge is crucial to design practice" (p. 34), Höök, Bardzell, et al. (2015) argue that such knowledge ought not overshadow the necessity for articulation of other forms of knowledge (i.e., theory and intermediate-level knowledge) which may be produced through, or extracted from, design-oriented practices. Given evident issues arising from knowledge processes prevalent within the field hitherto, researchers (e.g., Y. Liu et al., 2014) have debated prescription of standards of order within, or standardisation of, the field – that is, whether to "stem the tide and impose some order and rules or let the field continue to expand in an unruly fashion" (Rogers, 2012, p. 2) – in order to cohere and consolidate knowledge therein (Reeves, 2015). Such an agenda calls for establishment of criteria related to design-oriented research practices, including development of "agreed methodological standards, hand in hand with a firm theoretical foundation" (Gaver, 2012, p.

937), which would facilitate assessment of contributions in a rigorous manner and accommodate cumulative development of knowledge.

Others (e.g., Antle & Hourcade, 2022; Gaver, 2012), however, have cautioned such “impulses towards convergence and standardisation”, contending that the Child-Computer Interaction community ought to “take pride in its aptitude for exploring and speculating, particularising and diversifying, and - especially - its ability to manifest the results in the form of new, conceptually rich artefacts” (Gaver, 2012, p. 937). Gaver (2012) asserts that calls for agreed-upon standards and formalisation of theories and methods are premised on the assumption that convergence of knowledge within the field constitutes a prerequisite for cumulative development of understanding and that the production of “an endless stream of design examples is an inadequate basis for its pursuit” (p. 938). Arguing to the contrary, researchers (e.g., Antle & Hourcade, 2022; Blackwell, 2015; Giannakos et al., 2022) maintain design-oriented practices and artefact-centred research are ”at the core of how design research should operate” (Gaver, 2012, p. 938) and indispensable to theory, with artefacts – corresponding to novel designs (e.g., prototypes, materials, or procedures) – embodying design choices and qualities, such as functionalities and affordances, in a manner unattainable through written accounts, and contending that the role of theory ought to be to annotate, rather than replace, design examples. Similarly, Blackwell (2015) asserts that the related field of Human-Computer Interaction, driven by the expectation, and serving as a catalyst, of innovation, is “not about static knowledge, but ways of deploying and engaging with knowledge in a technological setting” (Blackwell, 2015, p. 511; Frauenberger, 2016; Whittaker et al., 2000).

While advocating greater application of theory within CCI research and asserting the need for Child-Computer Interaction research to demonstrate its maturity and ability to develop knowledge which goes “beyond an artefact” (Giannakos et al., 2022, p. 7), Antle and Hourcade (2022) contend that an excessive focus on theory is unlikely to produce practical outputs which contribute meaningfully to children’s lives, an ethical imperative to which the field generally adheres, and suggest that insistence on application of theoretical frameworks in research may result in “forcing good ideas into theories that do not fit, or even favouring research mainly based on whether it applies a popular theory correctly rather than on whether it has a positive impact on children” (p. 7). Antle and Hourcade (2022) therefore propose that, as a hybrid of design and technology development traditions, CCI ought to value “theory-driven research alongside artefact-centric innovation” (pp. 7-8).

Shortcomings and concerns regarding application of theory within Child-Computer Interaction may be, in part, attributable to the manner in which theory has been employed throughout CCI research. Antle and Hourcade (2022) contend that the community has largely employed theory as “an umbrella to legitimize their research rather than as a means to investigate theoretical mechanisms underlying child–computer interaction in order to contribute to theory validation and generation” (p. 7). Such an assertion aligns with findings of Beck and Stolterman (2016) investigation of the manner in which researchers utilise theory in design research, which indicate that theory is primarily applied as a contextual tool, serving to situate research questions within a particular discourse. Predominance of use of theory as a contextual tool is, Beck and Stolterman (2016) propose, a consequence of greater perceived value of such application amongst researchers, commonly regarded as bolstering implicit claims to legitimacy, validity, or authenticity, and thereby increasing likelihood of publication. Conversely, Beck and Stolterman (2016) note a dearth of, and limited perception of value in, application of theory as an analytical or methodological tool, despite the potential utility of such theory in progressing research “beyond observation and interpretation into the realm of shareable knowledge” (p. 126). As consequence of the evident manner in which theory is utilised and thereby developed in design research, Beck and Stolterman (2016) argue that accomplishment of any form of cumulative knowledge production therethrough is unlikely. However, providing a means through which knowledge may be structured, evaluated, and shared, application of theory as an analytical tool in interpreting findings and, as suggested by Gaver (2012), annotating design artefacts may, in particular, support progression beyond an apparent succession of unique instances to broad explanatory principles applicable to various contexts and problems (Beck & Stolterman, 2016; Friedman, 2003; Skovbjerg et al., 2022).

Gaver (2012) argues that, in describing influences, discussing rationales for design decisions, and articulating assessments of design outputs and their efficacy, researchers engage in "a form of implicit conceptual work" (p. 938) through identification of consequential issues and aspects, dimensions of similarity, and criteria for design choices and success. To the extent that such conceptual constructs are articulated, or abstracted, in generalisable forms and may be applied in multiple design instances, they may themselves come to resemble, or constitute, theories within the field (Gaver, 2012; Giannakos et al., 2022; Sutcliffe, 2000). Artefact-centred papers are thus regarded as offering primary knowledge and 'data-points' necessary to progress generalised knowledge and insights within CCI (Giannakos et al., 2022). Perceived lack of consensus or convergence within the field which persists in spite of such asserted contributions to generalisable knowledge, Garver (2012) posits, may be attributable to a tendency within research to focus on controversies and debates related to emergent and unresolved findings rather than restate agreed fundamentals of the field (T. S. Kuhn, 1970), with a greater "shared sense of understanding guiding research through design" (p. 942) than often apparent only perceptible when viewing the field from a distance (rather than when experiencing from within).

Design-oriented research practices, whilst commonly applied in constructing highly contextualised knowledge related to particular artefacts, are thus nonetheless regarded as providing opportunity for construction of knowledge which is more abstracted than specific instances but does not aspire to the scope of generalised theories (i.e., intermediate-level knowledge; Höök, Bardzell, et al., 2015; Höök & Löwgren, 2012; Stolterman & Wiberg, 2010). Rather than stopping at performing design work and detailing resultant instances, researchers may 'tease out' intermediate-level knowledge from design-oriented research practices through engagement in reflection, analysis, abstraction, articulation and elaboration (Höök & Löwgren, 2012). Giannakos et al. (2022) propose that such work, constructing intermediate-level knowledge within Child-Computer Interaction, supports the development of models, theories, and guidelines which may guide future design of interactive artefacts for children, thereby closing “the gap between theory and design/practice” (p. 7) and accelerating progress in the field. Various forms of intermediate-level knowledge have been proposed, differing in how they bring forth, articulate, and manifest knowledge, as well as how and why such knowledge is intended to be used (e.g., generative, evaluative, inspirational, or critical purposes), including strong concepts, annotated portfolios, and bridging concepts (Barendregt et al., 2017; Höök, Bardzell, et al., 2015; Höök & Löwgren, 2012).

The primary challenge in developing such intermediate-level knowledge, Höök, Bardzell, et al. (2015) indicate, is ensuring that such knowledge offers utility to others (i.e., researchers, designers, etc.) and, more practically, is understandable or interpretable to the intended audience (e.g., the broader scientific community), identifying a need for development of “formats for communicating, contesting, and developing this knowledge in academic fora” (p. 34). Following calls for the development of higher-level (i.e., generalisable) knowledge within Child-Computer Interaction in Markopoulos’s keynote at the 2016 IDC conference, there have been growing efforts to cultivate intermediate-level knowledge in the community, including Barendregt et al.'s (2017) formulation of strong concepts of *head-up gaming*, *collective storytelling*, and *remote sensing* based on analysis of often-cited artefact-centred IDC papers, organisation of a workshop exploring establishment of intermediate-level knowledge in CCI (Barendregt et al., 2018), and forthcoming publication of a journal [*Interaction Design and Architecture(s)*] special issue concerned with research related to intermediate-level knowledge in CCI[3]. In order to further nurture works advancing the community through contribution to intermediate-level knowledge therein, Giannakos et al. (2022) suggest raising awareness amongst researchers that such works will receive fair treatment from publication venues

[3] Call for submissions: http://ixdea.uniroma2.it/inevent/events/idea2010/index.php?s=102&link=call40

(and reviewers) through dedicated calls from journals and explicit requests for such contributions from the community's main venues (i.e., IDC, IJCCI).

Ongoing discussion has emerged within the Child-Computer Interaction community throughout recent years concerning the development, and status of, Child-Computer Interaction as a field of research (Barendregt et al., 2017, 2018; Giannakos et al., 2022). In particular, discussion has addressed knowledge construction processes in CCI, identifying a prominence of design-oriented research practices and artefact-centred contributions (Barendregt et al., 2017; Jensen & Skov, 2005; Yarosh et al., 2011) which, whilst regarded a pivotal component of design research and argued as providing opportunity for construction of more abstract knowledge (i.e., intermediate-level knowledge), typically produce highly contextualised, situated knowledge related to novel solutions. Considerable debate remains concerning the value of design-oriented practices and artefact-centred contributions and convergence and accumulation of knowledge within the field (Antle & Hourcade, 2022; Barendregt et al., 2017). Nonetheless, empirical literature investigating knowledge construction processes within CCI remains exiguous and limited in scope, and generally neglects researchers' perspectives thereon.

2.4. Summary

Following review of extant literature related to the development, structure, and construction knowledge within the field of Child-Computer Interaction, a number of notable gaps and shortcomings have been identified therein. Prior reviews of the field, mapping the structure thereof, exhibit limited scope due to practical limitations associated with methods and fail to provide representations which adequately account for the heterogeneity of research papers in CCI. Furthermore, whilst considerable discussion and debate has emerged in recent years within CCI concerning processes, and consequences, of knowledge construction therein, empirical investigation remains scant. Evident limitations throughout extant literature may impede, or misinform, the CCI community's reflection upon, and critical dialogue concerning, the development, current state, and future directions of the field, as it continues to form a distinct identity. The following chapters will articulate the current study, which seeks to address these identified gaps in literature.

Chapter Three: Conceptual Framework

In order to investigate the development, and current state, of knowledge, the processes and practices through which such knowledge is (re)produced and transformed, and their consequences, within the field of Child-Computer Interaction, the current study implements a conceptual framework drawing upon the theoretical underpinnings and assertions of the *sociology of knowledge approach to discourse* (SKAD) advanced by Keller (2005, 2006, 2011, 2018). SKAD accommodates such investigation through linking arguments from the respective traditions of social constructivism – specifically Berger and Luckmann's (1966) *sociology of knowledge* – and Foucauldian discourse (Foucault, 1972, 1980), elaborating a theoretical framework which articulates a dialectic relationship between agentic social actors and discourses as structuration contexts (i.e., structured and structuring structures; Bourdieu, 1984). The present chapter details the theoretical underpinnings, assertions, and affordances of Keller’s sociology of knowledge approach to discourse, and elaborates the conceptual framework derived therefrom implemented in this study.

3.1. Sociology of Knowledge Approach to Discourse

The *sociology of knowledge approach to discourse* (or *Wissenssoziologische Diskursanalyse*; SKAD), a research programme developed in the late 1990s by Keller (2001) which has been widely employed amongst social scientists undertaking discourse research in German-speaking contexts (Keller, 2011, 2013), offers a framework through which processes and practices related to the production and circulation of knowledge at the level of institutional fields – such as scientific fields or the public domain – may be analysed and understood. SKAD examines the ongoing and heterogenous social practices and processes of discursive construction, circulation, and transformation of symbolic orders – which occurs in the form of conflicting social knowledge relationships and competing politics of knowledge – and their social consequences or effects (Keller, 2006, 2013). Embedding a Foucauldian discourse perspective (Foucault, 1972, 1980) in the sociology of knowledge theory of Berger and

Luckmann (1966, 1991), SKAD argues for a consistent theoretical and methodological grounding of a genuine social sciences perspective on discourse which is concerned with reconstruction of the processes which occur in social construction, objectivization, communication and legitimisation of meaning structures, or orders of knowledge, at the institutional or social (collective) actors level, analysing the "knowledge side and the 'power effects of discourse', the infrastructures of discourse production as well as the institutional effects and 'external' impacts on practice emerging out of discourses meeting fields of practices" (Keller, 2011, p. 63) therethrough.

It ought to be clarified that the concept of '*knowledge*' invoked here, originating within the context of social constructivism, refers not only to the contents of socially recognised and confirmed positive knowledge, but the entirety of all social systems of signs, including the symbolic orderings and institutionalised stocks of knowledge constituted by these systems which mediate respective historical persons' interpretation and shaping of the surrounding reality (Jäger, 2001; Keller, 2011, 2012). Individuals derive knowledge from the respective discursive contexts in which they are involved and contribute to the social construction of knowledge through an ongoing activity, performance, and process (Keller, 2006). Collective stocks of knowledge are realised as institutions, organisations, texts, and a broad variety of '*materialities*' (e.g., practices, artefacts; Keller, 2006).

3.1.1. Berger and Luckmann's Sociology of Knowledge

Berger and Luckmann, in their seminal work *The Social Construction of Reality* (1966), proposed a synthesis of various strands of sociology of knowledge approaches, including Marx, Durkheim, Mead, and Schütz, developing "the theoretical groundings of a comprehensive sociological analysis of the social production and circulation of knowledge" (Keller, 2006, p. 226). Commonly referred to as *Hermeneutische Wissenssoziologie* (hermeneutic[al] sociology of knowledge; Hitzler et al., 1999) in German contexts, Berger and Luckmann's sociology of knowledge theory construes society as both an "objective" and "subjective" reality, realised through all forms of knowledge, which is understood as an ongoing dialectical process comprised of social knowledge-production (i.e., externalisation), institutional stabilisation of supplies of knowledge (i.e., objectivation), and knowledge acquisition (i.e., internalisation; Berger & Luckmann, 1966; Eberle, 1993; Keller, 2011). Here, it should be noted that the term 'knowledge' is defined by Berger and Luckmann (1991) as "the certainty that phenomena are real and that they possess specific characteristics" (p.13) and interpreted by Keller (2012) as referring to "all kind of symbolic orderings and institutionalized symbolic orders (including common sense knowledge, religion, theory, ideology and scientific knowledges, and so on)" (p.55).

The sociology of knowledge perspective forwarded by Berger and Luckmann encompasses processes by which knowledge is generated, objectified, and sedimented within institutions and stocks of knowledge, constituting an 'objective reality', as well as mechanisms by which individual actors, more or less creatively, adopt and appropriate – that is, internalise and subsequently reproduce, and occasionally transform - these collective knowledge patterns through diverse socialisation processes (Keller, 2011; Schütz & Luckmann, 1973). Specific, subjective stocks of knowledge of individuals, comparable to Bourdieu's habitus (Bourdieu, 1975, 1990, 2004), are therefore understood as "inconsistent, heterogeneous, complex sedimentations and actualizations" (Keller, 2011, p. 50) of socio-historically generated and established collective stocks of knowledge, which are, themselves, not the intentional outcome of any individual effort but rather formed through, and an effect of, everyday processes of social interaction, habitualisation, and routinisation. Berger and Luckmann emphasise the role of language and daily "conversation machinery" – themselves regarded as typified and typifying concepts – in such (co-)construction of a shared social reality, with knowledge "typified and 'realized' through interactions and socially objectified in differing process of institutionalization" (Keller, 2011, p. 44).

In elaborating this theoretical foundation which considers, through a dialectical perspective, both institutional knowledge processes and life-world adoption and usage of stocks of knowledge, Berger and Luckmann temporalize and neutralise longstanding tensions and antagonisms between structure and actions, construing structures (i.e., institutions) as the historically situated (side) effects of social actors' practices and interactions and social actors' agency and creativity as constituted by a "socio-historical *a priori*" (i.e., existing social contexts; Keller, 2012, p. 56, emphasis in original). Berger and Luckmann (1991) therefore argue that the analysis of the role of knowledge in the dialectic of individual and society necessitates a "systematic accounting of the dialectical relation between the structural realities and the human enterprise of constructing reality" (p. 208).

Whilst Berger and Luckmann's sociology of knowledge theory offers a relatively comprehensive conception of society as symbolic order and ordering, incorporating institutional processes and structures and actors' agencies, as well as the interplay therebetween, in social relations of knowledge, Keller (2006, 2012; Ullrich & Keller, 2014) argues that adoptions of the Berger and Luckmann tradition have prioritised microanalysis of knowledge, directing its interest towards ethnographies of individuals' "small life-worlds" (Luckmann, 1970) and actors' interpretations of their everyday activities. In so doing, sociology of knowledge has largely neglected consideration of the social meso- and macro-conditions in the constitution and circulation of knowledge, despite such phenomena representing aspects of a comprehensive sociology of knowledge perspective (Keller, 2013). In order to overcome such reductionist adoptions of the Berger and Luckmann tradition and accommodate more detailed exploration of processes of institutionalisation and transformation of symbolic orderings often neglected therein, Keller (2006, 2011, 2018) proposes an extension of the sociology of knowledge theory, elaborating on the institutional processes and structures of circulation of knowledge, through integration of Foucauldian concepts of discourse.

3.1.2. Foucauldian Conception of Discourse

In his seminal book *The Archaeology of Knowledge*, Foucault (1972) proposes a theoretical framework concerned with *discourse*, conceived as "historically situated real social practices, not representing external objects but constituting them" (Keller, 2012, p. 53). Discourses are constituted by socio-historically situated performative statement practices inscribed with meaning (termed *statements*, or *énoncés*), or "ways of constituting knowledge, together with the social practices, forms of subjectivity and power relations which inhere" (Weedon, 1987, p. 108) in and between such statements (Foucault, 1977, 1984). Foucault (1972) regards discourse, therefore, as concerning what can be said and thought, as well as who can speak, when, and with what authority. Foucault (1972) asserts the materiality of discourse, whereby discourses are manifested and exist as concrete social practice through various linguistic actions and communicative processes undertaken by social actors throughout everyday life, thereby finding expression within documents, oral and written language, images, and general usage of signs and symbols (Keller, 2011; Pitsoe & Letseka, 2013).

Statements, in which discourses are more or less comprehensively actualised, may be differentiated and individuated according to a single system of formation, defined on the basis of a set of semantic relations between statements. Foucault (1972) applies the term *discursive formation* to describe "the general enunciative principle that governs a group of verbal performances" (p.117), as well as refer to the particular discourse governed by this principle in which a group statements share patterns of concern, perspectives, themes, or concepts. Discursive formation thus refers to the ways in which statements may be organised with respect to each other (Radford, 2003). A function of discursive formations, discursive practices are sets of anonymous and historical rules with which statements must comply in order to be recognised and privileged as reality or truth, thereby defining the framework within which enunciative functions are exercised and delimiting the boundaries of discourse through dictating what can be said and how (Foucault, 1972; McHoul & Grace, 1993). Discursive fields are understood as social arenas, constituted around contested issues, problematisations, and truth claims, in which discourses are in reciprocal competition with one another, creating the "effects of truth" through organising ideas, images, and signs and symbols into both a "discipline", or body of knowledge, and associated "disciplinary practices", or techniques of social control (Foucault, 1980; Kroll-Smith & Gunter, 2005).

Consequently, the term ‘discourse’, from a Foucauldian perspective, characterises a quantity of dispersed statements produced in different places and formed according to the same rule-system which may “therefore be attributed to one and the same discourse and constitute its objects” (Keller, 2013, p. 46). Rule-systems associated with discourses - which define enabling and exclusion criteria, according to which statements constituting a discourse are formed - do not refer to linguistic-grammatical patterns of language use, but rather the semantic level of meanings and institutionally embedded practices of discourse production (Keller, 2013). However, Jäger (2001) notes that discourses are inevitably intertwined and entangled, comprising a complex “discursive milling mass” (p.35). Discourse analysis, therefore, endeavours to disentangle discourses and is concerned with the reconstruction of discourses’ associated rule-systems – specifically, the “institutionally-practical and symbolically-semantic scarcity mechanisms which lead to the occurrence of specific statements in particular places” (Keller, 2013, p. 46).

Discourses are pervaded by, embedded within, and produce power effects in conflict-ridden networks of social actors and knowledge systems, such that Foucault addresses discourses as *battle fields* which involve power struggles concerning, and consequent shifts in, the enunciations of discourse regarded accepted as legitimate (Foucault, 1982; Keller, 2011; Wells, 2004). Social arenas constituted around contested issues, truth claims, and “competing ways of giving meaning to the world and of organizing social institutions and processes” (Weedon, 1987, p. 34), comprised of conflicting and contradictory discourses, are termed *discursive fields* (Foucault, 1972). Foucault (1972) asserts that shifts in legitimate discourse, which establish what is accepted as ‘truth’, are functions of shifts in power relations, with those enunciations privileged as ‘truth’ consequently liable to change with time and place. Thus, Keller (2011) argues, discourses are “power structures; discursive conflicts are powerful struggles about the power of interpretation and action” (p. 54).

External ‘power effects’ of discourses are realised and exerted through *dispositifs* (commonly translated as *apparatus*; see Foucault, 1980), conceived as the material, cognitive, and normative infrastructure of discourse production and the infrastructure of discourse implementation, which mediate between discourses and fields of practice (Keller, 2013). Such dispositifs are established by social actors who mobilise, and are mobilised by, a discourse, and may contribute to the materialisation and reproduction of a discourse and act as a means through which a discourse's power effects, by which it intervenes in the world, may be realised.

Discourses, however, do not speak for themselves, but are rather realised by social actors through historically situated processes of interaction and institution building, and communicative actions within pre-existent social fields of practice and institutional structures (Keller, 2011). Actors, therefore, formulate communicated components from which discourses emerge and unfold, with actors' discursive practices oriented according to available resources and established rules associated with the particular fields of discourse (Keller, 2013). Despite this acknowledgement of social actors in (re)producing discourse through discursive practices, Foucault's theory of discourse has been subject to criticism due to its perceived neglect of the agency of social actors in so doing, implying that rules and resources available as discourses act to deterministically regulate social actors' discursive practices (Jäger, 2001; Ullrich & Keller, 2014). Keller (2011) argues that in order to satisfactorily explain the (more or less) creative implementation of discursive practices, discourse theories and research must account for the agency of actors. Through embedding Foucauldian ideas and concepts within the sociology of knowledge theory of Berger and Luckmann (1966, 1991), Keller's (2005, 2006, 2011) sociology of knowledge approach to discourse proposes an approach to discourse research which recognises the agency of actors in processing and production of statements.

3.1.3. Integration of Sociology of Knowledge and Foucauldian Discourse

Within the sociology of knowledge approach to discourse proposed by Keller (2005, 2006, 2011, 2018), emulating Berger and Luckmann's (1966) conception of the manifestation of institutions through social processes of institutionalisation, the processing of discourses through society is formulated as "a dialectical interplay between actors producing statements and the pre-given as well as emerging structurations and sociohistorical means they have to draw upon" (Keller, 2011, p. 52). Discourses are thus construed as denoting structuration contexts – that is, considered as simultaneously structured (by prior processes of structure-formation) and structuring (subsequent discursive events) structures (Bourdieu, 1984) - which serve as the bases of disseminated discursive events, shaping social practices of enunciation (Keller, 2006, 2011). The relationship between discourse and discursive events, therefore, is asserted as corresponding to that between structure and individual action as articulated in Giddens (1984) concept of *duality of structure*, whereby, through a recursive relationship, discourses exist only insofar as they are actualised by social actors, whilst simultaneously forming the precondition for such actualisation. Adopting the assertions of Giddens and Bourdieu in specifying such a structure, discourses are conceived as "simultaneously both an expression and constitutional prerequisite of the social" (Keller, 2011, p. 52) – that is, both outcome and medium of social structures and actions (Fuchs, 2003; Morrison, 2005). In conceiving discourses as *structured* and *structuring* structures and elaborating a dialectic relationship between actors' discursive practices and the discourse structures which frame them, the sociology of knowledge approach to discourse proposes a perspective on discourse which reconciles and bridges agency- and structure-oriented traditions in sociology.

Keller (2011, 2012) clarifies that, whilst regarded as (co-)constituted by the existing structuring of discursive orders or formations, social actors in no way act as mere "marionettes of discourses" or "cultural dopes" (Garfinkel, 1967; Lynch, 2012), but rather as "lively, interested producers of statements, as articulators with more or less strong resources and creativity potentials" (Keller, 2011, p. 52). Social actors – regarded as "*socially configured incarnations of agency, according to the socio-historical and situational conditions*, who more or less obstinately interpret social knowledge supplies as 'offered rules' in their everyday interpretation activities" (Keller, 2011, p. 54, emphasis in original) – are understood to actively utilise the rules and resources available as discourses in their discursive practice, interpreting, articulating, and (co-)producing them for practical needs, strategies, and contexts. Thus, social actors' discursive practices are not a direct effect of structural rules associated with discourses, but rather a consequence of actors' active interpretation and articulation of discourses as orientation models, thereby representing a creative and performative achievement. Discourses, which are realised through social actors' communicative actions, are defined as manifest, observable, and describable social practice, expressed in various forms, including written and oral language and usage of signs (Keller, 2011).

Discourses, as such, are "'brought to life' in historically situated processes of interaction and institution building by social actors, and their communication (inter-)acts within pre-existing social fields of practice and institutional structures" (Keller, 2011, p. 64). In so doing, social actors actualise discourse structures in more or less varied forms through transferring discourse structures into real events and thereby modifying or adapting these structures to the conditions of a given situational context. Thus, contrary to common Foucauldian approaches to discourse analysis, the sociology of knowledge approach to discourse "recognises the importance of socially constituted actors in the social production and circulation of knowledge" (Keller, 2006, p. 223).

The sociology of knowledge approach to discourse proposes that discourse structures are reproduced and transformed by social actors "through the contingency of historically situated conditions and concrete action while they, with more or less excitement and competition, pursue their respective daily routine" (Keller, 2011, p. 53). Discourses produced through these processes are not derived from individual actors, but rather "from the structuring effect of collective practices under competitive conditions and power relations" (Engelhardt, 2015, p. 135), and are thereby continuously (re)constituted through the aggregated effects of social actors' discursive practices. Although social actors, in actualising (i.e., transferring into a real event) discourse structures through discursive practices during individual discursive events, are conceived as modifying and adapting (i.e., transforming) discourses to varying extents, Keller (2011) qualifies that qualitatively significant transformations in discourses, due to conditions of *institutional inertia* to which they are subject, are seldom attributable to individual discursive events, but rather "originate out of the sum of variations" (p.53).

Furthermore, the sociology of knowledge approach to discourse adopts Foucault's perspective on discourses as "practices of power/knowledge", regarding discourse structures as power structures and discursive practice as exercising power (Jäger, 2001; Keller, 2011, 2012). In addition to consideration of the knowledge configuration (i.e., structuring of contents) of discourses and infrastructures of discourse production, SKAD investigates the power effects of discourses and the institutional effects on practice emerging through interaction between discourses and fields of practice (Keller, 2011). *Power effects*, in the context of SKAD, refer to both intended and unintended consequences, or changes in the world, associated with the social processing of discourses. External power effects of discourses – here, the changes introduced or elicited in fields of practice addressed – are exerted, or realised, through dispositifs, which represent infrastructures of discourse production and "apparatuses of world intervention" (Keller, 2011, p. 60), mediating between discourses and fields of practice. Through realising power effects, dispositifs may act to institutionally reinforce, or exclude, certain utterances, actions, and perspectives (Jäger, 2001).

Thus, within the sociology of knowledge approach to discourse, through integration with Berger and Luckmann's (1966) sociology of knowledge theory, which provides a theoretical foundation considering both institutional knowledge processes and life-world adoption and usage of stocks of knowledge, the Foucauldian programme of analysing discourse is expanded, through the introduction of a sociological conception of actors and practices, to acknowledge and consider the influence of participating social actors and their actions within a discourse, as well as societal arenas of discursive disputes (Engelhardt, 2015; Keller, 2011). Engelhardt (2015) identifies the resultant perspective on the relationship between social actors and discourse, in which individual "actors do not get lost within the discursive struggle" (p.137) but rather play a crucial role in (co)constituting discourses through discursive practices (which are not restricted to elements of dispositifs), as foremost amongst the distinct advantages associated with SKAD. Reciprocally, the Foucauldian perspective accounts for the historical and collective dimensions of knowledge and knowledge construction practices, thereby extending the field of sociology of knowledge to consider social regimes and politics of knowledge (Keller, 2006). Thus, in adopting Foucault's general proposals concerning discourse as a social phenomenon and anchoring them in the framework of Berger and Luckmann's sociology of knowledge both frameworks are transformed and extended, presenting cohesive theoretical groundings, methodological implications, and functional devices for a sociology of knowledge approach to discourse.

Hence, the sociology of knowledge approach to discourse moves beyond questions of language in use, bridging the semiotic and semantic levels of discourse and the level of discursive practices, and is concerned with the "correlation between sign usage as a social practice and the (re)-production/transformation of social orders of knowledge" (Ullrich & Keller, 2014, pp. 11–12). SKAD thereby addresses sociological interests, analysing social relations and conventions, and structuration of symbolic ordering (i.e., politics of knowledge), as well as the symbolic structuring of social orders (i.e., discursive construction of reality; Keller, 2006, 2011). In so doing, SKAD addresses questions related to both knowledge configurations and infrastructures of discourse production, ranging from micro-levels of discursive and non-discursive practices to more general (i.e., meso- and macro-level) issues related to the structuring of contents of discourses, material 'foundations' and artefacts of utterance production processes and the power effects which emanate therefrom, and processes of discourse (re)production and transformation (Keller, 2006, 2013). As an approach to analysis of knowledge production and circulation, whilst not pretending to offer a 'true' Foucauldian application of discourse research, SKAD, Keller (2006) contends, provides an approach which is closer to the original Foucauldian programme of analysing discourse as practices of power/knowledge and meaning production than the established focus on language in use.

3.1.4. Analysis of Discourse

Following Foucault, discourses are understood, within the sociology of knowledge approach to discourse, as analytically definable ensembles of distinguished and interrelated structured practices of sign usage and meaning attributions which are studied in regard to common stabilised patterns of meaning in a collective body of knowledge (Engelhardt, 2015; Keller, 2006). Discourses are therefore examined as "performative statement practices and symbolic orderings, which constitute reality orders and also produce power effects in a conflict-ridden network of social actors, institutional dispositifs, and knowledge stocks" (Keller, 2012, p. 59). SKAD, as claimed by Foucault, maintains the materiality of discourses, finding concrete manifestation in linguistic, pictorial, practicable, structural, and material forms (Keller, 2011, 2013).

The sociology of knowledge approach to discourse is concerned with, and considers, various analysis dimensions of social relations of knowledge, including the structuring of the contents of discourse, the material infrastructure of discourse production, the power effects emanating therefrom, the levels of discourse context (macro-, meso-, and micro-level), and the general processes of discourse reproduction and transformation from historical, spatial, and social perspectives (Keller, 2011). These dimensions are explored through analysis of "*dispositifs* (assemblages of actors, practices, things) performing discourse production" and "the objectivizations and consequences of discursive claims manifesting themselves as artefacts, social practices, communication processes and subject positions" (Keller, 2011, p. 49, emphasis in original). In order to accommodate such analysis, sociology of knowledge analysis of discourse "places various data types and interpretation steps in relation to one another" (Keller, 2011, p. 62) through various methods of analysis, including textual analysis, case studies, observation, and focused ethnography which considers elements of discourse in their socio-historical settings.

Methodological devices proposed and offered by traditional discourse analysis, almost exclusively concerned with investigation of the semantic content of texts, although providing rich insights, fail to adequately consider the influences of the conditions under which actors participate in discursive practices and are regarded as insufficient in addressing the interests of sociological discourse research at more comprehensive (i.e., meso- and macro-) levels, requiring supplementation and extension (Keller, 2006, 2013). Keller (2013) asserts that sociological discourse research is not purely textual research, but rather is concerned with "the social relationship between linguistic or semiotic usage and meaning production as the basis for the objectivization of social knowledge" (p.110). Supplementing approaches rooted in linguistics and traditional discourse analysis, the methodological richness of sociology accommodates a broader empirical underpinning of discourse, making accessible the practices of discourse production not only through texts, but through observation of discursive practices more or less in actu, including their rules and resources, the role of collective actors, and the reception of discourses in fields of social practice (i.e., 'doing discourse'; Engelhardt, 2015; Keller, 2013). Such an approach enables researchers to connect macro aspects of semantics and grammar with micro aspects of negotiation and interaction of actors (or speakers; Engelhardt, 2015).

Methodological procedures for data collection and analysis may, therefore, take various forms and directions, oriented by theoretical assumptions and the specific research questions concerning social mechanisms and rules for production and structuring of orders of knowledge investigated (Keller, 2013). As such, Keller (2013) argues that discourse research (undertaken from the SKAD perspective) sets out as 'multi-methodological', availing of both qualitative and quantitative approaches depending on particular research interests, "correlates a variety of data and methods" (p. 81), and addresses a spectrum of specified research questions (often across multiple studies or research projects). Consequently, Keller (2011, 2013) refrains from presenting or prescribing a standard model of discourse analysis. Nonetheless, Keller identifies the utility of analysis of large text corpora, focusing on the reconstruction of typical structural elements, in "linking the social (institutional) dimensions of knowledge production and circulation with the symbolic order that is thereby achieved" (Keller, 2006, p. 235), as well as ethnographic observations of institutional settings and particular events of discourse production and performance and interviews of participating actors in meeting "the tenuous situation of knowledge beyond a content analysis of texts" (Engelhardt, 2015, p. 155) and making "accessible unfolding processes of discourse production and discourse reception" (Keller, 2013, p. 102).

3.2. Conceptual Framework

The current study formulates a conceptual framework inspired by the assertions and affordances of the sociology of knowledge approach to discourse (SKAD; Keller, 2001, 2006, 2011, 2013, 2018) in order to conceive the relationships between researchers, research contributions, and the field of Child-Computer Interaction, as well as the practices and processes which mediate these relationships. This framework is elaborated and visually illustrated (see **Figure 3.1**) below.

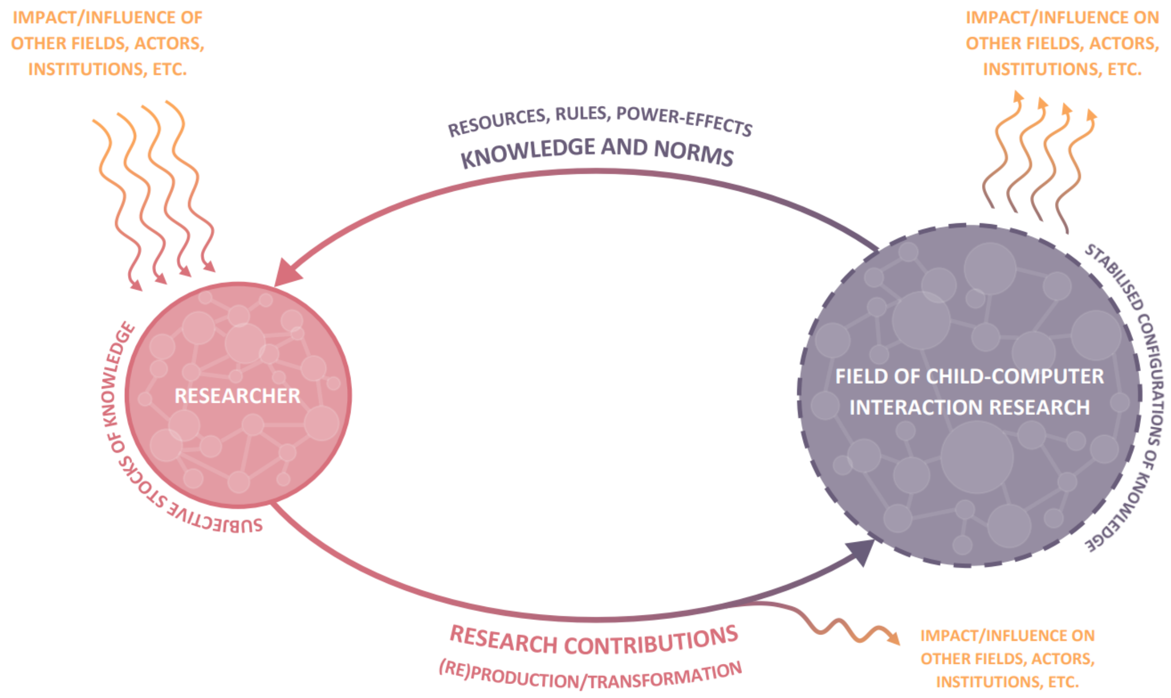


Figure 3.1. *Conceptual Framework*

The field of Child-Computer Interaction is conceived as a discursive field, a "battlefield of competing discourses" (Keller, 2006, p. 232) which change over time (L. King, 2007). Illustrated in

Figure 3.1 by the dotted boundary, the field is regarded as fluid and without fixed borders (L. King, 2007). Therein, various overlapping thematic subfields of knowledge – (relatively stable) configurations of knowledge and systems of meaning (i.e., discourses) – arise (illustrated as a network in which nodes represent discourses and edges the [power] relations therebetween), shaped (or structured) by the collective research practices and contributions (i.e., discursive practices) of researchers (i.e., social actors). Discourses constituting the field are materialised within research publications (i.e., journal articles, conference papers), which "may intertwine different discourses with each other in more or less complex ways, or put them in opposition to one another" (Keller, 2013, p. 94). Thus, discourses constituting the field are observable in published texts (Antons et al., 2019).

Supplies, and associated configurations, of knowledge within the field are, more or less obstinately, interpreted by researchers as resources for action (i.e., knowledge) and normative orientations and rules (i.e., norms) for the construction of meanings, including "rules instructing (rather than determining) who is allowed to speak, how a particular discourse is to be performed and what could be said" (Keller, 2012, p. 53), thereby forming the basis of (i.e., structuring) subsequent research practices (i.e., discursive practices) performed by researchers. Availing of these rules and resources to varying extents, researchers undertake research practices, in so doing (re)producing and transforming Child-Computer Interaction knowledge.

Notably, as per Berger and Luckmann's (1966) sociology of knowledge, researchers are not construed as "empty addressees of knowledge supplies and the value assessments embedded therein" who, in performing research practices, ventriloquise existing CCI discourse, but rather as "*socially configured incarnations of agency*" possessing subjective stocks of knowledge, which are "inconsistent, heterogeneous, complex sedimentations and actualizations of knowledge triggered from the outside", and standing in the "crossfire of multiple and heterogeneous, maybe even contradicting discourses" (Keller, 2011, pp. 50–54, emphasis in original; illustrated as a network in which nodes represent discourses and edges the [power] relations therebetween). Consequently, it is posited, in performing research practices, researchers may be influenced by, and simultaneously (re)produce and transform, various social orders of knowledge derived through interactions with other actors (e.g., peers), institutions (e.g., universities, funding organisations), and fields (e.g., education), introducing these orders of knowledge into CCI discourse in a manner compliant with their interpretation of the rules for construction of meaning in CCI. In this way, a myriad of influences may be exercised upon, and expressed within, researchers' research practices, thereby transforming knowledge in the field of CCI research. Thus, whilst researchers may be predisposed towards reproduction of knowledge by resources, orientations, and rules acquired from the field, transformations may arise inadvertently, or be intentionally pursued, within research.

Manifested in manuscripts, research practices are submitted for validation within, and admission to, the field through publication processes. Peer review, whereby research is subjected to the scrutiny of others versed in Child-Computer Interaction discourse, acts as the main scientific gatekeeping, or regulatory, institution of the field, with only those contributions adhering to reviewers' interpretations of CCI discourse and offering sufficient value in affirming or advancing knowledge therein accepted into the field. Thus, the field may be conceived as produced through an "ongoing conversation—a process of discursive knowledge construction in which contributions are offered, assessed, synthesized, elaborated upon, and sometimes rejected through the channels of scholarly communication" (Höök & Löwgren, 2012, p. 16).

Through publication (as journal articles and conference papers), research practices thus proceed to (re)structure knowledge within the field of Child-Computer Interaction. However, the configuration of knowledge within the field arises through "the structuring effect of collective practices under competitive conditions and power relations" (Engelhardt, 2015, p. 135). Therefore, individual research practices and publications rarely produce qualitatively significant transformation of knowledge in the field. Rather, consequential transformations in the configuration of knowledge arise through the sum of variations throughout research practices in the field. Consequently, configurations of knowledge in the field remain relatively stable and resilient to substantial transformation, existing under conditions of *institutional inertia* (Keller, 2011). It is proposed that, only through concerted or sustained variation in a (relatively) consistent direction (i.e., gathering sufficient 'momentum') can a qualitatively significant transformation in the configuration of knowledge gain (relative) stability and legitimacy within the field, thereby realising 'shifts' therein (T. S. Kuhn, 1962).

It is noted, within the proposed framework, that research in the field of Child-Computer Interaction, both at the individual and collective level, may impact and influence social actors, organisations, institutions, and fields beyond those directly engaged in such research, within academia (e.g., informing research in neighbouring and related fields) and beyond (e.g., informing industry practice). Such influences and impacts may be either intended or unintended, overt or discreet, and vary in magnitude.

Thus, the conceptual framework implemented in the current study assumes a dialectic relationship between the research practices and processes through which Child-Computer Interaction knowledge is (re)produced and transformed and the existing, as well as emerging, configurations of knowledge constituting the field of Child-Computer Interaction research, thereby framing empirical investigation of the processes and practices through which knowledge is (re)constructed and transformed, and their consequences, within the field of Child-Computer Interaction.

Chapter Four: Research Design and Methodology

The current study adopts a mixed methods research design, incorporating multiple methods, involving collection, analysis, interpretation, and reporting of both quantitative and qualitative data, in addressing research questions in an appropriate, principled manner. Such a methodological approach is framed within, and supported by, the conceptual framework employed in this study (see **Chapter Three**; Keller, 2005, 2006, 2011, 2018). This chapter introduces the mixed methods research design, an *iterative sequential mixed methods design* (Tashakkori et al., 2020) implemented, comprising three distinct, sequential phases (QUAN → QUAL → QUAN), pragmatic paradigmatic stance, and criteria to assess rigour adopted, and presents the research questions guiding, and addressed through, the study. Data collection and analysis methods, as well as criteria to assess rigour, related to respective quantitative and qualitative phases of the mixed methods design are then detailed. The chapter concludes by addressing ethical considerations and principles guiding the research design and practices.

4.1. Mixed Methods Research

Regarding discourse research as "multi-methodological", correlating a variety of data and methods of analysis (Keller, 2013), and concerned with analysis of both *materialities* and processes of symbolic ordering (or meaning production) associated with discourse (Keller, 2006), the sociology of knowledge approach to discourse, upon which the conceptual framework implemented is based (see **Chapter Three**), accommodates, and endorses, adaption of a diverse range of both quantitate and qualitative methods which accord with theoretical assumptions related to discourse therein and particular research interests. In integrating the sociology of knowledge, according to Burger and Luckman, with Foucauldian discourse, Keller (2013) asserts that the "methodological richness of sociology permits a broader empirical underpinning of discourse research than is possible in approaches rooted in linguistics or discourse theory" (p.64). Thereby facilitating potential disengagement from 'text' and use of additional meaning-oriented methods of reconstruction, application of diverse qualitative and quantitative methods may "make accessible the practices of discourse production not only through texts, but can observe them more or less *in actu*, including their rules and (unequally divided) resources, the role of collective actors, the concrete situative conditions, and the social contexts that go beyond these" (Keller, 2013, p.64, emphasis in original). The present study, investigating the relationship between practices of discourse production and the structure of discourses achieved thereby within the field of Child-Computer Interaction, seeks to capitalise upon the methodological flexibility afforded within the framework articulated through implementation of a mixed methods research design.

Mixed methods research (MMR) is characterized by the purposeful mixing of quantitative and qualitative methods or paradigm characteristics in collection and analysis of data, and integration and interpretation of findings, within a single study or program of enquiry (Bryman, 2012; Creswell & Plano Clark, 2011; Dawadi et al., 2021; Onwuegbuzie & Johnson, 2006; Rocco et al., 2003; Schoonenboom & Johnson, 2017; Shorten & Smith, 2017; Tashakkori & Creswell, 2007). As is partly the case in the present study, the rationale for such a mixture of methods within a single study is derived from the assertion that, for given research questions or problems, neither qualitative nor quantitative methods, by themselves, yield adequate insight or understanding (Creswell, 2005; Ivankova et al., 2006; Tashakkori & Teddlie, 2003). Through 'mixing', or integrating, qualitative and quantitative elements at an appropriate stage in the research process, mixed methods research produces an integrated response to research questions which offers greater breadth and depth of understanding of the phenomenon under study than could be achieved by either method (Johnson et al., 2007; Teddlie & Tashakkori, 2010; Zhang & Creswell, 2013). The integration of quantitative and qualitative elements may occur at any stage or stages of the research process, but is integral to ensuring rigour in mixed methods research (Alivernini, 2012; Halcomb & Hickman, 2015).

Mixed methods research designs offer a number of advantages in investigating complex research issues, integrating quantitative and qualitative methods, approaches, and concepts which exhibit complementary strengths and nonoverlapping weaknesses in order to derive insights (i.e., *the fundamental principle of mixed research*; Onwuegbuzie & Johnson, 2006). Capitalising upon the strengths of both qualitative and quantitative methods, whilst simultaneously compensating for respective limitations, mixed methods research facilitates exploration of diverse perspectives and identification of relationships between layers of multifaceted research questions, portraying phenomena from various viewpoints and through diverse research lenses (Ivankova et al., 2006; Molina-Azorín, 2011; Wisdom et al., 2012). Principled integration of qualitative and quantitative methods within mixed methods research, it has been argued, can extend the breadth and depth of enquiry (Dawadi et al., 2021; Lund, 2012; Schoonenboom & Johnson, 2017), access insights unavailable to qualitative or quantitative studies undertaken independently (O'Cathain et al., 2007), and support superior inferences to those obtained through monomethod research (Creswell & Plano Clark, 2007; Johnson & Onwuegbuzie, 2004). Thus, mixed methods can "facilitate different avenues of exploration that enrich the evidence and enable questions to be answered more deeply" (Shorten & Smith, 2017, p. 75).

In mixing methods within a single multiphase study, however, the complexity of conducting research may be increased considerably (Creswell & Plano Clark, 2007; Shorten & Smith, 2017). Creswell and Plano Clark (2011) and Molina-Azorín (2011) enumerate challenges associated with mixed methods studies, including extensive time and resources which may be required in order to implement both quantitative and qualitative phases (or strands; Teddlie & Tashakkori, 2006), with researchers (e.g., David et al., 2018; Linnander et al., 2019) noting in particular the demanding timeline of participant recruitment and intensive labour in data collection, as well as the necessity that researchers possess, or develop, a broader skill set, encompassing conversance – if not proficiency – in both quantitative and qualitative methods. Furthermore, various researchers (e.g., Halcomb & Hickman, 2015; Onwuegbuzie & Johnson, 2006; Tashakkori & Teddlie, 2008; Wisdom et al., 2012) have expressed concern regarding the demonstration of rigour within mixed methods research, asserting that, although respective problems of validity concomitant with quantitative and qualitative components may be exacerbated to yield an “additive or a multiplicative threat” (Onwuegbuzie & Johnson, 2006, p. 52), methods of doing so remain poorly defined. Approaches adopted in addressing such challenges in the context of the current study are discussed in later sections of the present chapter (see **Section 4.3**).

The underlying rationale for mixed method enquiry, J. C. Greene and Caracelli (1997) assert, “is to understand more fully, to generate deeper and broader insights, [and] to develop important knowledge claims that respect a wider range of interests and perspectives” (p. 7). J. C. Greene et al. (1989) conceptualised a typology, subsequently elaborated upon and expanded by Bryman (2006), delineating purposes for integration (i.e., mixing) of qualitative and quantitative methods. In conducting the current study, the mixed methods research design served a number of purposes, such that quantitative and qualitative methods were integrated in order to: (a) extend the depth and breadth of enquiry, generating detailed insight into phenomena and generalising findings (i.e., *expansion*; J. C. Greene et al., 1989; Halcomb & Hickman, 2015; Wisdom et al., 2012); (2) elaborate, enhance, illustrate, and clarify results from one methods with those from the other, obtaining a more meaningful, holistic understanding of a phenomenon (i.e., *complementarity*; Graff, 2014; J. C. Greene et al., 1989; Schoonenboom & Johnson, 2017); and (3) enhance the integrity and validity of inferences through convergence, corroboration, and correspondence of findings (i.e., *triangulation* and *credibility*; Bryman, 2006; Creswell & Plano Clark, 2007; J. C. Greene et al., 1989). The specified purposes for the use of mixed methods, as noted by K. M. T. Collins et al. (2006), acted to guide various mixed analysis decisions throughout the study.

4.1.1. Paradigmatic Positioning

Notwithstanding the wide recognition, and broad application, of mixed methods as an alternative methodological approach in research (Creswell & Plano Clark, 2011), the philosophical assumptions related to paradigms of enquiry, or "worldviews" (Creswell, 2013; Creswell & Plano Clark, 2007), upon which mixed methods research is predicated remain contentious. Mixed methods research, it has been argued, is not possible due to perceived incompatibility of qualitative and quantitative research paradigms as a consequence of incommensurable philosophical presuppositions upon which they are premised (Brannen, 2005; Hammersley, 1996). Those advocating such an *incompatibility thesis* regard qualitative and quantitative methods as inherently entrenched in distinct, irreconcilable paradigms of enquiry (constructivism or interpretivism and [post]positivism respectively), the asserted incompatibility of which is argued to inhibit their combination within mixed methods studies, such that the adoption of one such paradigm is perceived as precluding the other (Creswell & Tashakkori, 2007; Dawadi et al., 2021).

Researchers (e.g., Creswell & Tashakkori, 2007; J. C. Greene, 2006; Howe, 1988; Reichardt & Rallis, 1994) have, however, challenged assertions of incompatibility, arguing that partnership between, or combination of, qualitative and quantitative methods is not only demonstrably feasible, but offers distinct value in accommodating comparison and contrast of inferences emerging from examination of findings from multiple worldviews or perspectives. Therefore, researchers have proposed and developed a number of alternative paradigmatic stances which address arguments related to incommensurability of paradigms through characterisation of mixed methods as a methodological approach compatible with different sets of philosophical assumptions, including the *pragmatic* paradigm (Howe, 1988) adopted in undertaking the current study.

Philosophical and methodological pragmatism, an alternative paradigm commonly associated with mixed methods research (Tashakkori et al., 2020), circumvents the contentious issues of paradigmatic incompatibility, accepting, philosophically, that there are both singular and multiple realities which are open to empirical enquiry, and thereby supporting a pluralistic position oriented towards meeting the practical demands of a particular enquiry through selection of paradigms or methods which best address research questions (Creswell & Plano Clark, 2007, 2011). Pluralistic positioning accommodated thereby aligns with assertions of the conceptual framework applied within the present study (see **Chapter Three**), whereby, premised on Berger and Luckmann's sociology of knowledge, a dialectical perspective on society both as 'objective' and 'subjective' reality, each of which is considered scrutable, is stipulated.

Philosophical assumptions related to paradigms of enquiry are regarded as "logically independent of" (Rocco et al., 2003, p. 596) decisions related to the selection of methods, and less important than the manifold practical demands related to particular research enquiries, prioritising "situational responsiveness and a commitment to an empirical perspective" (J. C. Greene & Caracelli, 1997, p. 9). Pragmatism supports the use of mixed methods based on the assumption that no one set of methods is appropriate in addressing research questions, valuing both objective and subjective knowledge in pursuing research objectives and encouraging selection and use of research methods guided by research questions (Mertens, 2012). In so doing, pragmatism allows researchers to "[s]tudy what interests and is of value to [them], study it in the different ways that [they] deem appropriate, and use the results in ways that can bring about positive consequences within [their] value system" (Tashakkori & Teddlie, 1998, p. 30). Therefore, as recommended within SKAD by Keller (2013), methodological approaches employed were "decided in relation to the specific question, the data selection used and the planned empirical or analytical depth of an investigation" (p.89).

As cautioned by Feilzer (2010), however, whilst pragmatists may not "care" which methods they utilise "as long as the methods chosen have the potential of answering what it is one wants to know" (p. 14; Denscombe, 2008), the pragmatic stance does not serve as an excuse for less rigorous research, but rather necessitates a strong understanding of quantitative and qualitative methods and analyses, as well as transparent and replicable reporting of methods – quantitative and qualitative methods employed in the present study are reported in such a manner in later sections (see **Sections 4.4.4** and **4.5.3** respectively).

4.1.2. Research Questions

A pragmatic approach to mixed methods research, aligning with the methodological orientation encouraged by the conceptual framework employed (see **Chapter Three**), focuses on, and prioritises, research questions in determining methods employed within a given study, with the opportunity to pursue and gain knowledge outweighing paradigmatic or methodological norms and preferences (Bryman, 2006; Christ, 2007; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998). This *centrality of the research question* within the pragmatic paradigm, Teddlie and Tashakkori (2010) assert, was "initially intended to move researchers (particularly novices) beyond intractable philosophical issues (e.g., epistemological, ontological) associated with the paradigms debate and toward the selection of methods that were best suited to investigate phenomena of interest to them" (p. 10). Within mixed methods research, research questions therefore play a pivotal role, dictating appropriate methodological decisions through an iterative, emergent, and evolving process (Onwuegbuzie & Johnson, 2006; Teddlie & Tashakkori, 2010).

In the current study, research questions were devised based upon, and shaped by, the purpose of the study and in turn guided the methods and design of the investigation (Tashakkori & Creswell, 2007). As suggested by Creswell and Plano Clark (2011) and Tashakkori and Creswell (2007), an overarching mixed methods question, which makes explicit the nature of integration of qualitative and quantitative strands of the study (i.e., how findings of various phases relate to each other), was formulated, followed by separate quantitative and qualitative sub-questions to be addressed in respective phases of the study. Yin (2006) argued in favour of such an approach to research questions when framing mixed methods studies, as the adoption of a single overarching focus – represented as a mixed methods research question – may, it is contended, mitigate the risk that "methodological sections essentially create decomposed multiply related studies" (Christ, 2007, p. 239). As is common within *sequential* mixed designs such as that implemented in the current study (see **Section 4.2**), research questions were regarded as flexible and dynamic, emerging and evolving as the study progressed, such that, as in the recursive approach to designing research questions proposed by Christ (2007), each phase within the study may have served to initiate, reconfigure, reframe, or refine research questions of subsequent phases in a continuous manner (Graff, 2014; Tashakkori & Creswell, 2007). Based on this approach, the following overarching research question and associated sub-questions related to the structure of knowledge within the field of Child-Computer Interaction, and the research practices and processes through which such knowledge is (re)constructed, were developed and pursued, driving the methods and design of the investigation:

1. How have research practices shaped knowledge developed within the field of Child-Computer Interaction throughout the period 2003 to 2021?
    - 1.1. What major themes of study were addressed in the field of Child-Computer Interaction during the period 2003 to 2021?
    - 1.2. How have major themes of study in Child-Computer Interaction changed in prominence within research throughout the field's development?
    - 1.3. How have major themes of study been combined within Child-Computer Interaction research during the period 2003 to 2021?
    - 1.4. What factors have influenced trends in research priorities within Child-Computer Interaction throughout the field's development?
    - 1.5. How have norms and structures associated with the field of Child-Computer Interaction influenced research and publication practices therein?
    - 1.6. How do researchers negotiate norms and structures associated with the field of Child-Computer Interaction in producing novel knowledge in the field?

In addition to the above research questions, findings of qualitative analysis addressing research question (RQ) **1.6** related to strategic practices utilised by researchers' in negotiating norms associated with the field, supported by a supplementary review of literature (see **Appendix I**), prompted and informed the following testable hypotheses which were addressed through subsequent quantitative analysis (see **Section 4.2.4**):

H1. Researchers strategically publish more novel contributions to the field of Child-Computer Interaction in non-specialised publication venues.

H2. Innovative contributions embedded in conventional knowledge within the field of Child-Computer Interaction achieve greatest subsequent uptake within the field.

H3. Child-Computer Interaction research papers exhibiting greater novelty within the field attain greater scientific impact.

4.2. Research Design

Researchers (e.g., Creswell & Plano Clark, 2011; Leech & Onwuegbuzie, 2009; Tashakkori & Teddlie, 2010) have proposed several design frameworks and associated typologies intended to guide the rigorous conduct and evaluation of mixed methods research. Frameworks differentiate mixed methods research designs along a number of common design dimensions, with typologies distinguished based upon criteria and characteristics associated with these dimensions. Collectively, these frameworks advise consideration of the following methodological issues, or dimensions, in selecting a specific mixed methods research design: *relative priority*, or weight, of the quantitative and qualitative data collection and analysis in the study; *extent* and *timing of connection and interaction*, or mixing, between quantitative and qualitative phases and integration of results; *time orientation*, or sequence, of quantitative and qualitative data collection and analysis (Ivankova et al., 2006; Leech & Onwuegbuzie, 2009; Teddlie & Tashakkori, 2010). Decisions related to these dimensions throughout the present study, detailed in the following sections, informed and produced an iterative sequential mixed methods design (Tashakkori et al., 2020).

4.2.1. Priority

Priority, or weighting, of approaches refers to the relative importance attributed, and attention dedicated, to qualitative and quantitative data in addressing the research questions (Creswell & Plano Clark, 2007; Morgan, 1998). Priority within mixed methods research designs may thus depend upon the goals of the enquiry, the research question(s), the intended audience for the study, and the utilisation of procedures drawn from various research traditions (Creswell & Plano Clark, 2007; Plano Clark & Ivankova, 2016). Johnson et al. (2007) assert that mixed methods research designs may be qualitative dominant (i.e., qualitatively driven), quantitative dominant (i.e., quantitatively driven), or ascribe equal status qualitative and quantitative data and approaches. The present study attributed equal importance to qualitative and quantitative data in answering research questions.

Whilst researchers (e.g., Morse, 2003; Morse & Niehaus, 2009) have considered the prioritisation, or dominance, of either quantitative or qualitative components as inevitable within mixed methods designs, producing core and supplemental phases, and thereby disregarded the viability of preserving an equal weighting of respective components, others (e.g., Johnson et al., 2007; Tashakkori & Teddlie, 1998) maintain that such equality is achievable when no one method, or paradigm of enquiry associated therewith, predominates. Cronenberg (2020) clarifies that equality does not arise from the number of participants, or volume of data collected, in each respective phase, but rather from the manner in which data are valued during integration. Within the current study, regarding both qualitative and quantitative data and analyses as pertinent to most, if not all, research questions addressed and construed within the pragmatic paradigm adopted (see **Section 4.1.1** above) as equally valid in portraying phenomena of interest, it was determined that both qualitative and quantitative components would be afforded equal weighting throughout and integrated in an equitable manner.

4.2.2. Timing and Extent of Integration

Data integration, or linkage, at an appropriate stage represents an essential step and core component in mixed methods research, and is defined as the "explicit interrelating of the quantitative and qualitative component in a mixed methods study" (Plano Clark & Ivankova, 2016, p. 40) in such a manner as "to be mutually illuminating, thereby producing findings that are greater than the sum of the parts" (Woolley, 2009, p. 7). Mixed methods studies, by definition, require at least one "point of integration" (Schoonenboom & Johnson, 2017), alternately referred to as a "point of interface" by Morse and Niehaus (2009) and Guest (2013), at which respective strands are connected or mixed in some way, with such integration central to ensuring rigour in mixed methods research (Halcomb & Hickman, 2015).

Whilst integration may occur at one or all methodological and analytical stages throughout the research process (Graff, 2014; Halcomb & Hickman, 2015), Morse and Niehaus (2009) identify two particular potential points of integration: the *results point of integration* and the *analytical point of integration*. Integration in mixed methods studies most commonly takes place in the *results point of integration*, at which point respective findings and inferences produced through qualitative and quantitative phases are connected and interlinked in order to draw "conclusions or inferences that reflect what was learned from the combination of results from the two strands of the study, such as by comparing and synthesizing the results in a discussion." (Creswell & Plano Clark, 2011, p. 67). Tashakkori and Teddlie (2008) posit that close integration of findings and inferences derived from respective phases support *meta-inferences*, a unique affordance of mixed methods approaches whereby overall conclusions, explanations, or original understandings are developed through interpretation of findings from the integration of qualitative and quantitative strands (Hong et al., 2018).

In the present study, results of respective qualitative and quantitative analyses were integrated during interpretation, permitting thorough analysis of data separately and subsequent integration of quantitative and qualitative findings when interpreting data in order to provide an integrated response to research questions which offers greater breadth and depth than would be attainable by either method alone. Such integration allowed the findings of respective phases to explore, expand, clarify, and explain the findings produced by other phases, with the dialectic between complementary and contrasting findings therein contributing to new insights, perspectives, and understandings (Creswell, 2009; Maxwell, 2016; Scott et al., 2007). The approach in reporting mixed methods research employed, whereby qualitative and quantitative phases are presented in separate chapters and integrated thereafter during discussion, represents a *segregated model of presentation* (Halcomb & Andrew, 2009; O'Cathain, 2009) and reflects the sequential nature of the study (see **Section 4.2.3** below). The approach to integration of qualitative and quantitative data at the interpretation level is further detailed below (see **Section 4.2.2.1**)

Furthermore, in sequential mixed methods designs such as that implemented in the current study (see **Section 4.2.3** below), quantitative and qualitative phases are connected in the intermediate stage (i.e., between the conclusion of one phase and the commencement of a subsequent phase) when data collection protocols are informed or guided by the results of data analysis in the preceding phase (Creswell et al., 2003; Ivankova et al., 2006). Such interaction between quantitative and qualitative methods "underscores the elaborating purpose of the mixed-methods sequential explanatory design" (Ivankova et al., 2006, p. 11). In the present study, quantitative and qualitative phases were connected during intermediate stages in the research process, such that findings obtained in each phase acted to initiate or refine research questions addressed, and inform hypotheses investigated, through subsequent phases – for example, findings of Phase 1 analysis informed research questions of Phase 2, which were intended to explain Phase 1 findings, and hypotheses addressed in Phase 3 were prompted by, and sought to further explore, Phase 2 findings (see **Section 4.2.4**). Additionally, results of Phase 1 quantitative data analysis served to inform sampling through which prospective participants in Phase 2 qualitative data collection were identified (see **Section 4.5.1.6**).

4.2.2.1. Approach to Integration at the Interpretation Level

Presenting results of respective phases of analysis in separate chapters (i.e., **Chapter Five**, **Six**, and **Seven**), the current study implements a *contiguous approach* (Fetters et al., 2013) to integration. However, subsequent integration of findings of both qualitative and quantitative findings in detailing interpretation thereof during discussion (i.e., **Chapter Eight**) is undertaken through a *weaving approach* (Fetters et al., 2013), whereby findings of respective phases are presented in an interrelated manner on a "theme-by-theme or concept-by-concept basis" (p. 2142; Skamagki et al., 2022). In the present study, themes by which findings were integrated during interpretation were informed by research questions, with relevant findings across phases identified through an approach reminiscent of Moran-Ellis et al.'s (2006) "following a thread" approach. In the current study, this adapted approach consisted of initial analysis of each phase based on the research questions explicitly addressed therein, identifying key findings requiring further explanation or exploration related thereto, and proceeding to 'follow'' questions or themes evident within one phase across the others (i.e., the thread) "to create a constellation of findings which can be used to generate a multi-faceted picture of the phenomenon".

Integration of findings of qualitative and quantitative phases of analysis in addressing specified research questions through the weaving approach applied accommodated, and established, explanatory and exploratory relationships, or dependence, between respective phases. In practice, findings related to research questions primarily – although not exclusively – addressed within a given phase (e.g., **RQs 1.1**, **1.2**, and **1.3** were predominantly addressed through Phase 1 analysis) were further explained or elaborated (i.e., explored) through pursuit of observed 'threads' (i.e., themes, concepts, and questions) across preceding and/or succeeding phases in order to identify relevant findings therein. Related findings identified across phases (i.e., those associated with particular 'threads') were placed in contrast, whereby how respective results 'spoke' to each other (i.e., agreement or disagreement, explanation or exploration) was examined, and collectively interpreted with respect to research questions. For example, trends in prominence of major themes of study throughout the development of the field of Child-Computer Interaction (**RQ 1.2**) deduced through quantitative analysis (Phase 1) served as 'threads' followed through subsequent interpretation of findings of qualitative analysis (Phase 2), yielding additional insights which acted to explain identified trends. Similarly, corroboration of the influence of norms and structures associated with the field upon research and publications practices (**RQ 1.5**) identified ('threads') through qualitative analysis (Phase 2) was sought through consequent review of findings of Phase 1 quantitative analysis and explored within findings of Phase 3 quantitative analysis. Thus, through an iterative process of data integration, interweaving germane, complementary findings emerging from each dataset in a principled manner, detailed insights into, and holistic understanding of, phenomena were developed.

4.2.3. Time orientation

Time orientation – variously termed "timing", "time ordering", "implementation", or "sequence" – refers to the temporal relationship between respective phases within a mixed method study (Creswell & Plano Clark, 2007; J. C. Greene et al., 1989; Johnson & Onwuegbuzie, 2004; Morgan, 1998). Schoonenboom and Johnson (2017) propose that timing within mixed methods studies is defined along two distinct dimensions, *simultaneity* and *dependence*, which relate to the sequence of, and relationship between, data collection and analysis within phases respectively. Simultaneity concerns whether *data collection* is undertaken sequentially (i.e., one phase precedes the other) or concurrently (i.e., phases are implemented in parallel), thus forming the basis of distinction between concurrent and sequential design typologies (see Creswell et al., 2003; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998). Dependence relates to whether the implementation of one phase depends upon – or is independent of – results of *data analysis* of a preceding phase, with dependent research activities often involving reconfiguration or redirection of subsequent research enquiry. The current study implements a *sequential-dependent* design, whereby data collection and analysis of one phase succeeds, and is dependent upon, the outcomes of another phase.

In a sequential-dependent design, qualitative and quantitative data collection and analysis are implemented across distinct, sequential phases, with each phase logically guiding and providing "conceptual and/or methodological grounds for the next one in the chain" (Tashakkori & Teddlie, 1998, pp. 149–150). Research questions and procedures in later phases emerge from, depend on, or build upon findings from preceding phases, typically with the intention of further exploring, explaining, or confirming findings from preceding phases (Graff, 2014; Halcomb & Hickman, 2015; Ivankova et al., 2006; Schoonenboom & Johnson, 2017). Within sequential designs, research questions are interrelated and often evolve throughout the course of the study (Tashakkori et al., 2020). Findings from respective phases are integrated in a separate phase, from which final conclusions that are "more compelling than what can be produced separately in a single method study" (Christ, 2007, p. 239) may be drawn.

Researchers (e.g., Creswell et al., 2003; Tashakkori & Teddlie, 1998) have proposed a range of sequential mixed methods design models or typologies, generally distinguished by the intended purpose of subsequent phases relative to the initial phase (i.e., explanatory, exploratory, confirmatory). This study, through utilisation of an *iterative* sequential design (Tashakkori et al., 2020), a sequential design which involves more than two phases, incorporates both explanatory and exploratory phases. The present study, constituted by three distinct, sequential phases, may be represented through the Morse (1991, 2003, 2010) mixed methods notation system as QUAN → QUAL → QUAN, wherein QUAN and QUAL represent quantitative and qualitative phases respectively, capitalisation represents primacy of phases (here, phases receive equal status; Johnson & Christensen, 2017), and arrows (→) represent a sequential relationship between phases. Qualitative data collected and analysed during Phase 2 (QUAL) here served to *explain* and build upon initial quantitative findings obtained through Phase 1 (QUAN), providing more detailed understanding of noteworthy and unexpected results (Creswell & Plano Clark, 2007; Ivankova et al., 2006; Scott et al., 2007). Quantitative data collected and analysed during Phase 3 (QUAN) served to explore and empirically test findings obtained through Phase 2 (QUAL), generalising and extending qualitative findings

(Creswell & Plano Clark, 2011; Halcomb & Hickman, 2015; Shorten & Smith, 2017). The iterative sequential design implemented is illustrated, based on the recommendations of Ivankova et al. (2006) for drawing visual models for mixed-methods procedures, in **Figure 4.1**. Details regarding procedures in each phase are elaborated in later sections (i.e., **Sections 4.4.2**, **4.4.3,** and **4.5.2**).

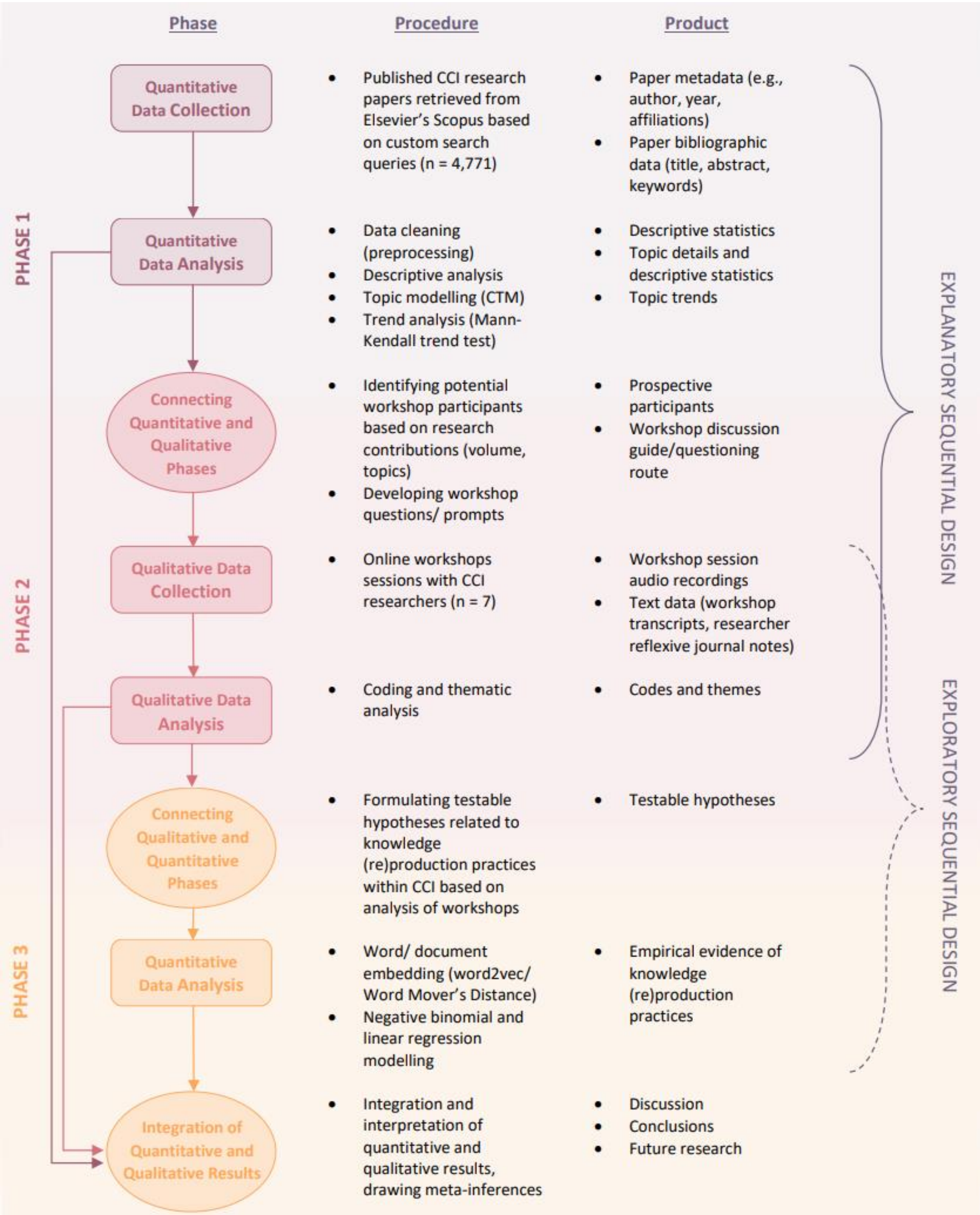


Figure 4.1. *Iterative sequential design implemented. Adapted from Tashakkori et al. (2020) and Ivankova et al. (2006).*

4.2.4. Alterations to the Original Research Design

Originally, the current study design was conceived as a "pure" explanatory sequential design (QUAN → QUAL), comprised of the first and second phases above indicated, in which the initial quantitative phase, involving mapping of the structure of the field of Child-Computer Interaction through text mining analyses of published research papers, would be followed by a qualitative phase, involving examination of processes and practices through which researchers have (re)structured knowledge comprising the field through workshop discussions with prominent community members, intended to refine, explain, and build upon quantitative results. However, following analysis of qualitative results (i.e., Phase 2), the emergence of unanticipated findings related to researchers' strategic practices in pursuing publication and integration of innovative contributions to the field, supported by supplementary review of relevant literature (see **Appendix I**), prompted consideration of a further quantitative phase intended to further explore these findings. Quantitative methods by which data collected during the initial phase of the study could be analysed in order to facilitate meaningful exploration and investigation of generalisability of these qualitative findings, building upon approaches identified through review of relevant extant literature (see **Appendix I**), were conceived. Consequently, the study design was amended to include an additional quantitative phase (i.e., Phase 3) which develops upon, and elaborates, the results of the preceding qualitative phase in an exploratory manner (i.e., exploratory sequential design). Hence, with the addition of this third phase, an iterative sequential design was implemented.

4.3. Rigour in Mixed Methods

Mixed methods research is associated with unique methodological challenges, particularly related to rigour. Whilst the use of mixed methods may, Halcomb and Hickman (2015) suggest, enhance validity, Onwuegbuzie and Johnson (2006) argue that, due to the combination of quantitative and qualitative methods, each of which entail distinct issues of validity, problems of validity may be exacerbated and evaluation of validity complicated in mixed methods research. Despite the increasing popularity of mixed methods research, discussions concerning issues of rigour remain in their infancy, with concepts of, and methods of demonstrating, rigour and validity sparingly addressed and yet to be adequately delineated within mixed methods research (Dellinger & Leech, 2007; Halcomb & Hickman, 2015; Onwuegbuzie & Johnson, 2006; Tashakkori & Teddlie, 2008).

Researchers (e.g., Creswell, 2015; Graff, 2014; Wisdom et al., 2012) assert that rigorous mixed methods research requires individual components (i.e., qualitative and quantitative) demonstrate rigour adhering to their respective established standards and criteria. Hong et al. (2018) argue that "the overall quality of a mixed methods study cannot exceed the quality of its weakest component" (p. 7). Therefore, the present study addresses relevant issues of rigour associated with quantitative and qualitative components in their respective phases (see **Sections 4.4.4** and **4.5.3**).

However, Tashakkori and Teddlie (2008) caution that rigorous qualitative and quantitative components, whilst necessary, are not sufficient for rigorous mixed methods research. In addition to demonstration of rigour based on criteria applicable to quantitative or qualitative investigation, researchers (e.g., Creswell & Plano Clark, 2011; Wisdom et al., 2012) advocate consideration of specific mixed methods criteria. Such criteria concern aspects unique to mixed methods, including details related to the integration of the multiple components and interpretive consistency between findings obtained through each method (O'Cathain et al., 2007; Sale & Brazil, 2004). In addressing and resolving pertinent qualitative, quantitative, and mixed methods validities in order to develop high-quality meta-inferences, mixed methods research may achieve *multiple validities legitimation* (Johnson & Christensen, 2017; Onwuegbuzie & Johnson, 2006).

Rigour in mixed methods research involves transparent reporting of study procedures (Creswell & Plano Clark, 2011), including provision of an auditable trail demonstrating "well-considered, justified rationales for the decisions made throughout the research process, regardless of the specific tool or method used" (Halcomb & Hickman, 2015, p.46), which offers sufficient detail to enable readers to make inferences concerning study quality (Lincoln & Guba, 1985; Tashakkori et al., 2020; Wisdom et al., 2012). Various frameworks have been proposed to support and evaluate rigorous conduct and reporting of qualitative, quantitative, and mixed portions of mixed methods studies (e.g., Creswell & Plano Clark, 2011; Leech et al., 2010; O'Cathain et al., 2008; Sale & Brazil, 2004; Tashakkori & Teddlie, 2008, 2010), a number of which were consulted throughout the design, execution, and reporting of the current study. In particular, the present study considered the following frameworks, guidance, and criteria to ensure methodological rigour throughout and transparent, auditable reporting of procedures: the McMaster University Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018), a critical appraisal tool designed for systematic mixed studies reviews employed as a design checklist during planning; O'Cathain et al.'s (2008) guidelines for Good Reporting of A Mixed Methods Study (GRAMMS), a set of guidelines supporting transparency in reporting mixed methods studies; and Tashakkori and Teddlie's (2008) integrative model, or framework, of inference quality in mixed methods research, which provides a general set of audits related to design and interpretive quality for evaluating inference quality in mixed methods research (see **Appendix A** for methodological and inference quality criteria considered). A range of the considered criteria have been addressed throughout the preceding sections detailing various aspects of the mixed methods design implemented, whilst further criteria are addressed at relevant points throughout the thesis.

4.4. Quantitative Methods

Within the earlier adumbrated mixed methods research design, the first (Phase 1) and third (Phase 3) phases of this study utilised quantitative methods in order to investigate the thematic structure of knowledge constituting the field of Child-Computer Interaction (**RQs 1.1**, **1.2**, **1.3**) and explore proposed strategic practices through which innovative contributions to knowledge may be introduced to, and integrated within, the field (**RQ 1.6**) respectively. The following sections detail data collection (note, both quantitative phases analyse the same data) and methods of analysis applied in each phase in order to address specified research question.

4.4.1. Data Collection

As opposed to a tacit, subjective interpretation of the field of Child-Computer Interaction, the present study quantifies the thematic structure of the field as manifested in relevant published research papers. As asserted within the conceptual framework implemented in the current study (see **Chapter Three**), the structured processing of discourses constituting the field of Child-Computer Interaction is, consistent with Foucault (1972), regarded as material in statements, practices, and dispositifs which are expressed and manifested, and thereby observable, within research publications (i.e., journal articles, conference papers). Textual data conveyed therein are, rather than outcomes of subjective or objective case structures, conceived as reflections of societal knowledge orders and politics pervading such orders and regarded as providing a "context – internal or external to the discourse – on different levels for the detailed analysis of … the discursive fields and the reconstruction of the discourse as *collective* bodies of knowledge" (Berger & Luckmann, 1980, p. 99, as cited in Engelhardt, 2015, p. 138). Therefore, relevant peer-reviewed Child-Computer Interaction research papers – here, journal articles and conference papers – published since the formalisation of the field (i.e., 2003; see **Section 2.1**) were identified within, and their associated bibliographic data retrieved from, Elsevier's Scopus database utilising custom search queries (see **Table 4.1**) submitted through the rscopus R package (which facilitates interfacing with the Scopus application programming interface, or API; Muschelli, 2019) on the 8th June 2021.

Elsevier's Scopus is a large curated abstract and citation database of peer-reviewed scientific literature, with broad global and regional coverage of publication venues (e.g., scientific journals, conference proceedings, books), which claims to ensure only the highest quality data are indexed through rigorous content selection and continuous monitoring and re-evaluation procedures (Baas et al., 2020; Elsevier, 2020; Mongeon & Paul-Hus, 2016). Scopus indexes various elements of scientific publications, including title, abstract, keywords, author names and linked affiliations, and references, amongst others (Baas et al., 2020). Since 2014, Scopus data has been accessible for academic research purposes through the Scopus application programming interface (API; Elsevier, 2019). Thus, given its comprehensiveness, trustworthiness, and accessibility, Scopus has served as a bibliometric data source for various large-scale analyses in research assessments, research landscape studies, policy evaluations, and university rankings (see Baas et al., 2020 for examples). Baas et al. (2020) emphasise the potential utility of Scopus as a resource through which knowledge construction processes may be researched, asserting that "the potential of Scopus to uncover and understand the fundamental forces that drive human knowledge creation through the research endeavor may be limited only by our capability to ask the right questions" (p. 384).

Search queries consisted of relevant publication venues (i.e., academic and trade journals, and conference proceedings), a list of which was compiled based on recommendations of previous literature (e.g., Giannakos, Papamitsiou, et al., 2020; Iivari et al., 2021; Jensen & Skov, 2005; Lehnert et al., 2021; Van Mechelen et al., 2021) and sampling of venues in which prominent contributors to the field published research (see **Appendix B**), and qualifying terms intended to exclude papers which are not explicitly concerned with child-computer interaction.

Notably, proceedings of the Interaction Design and Children conference series and the (IDC) International Journal of Child-Computer Interaction (IJCCI), explicitly catering to research interests related to child-computer interaction and commonly regarded as the 'primary' or 'flagship' publication venues of the CCI community (Giannakos et al., 2022; Giannakos, Papamitsiou, et al., 2020), are, in the present study (as in prior studies; (e.g., Barendregt et al., 2017; Giannakos, Papamitsiou, et al., 2020; Kawas et al., 2020), considered as specialised venues associated with the field of Child-Computer Interaction. Consequently, papers published therein were assumed to relate specifically to child-computer interaction, with filtering or exclusion based on qualifying terms considered unnecessary. Therefore, two separate search queries were developed and submitted, one of which retrieved all papers published in these specialised CCI venues and the other selectively retrieving papers published in non-specialised venues based on stipulated inclusion and exclusion terms.

Table 4.1. *Search Query*

Search query for those specialised CCI venues (IDC and IJCCI)	((ISSN(2212-8689) OR CONF(IDC))) AND DOCTYPE(ar OR cp) AND LANGUAGE(english) AND PUBYEAR > 2002
Search query for non-specialised venues (see **Appendix B** for list of venues)	((ISSN(…) OR EISSN(…)) AND TITLE-ABS-KEY(("child*" AND NOT ("childhood" OR "child policy" OR "number of children" OR "percentage of children" OR "childbirth" OR "mother-to-child transmission")) OR ("kid*" AND NOT ("kidney*")) OR "toddler*" OR "infant*" OR "primary school student*" OR "primary school pupil*" OR "elementary school student*" OR "elementary school pupil*" OR "middle school student*" OR "middle school pupil*" OR "preschooler*" OR "pre-schooler*" OR "preschool student*" OR "preschool pupil*" OR "kindergartener*" OR "k-12 student*" OR "k-12 pupil*" OR "k-5 student*" OR "k-5 pupil*")) AND DOCTYPE(ar OR cp) AND LANGUAGE(english) AND PUBYEAR > 2002

Search queries collectively retrieved bibliographic data, including title, keywords, and abstracts, as well as associated metadata (e.g., authors, affiliations, publication date, publication venue) for 6,158 research papers. Obtained papers were systematically screened - a random selection of papers (approx. 300) was manually reviewed (i.e., close reading of title and abstract), facilitating diagnosis of reasons for search query compliance of non-relevant papers (e.g., papers addressing decision tree machine learning algorithms may have been retrieved due to use of the term “child node”), with deduced error patterns informing subsequent systematic searches and reviews – to identify and remove erroneous inclusions. Following removal of non-relevant (1,278) and duplicate papers (49), as well as those for which abstracts were unavailable (60), a final corpus of 4,771 papers (842,045 words) was retained, constituted by 3,216 conference papers and 1,555 journal articles.

As is common amongst studies conducting text mining on large document corpora (see Thakur & Kumar, 2021 for review), including studies analysing the thematic content and structure of research fields (e.g., Daenekindt & Huisman, 2020; Gurcan, Cagiltay, et al., 2021; Hofstra et al., 2020; Zhong et al., 2016), paper abstracts (along with titles and keywords) are analysed in lieu of full papers, an approach considered appropriate for content analysis for several reasons: (i) abstracts are widely available and accessible, relative to full paper text (only 10.8% of papers retained are Open Access); (ii) abstracts, along with titles and keywords, generally convey concise synopses of paper content, including major findings, thereby minimising the likelihood of identification of peripheral, non-relevant, or 'noisy' patterns in analysis; (iii) the lower volume of textual data, relative to full documents, reduces computational time and power required by analyses (Chen et al., 2020; S. Liu & Chen, 2013; Syed & Spruit, 2017; Zhong et al., 2016). Empirical work (e.g., Syed & Spruit, 2017) suggests abstracts provide sufficient syntheses of topics and concepts in papers. It is noted, however, that in a recent comparison of text mining of full-text articles as opposed to their corresponding abstracts, Westergaard et al. (2018) found the former to consistently outperform the latter – although these findings relate specifically to performance of Named Entity Recognition (NER), a differing information extraction task, and set of associated models, to that undertaken in this study. Nonetheless, it is contended that, in the current study, analysis of full-texts proves practically infeasible and computationally inefficient, and increases the likelihood of eliciting non-relevant and less interpretable (e.g., 'noisy') patterns from data.

4.4.1.1. Data Preprocessing

Preprocessing of text data, a common step undertaken in text mining, comprises a series of preparatory procedures implemented prior to analysis intended to clean raw text data, modify or remove features of text which are of negligible value in discerning latent semantic patterns, and convert text data to an appropriate format for analysis. In so doing, preprocessing reduces the complexity of model inputs in a manner which does not adversely "affect the interpretability or substantive conclusions of the subsequent model" (Denny & Spirling, 2018, p. 168; Kantardzic, 2019). Such preprocessing procedures, far from trivial, have been identified as having considerable impact on the validity of topic modelling results (see Denny & Spirling, 2018 for analysis). Notably, however, there exists no scientific method by which to ascertain whether data are sufficiently 'clean', leading Asmussen and Møller (2019) to suggest that preprocessing is, in some instances, "more of an art than science" (p. 7).

Preprocessing procedures were sequentially applied to text data to be analysed – here, paper title, abstract, and keywords. Text was converted to lowercase, and punctuation, special characters, numbers, excess whitespaces, and copyright information (identified through devised regular expression, or regex, patterns) were removed. Stopwords – commonly repeated features in text, including certain conjunctions, pronouns, and high-frequency articles – were also removed. Remaining words were stemmed through the application of the standard Porter Stemming Algorithm (Porter, 1980), whereby differing forms of the same word (e.g., "designing", "designs") are mapped to a consistent, basic form (i.e., stem; e.g., "design"), in order to reduce data volume and complexity. Bigrams and trigrams, contiguous sequences of two or three words (i.e., multiword expressions; e.g., "augmented reality", "autism spectrum disorder"), were extracted for inclusion in analysis to support interpretability. Frequent terms, consisting of domain general terms (e.g., "children", "research"), as well as infrequent terms (appearing in <1% of documents; Denny & Spirling, 2018; Grimmer & Stewart, 2013), which typically do not contribute to semantic pattern identification, were removed. Initially comprising 842,045 words (or terms), text data to be analysed was reduced to 367,100 terms through the above outlined preprocessing procedures.

4.4.2. Phase 1 Data Analysis: Correlated Topic Modelling

Methodological devices offered by traditional discourse analysis, Keller (2006) asserts, "do not serve well to address the interests of social sciences (sociological) discourse research at more comprehensive or meso/macro levels" (p. 225). Therefore, within the SKAD framework, upon which the conceptual framework implemented draws (see **Chapter Three**), analyses of discourse are conceived as both qualitatively reconstructive and quantitatively measuring, with quantitative approaches accommodating reconstruction of typical or "typifiable" structural elements, such as thematic foci, within large text corpora which underlie, as meaning-creating patterns, discourses therein (Jäger, 2001; Keller, 2013). Thus, in order to characterise the structure of Child-Computer Interaction discourse through analysis of large quantities of text in which such discourse is material, the current study utilises quantitative text mining and topic modelling approaches.

Topic models comprise a family of probabilistic, generative latent variable models which facilitate inference of the underlying semantic structure, or *topics*, of a document collection (or corpus; Blei et al., 2003; Griffiths & Steyvers, 2004). Assuming generative processes, these models discern probabilistic patterns of term occurrence, commonly based on hierarchical Bayesian analysis, and subsequently derive *topics*, defined as probability distributions over the fixed vocabulary of the corpus, which are assumed to express coherent content categories or themes (Blei et al., 2003; Blei & Lafferty, 2009; Y. Wang, 2017; P. Wu et al., 2018). As mixed-membership (or mixture) models, topic models are predicated on the assertion that, in contrast to traditional clustering methods, document content arises from multiple latent semantic topics – a natural assumption, as documents comprising corpora "tend to be heterogenous, combining a subset of main ideas or themes that permeate the collection as a whole" (Blei & Lafferty, 2009, p. 73) – and thereby capture the "the heterogeneity in grouped data that exhibit multiple latent patterns" (Blei & Lafferty, 2007, p. 20). Thus, each document within a corpus is modelled as addressing multiple topics to varying extents, each of which may be represented as probability-weighted lists of terms, with topics, substantively, representing the latent thematic dimensions of the corpus (Blei & Lafferty, 2007; Muchene & Safari, 2021; Munoz-Najar Galvez et al., 2020).

Typically – although not exclusively – applying unsupervised machine learning algorithms, whereby algorithms derive inference in the absence of training data or pre-assigned labels and may thereby offer new insight (Griffiths et al., 2007; Mohri et al., 2012), topic models, regarded as a "analogous to a quantitative version of grounded theory" (Munoz-Najar Galvez et al., 2020, p. 624), identify and exploit patterns of word co-occurrence throughout documents in order to infer latent semantic themes or topics (Blei & Lafferty, 2007, 2009). In order to infer these latent topics, topic models, as generative models, define a data generating process for each document as derived from a fixed number of latent topics, approximating, or learning, probable values for the latent variables which generate the observed corpus through the prescribed generative process via probabilistic posterior inference (Blei & Lafferty, 2009; Muchene & Safari, 2021; Roberts et al., 2019). Posterior distribution of latent variables derived therethrough may be loosely considered as the "reversal" of the specified generative process, such that, given the observed corpus, the posterior defines a distribution of latent variables which generated it, and thus determines a latent topical decomposition of the corpus (Blei & Lafferty, 2009).

Latent Dirichlet Allocation (LDA; Blei et al., 2003), developed based on seminal works in latent semantic indexing (LSI; Deerwester et al., 1990) and probabilistic LSI (pLSI; Hofmann, 1999), is amongst the most commonly applied and straightforward topic models, serving as a "springboard" for the development of a range of subsequent topic models (Roberts, Stewart, & Tingley, 2016; Steyvers & Griffiths, 2007). LDA is an unsupervised, generative probabilistic model widely applied in semantic analysis of unstructured text corpora, extracting latent (i.e., unobserved or hidden) semantic structures (i.e., topics) from a collection of documents. LDA defines, and models, documents as arising from a mixture of latent topics, with topic proportions varying stochastically across documents as they are drawn from a Dirichlet distribution which dictates the proportion of words in each document attributable to different topics (Blei & Lafferty, 2007). Whilst the use of a Dirichlet distribution in LDA models in modelling variability among topic proportions affords computational conveniences, particularly in facilitating straightforward approximate posterior inference, the independence assumptions implicit in the Dirichlet distribution (i.e., components of the proportions vector are nearly independent) introduce constraints such that the LDA model assumes latent topics to be independent of each other (Blei & Lafferty, 2009). Consequently, despite a natural expectation in many – if not most

– text corpora that underlying latent topics will be correlated, LDA fails to directly model correlation between topic occurrence, imposing a “strong and unrealistic modeling assumption that the presence of one topic is not correlated with the presence of another” (Blei & Lafferty, 2007, p. 19).

Building upon LDA through assumption of a nearly identical generative process (see **Appendix C**), the Correlated Topic Model (CTM; Blei & Lafferty, 2007) was developed to overcome the implicit limitations associated with the LDA model through replacing the Dirichlet distribution with a logistic Normal distribution, a more flexible distribution which incorporates a covariance structure among components, in modelling topic proportions (Aitchison, 1982; Aitchison & Shen, 1980; Blei & Lafferty, 2007, 2009; Roberts, Stewart, & Tingley, 2016). Within the CTM, each word (the observable random variables considered) in a document is assumed to originate from, or represent, one of the *K* latent topics, with each document defined as a mixture of topics based on the proportion of words therein attributable to each topic. Consequently, each document is modelled as a finite mixture of multiple latent topics, each of which is defined as a multinomial distribution over a fixed word vocabulary (Blei & Lafferty, 2007; Muchene & Safari, 2021). Thus, the CTM infers - based on the logistic Normal - the proportion of each document associated with each topic (i.e., the per-document topic distribution, a distribution over topic indices reflecting the probabilities with which words occurring in a document are drawn from each latent topic in the collection; θ_d) and the distribution of each topic over the vocabulary (i.e., the topic-word distribution, the probability of drawing a word for a particular topic; β_k; Blei & Lafferty, 2007; Nguyen & Jenkins, 2020). In so doing, the CTM model represents a corpus in low dimensional latent thematic space, embedding documents therein (Blei & Lafferty, 2007).

The CTM explicitly models the correlation between the occurrence of latent semantic topics in the collection, thereby producing a more expressive, realistic model of latent topic structure of a corpus wherein the presence of a latent topic may be correlated with the presence of another (Blei & Lafferty, 2009; Roberts et al., 2019). In so doing, the CTM yields better predictive performance (i.e., better fit of a document collection) than LDA, with quantitative results of a comparison between the

CTM and LDA based on held-out log-likelihood and predictive perplexity of models of varying numbers of topics consistently indicating better fit for the CTM (see Blei & Lafferty, 2007 for details). Moreover, the covariance structure derived through the CTM may be used to investigate and visualise relationships among topics (e.g., construction of topic graphs), offering an exploratory tool supporting understanding and navigation of corpora.

As a consequence of these distinct affordances in facilitating efficient, automated inductive content analysis and mapping of latent semantic structures (i.e., topics) within otherwise unstructured document collections, a task which would otherwise prove prohibitively time consuming or impractical for large document collections (Asmussen & Møller, 2019; Blei & Lafferty, 2009; Quinn et al., 2010), topic models have, in recent years, gained particular prominence and been extensively applied throughout a diverse range of fields – particularly the digital humanities and social sciences – as a means by which to analyse, understand, and represent the state-of-the-art therein (Blei & Lafferty, 2009). However, whilst recent studies have utilised topic models in investigating the thematic structure, and developmental and emerging trends therein, of research related to neighbouring fields including Human-Computer Interaction (Gurcan, Cagiltay, et al., 2021) and E-Learning (Gurcan, Ozyurt, et al., 2021), such methods, despite their evident utility, are yet to be applied in analysing research within the field of Child-Computer Interaction. Given the utility and distinct affordances of the CTM as a means by which to develop an empirically grounded mapping of a research field, the present study applies this method to elicit the thematic structure, and developmental trends therein, of research in the field of Child-Computer Interaction.

4.4.2.1. Model Implementation

This study implemented a CTM through the stm R package (Roberts et al., 2019, 2020). The Structural Topic Model (STM) developed by Roberts et al. (2013) which is supported within this package reduces to a fast implementation of Blei and Lafferty's (2007) Correlated Topic Model in the absence of covariates (i.e., constant intercept), as is the case in the current instance (Roberts et al., 2019; Roberts, Stewart, & Tingley, 2016). This implementation of the CTM utilises a partially collapsed variational expectation-maximisation algorithm, which builds upon prior work in variational inference for topic models (Blei & Lafferty, 2007; C. Wang & Blei, 2013), to facilitate computationally efficient approximation of the posterior distribution (the central computational problem of the CTM; see **Appendix D**) in place of standard simulation techniques developed for computing with Dirichlet-based mixed-membership models which are inapplicable due to the non-conjugacy of the logistic Normal with the multinomial likelihood. A comparison of the performance of the stm R package implementation of the CTM and that of the topicmodels R package (Grün & Hornik, 2011), which is based on the Blei and Lafferty's (2007) original implementation, has demonstrated the superior performance of the stm implementation in terms of model solution (measured by held-out log-likelihood), number of iterations required to converge on a solution, and runtime per iteration (Roberts et al., 2019).

A spectral method of initialization, here applying the spectral algorithm presented by Arora et al. (2013; see Roberts, Stewart, & Tingley, 2016 for details), is employed in estimating the initial parameter values (e.g., distribution over words for a particular topic), as recommended by Roberts et al. (2019). This spectral method of initialisation provides a deterministic and, under reasonable conditions, globally consistent estimation procedure providing optimal parameters, thereby consistently producing superior estimates relative to other methods of initialization (see Roberts, Stewart, & Tingley, 2016). Roberts et al. (2019) generally recommend use of the spectral method of initialization, having previously found this method to consistently produce better results relative to other methods of initialization (see Roberts, Stewart, & Tingley, 2016). The prior structure for the covariance matrix ($\Sigma = 0$) advised by Roberts et al. (2019) was specified, offering favourable model performance.

4.4.2.2. Number of Topics

An inherent, and persistent, challenge in the application of topic models (excepting hierarchical extensions, such as the Hierarchical Dirichlet Process; Teh et al., 2004) is the necessity to stipulate an appropriate number of topics (*K*) to be inferred by the model, which is assumed to be – but seldom is – known and fixed a priori (S. Liu & Chen, 2013; Muchene & Safari, 2021; Roberts et al., 2020). Although no "definitive" or "right" value for the number of topics appropriate for a given corpus exists (i.e., fitting a model to a collection will yield patterns whether or not they are "naturally" present; Blei & Lafferty, 2009; Grimmer & Stewart, 2013; Roberts et al., 2019), selection of an appropriate number of topics nonetheless constitutes a "nontrivial validation issue" (Munoz-Najar Galvez et al., 2020, p. 626) with significant implications for the performance of the model (see for analysis Aletras & Stevenson, 2014; D. Greene et al., 2014; Hecking & Leydesdorff, 2018; Koltcov et al., 2020; Stevens et al., 2012; Tang et al., 2014). Specification of too low a value for the number of topics to be modelled may generate topics which are coarse-grained and overly broad, whereas too high a value, while producing more fine-grained representations, may garner less precise, "over-clustered" estimates. Moreover, within some corpora, coherent topics may exist at several different resolutions or levels of granularity, from coarse to fine-grained (i.e., multiple values for number of topics may be appropriate; D. Greene et al., 2014).

Given the absence of an established objectively "true" number of latent semantic topics within a given corpus, identification of an optimal number of topics can prove challenging. Daenekindt and Huisman (2020) assert that the number of topics "should be chosen based on interpretability and analytic utility with regard to the research question" (p. 576). Commonly, procedures implemented in determining an appropriate level of granularity at which to model the corpus consist of ex post evaluation of models fitted for a range of numbers of topics, deemed plausible based on domain knowledge, prior analyses, and/or modelling guidance (e.g., Roberts et al., 2020 suggest a number of topics between 5 and 50 for small corpora as an initial estimate), based on human evaluation of topic interpretability and veracity (Chang et al., 2009), topic diagnostic metrics (e.g., semantic coherence, exclusivity; Bischof & Airoldi, 2012; Boyd-Graber et al., 2014), and model selection metrics (e.g., Arun et al., 2010; Cao et al., 2009; Deveaud et al., 2014; Griffiths & Steyvers, 2004).

The current analysis implemented a novel triangulation method, applying several methods sequentially, for determination of a suitable level of granularity and subsequent derivation of an appropriate number of topics for which to model the obtained corpus.

Corpus documents were initially clustered using *Hierarchical Density-Based Spatial Clustering of Applications with Noise* (HDBSCAN; Campello et al., 2015) through the dbscan R package (Hahsler et al., 2019), an unsupervised machine learning method which clusters areas of high density, here based on cosine distance (t-distributed stochastic neighbour embedding [t-SNE] dimensionally reduced; van der Maaten & Hinton, 2008) between documents as positioned in term frequency-inverse document frequency (tf-idf) weighted vector space (Baralis et al., 2013; Larsen & Aone, 1999). The number of clusters identified as optimal served as an indicative estimate of the number of topics which may be naturally present within the corpus (see **Appendix E**).

Subsequently, Latent Dirichlet Allocation (LDA) models were generated, using the topicmodels R package (Grün & Hornik, 2011), for a plausible range of number of topics values (HDBSCAN clusters ±30) and evaluated based on several proposed model selection metrics intended to estimate the natural number of latent concepts or topics in a corpus (Arun et al., 2010; Cao et al., 2009; Deveaud et al., 2014; Griffiths & Steyvers, 2004), calculated through the ldatuning R package (Nikita, 2020; see **Appendix F**). It ought to be noted, whilst LDA, rather than CTM, models are fitted here as model selection metrics applied are intended for use with LDA, results nonetheless serve as broadly indicative for CTM given similarities in the models' underlying assumptions and generative processes.

Correlated Topic Models (CTM) were similarly fitted for a plausible range of number of topics values (HDBSCAN clusters ±30) and evaluated based on model mean values across several commonly employed topic diagnostic metrics:

- *Semantic coherence*, a criterion developed by Mimno et al. (2011) which measures the semantic similarity of terms associated with a topic based on the frequency of their co-occurrence, thereby intimating internal consistency and interpretability of topics.
- *Exclusivity*, a measure of the uniqueness of terms associated with topics, as measured by a term's loading within a topic relative to that within other topics (Bischof & Airoldi, 2012).
- *Document completion held-out likelihood*, which estimates the probability of terms which have been withheld during model estimation appearing within a document based on model predictions (Roberts et al., 2019; see **Appendix G**).

Finally, candidate CTM models were fitted for several numbers of topics identified as auspicious through the above delineated approach and evaluated through manual review of the substantive content and interpretability of topics generated. Topics were evaluated through inspection of representative (i.e., demonstrating greatest probability of relating to, or addressing, a topic) terms and documents (based on topic-word distribution and document topic distribution respectively), both of which exemplify manifestation of topics within the corpus (Chen et al., 2020; Roberts, Stewart, & Tingley, 2016; see **Appendix H** for initial interpretations of candidate model topics). The model judged to offer greatest interpretability and analytic utility was selected as the final model.

4.4.2.3. Topic Labelling

Latent semantic topics inferred by the CTM are represented as a multinomial probability distribution over observed terms in the corpus vocabulary (Blei & Lafferty, 2009; Y. Wang, 2017; P. Wu et al., 2018). Therefore, in order to facilitate interpretation of the substantive content of topics, as is common practice, each topic is assigned a label considered sufficiently representative of the semantic content therein following inspection of terms and documents estimated to be associated with topics. Terms and documents associated with topics (i.e., demonstrating greatest probability of relating to, or addressing, a topic) are indicative of the latent semantic concept represented by topics and illustrative of their expression within the corpus (Asmussen & Møller, 2019; Blei & Lafferty, 2007; Roberts et al., 2019). Here, labelling was undertaken through review of the twenty terms with the greatest estimated probability of addressing each topic (based on the topic-word distribution, β_k) and greatest relative exclusivity in being associated with each topic (based on the frequency-exclusivity [FREX] metric proposed by Airoldi & Bischof, 2016 and Bischof & Airoldi, 2012), as well as close reading of the ten documents demonstrating greatest estimated probability of addressing each topic (based on the document-topic distributions, θd; Blei & Lafferty, 2009; Munoz-Najar Galvez et al., 2020; Roberts, Stewart, & Airoldi, 2016). Topic labelling proceeded through several iterations based on internal review, deliberation, and further inspection of topic content, until a consensus for each topic label was achieved (Älgå et al., 2020; Chen et al., 2020). Resultant topic labels, therefore, reflect inherently subjective judgements of topic content and are conceived as a "best fit", intended to broadly capture the thematic content of words and documents therein.

4.4.2.4. Topic Trends

Trends in the prevalence of inferred topics over time were investigated through application of the Mann-Kendall trend test (Kendall, 1975; Mann, 1945), a rank-based, non-parametric statistical test widely utilised in detecting monotonic (i.e., consistently increasing or decreasing) trends in time series data (Chen et al., 2020; D. Sharma et al., 2019; F. Wang et al., 2020). As the Mann-Kendall test is determined by ranks and sequences of time series data rather than original values, the test proves robust in dealing with deviations from normality (i.e., nonnormally distributed data), outliers, and missing values (Hamed, 2007; Hirsch & Slack, 1984; Önöz & Bayazit, 2003). Moreover, the Mann-Kendall test is capable of identifying trends in time series data without requiring specification of whether the trend is linear or non-linear (Hisdal et al., 2001; H. Wu et al., 2008). Mann-Kendall trend tests assessing trends in the prevalence of topics of study – here, the mean estimated probability of papers addressing each topic – throughout the field of CCI over time (i.e., by year) were implemented through the use of the modifiedmk R package (Patakamuri & O'Brien, 2020). Examination of trends in topics of study within the field offered insight concerning shifts in the thematic structure of the field of CCI throughout the course of its development

4.4.2.5. Topic Combination

The extent to which inferred topics cooccur, or interact, within Child-Computer Interaction research is examined based on the pairwise correlation (Pearson's *r*) between document-topic probability of inferred topics, such that topics demonstrating positive correlation tend to cooccur (i.e., be combined) within documents to greater extents (Blei & Lafferty, 2007; Chen et al., 2020; Munoz-Najar Galvez et al., 2020).

Diversity of topics addressed simultaneously within papers is calculated, similar to Daenekindt and Huisman (2020), Heiberger et al. (2021), and Munoz-Najar Galvez et al. (2020), as the relative balance of topics addressed within each paper, computed as the Shannon entropy (Shannon, 1948) of document-topic probability distributions. Adapting the explanation of diversity offered by Leinster, (2021), diversity is low when most of the semantic content of a document is concentrated into a small number (i.e., one or two) of topics, and high when the semantic content is spread evenly across all topics. Thus, the lower the entropy value, the less evenly distributed topics are within a paper, or, alternately, the more a paper focuses on particular topics, indicating greater specialisation within papers. Analysis of trends in the entropy of topics addressed in Child-Computer Interaction research papers, calculated through the use of the entropy R package (Hausser & Strimmer, 2021), offered insight regarding shifts in the diversity, or specialisation, of research over time.

4.4.3. Phase 3 Data Analysis: Innovation Analysis

Following analysis of qualitative data undertaken during Phase 2 of the current study (see **Chapter Six**), through which unanticipated findings related to researchers' application of strategic practices in negotiating norms and structures associated with the field of Child-Computer Interaction research in pursuing publication and integration of innovative contributions to knowledge emerged (**RQs 1.5**, **1.6**), and consequent supplementary review of relevant literature (see **Appendix I**), a subsequent quantitative phase (Phase 3) was devised in order to further develop, and elaborate upon, insights gained therethrough (see **Section 4.2.4**) and empirically test the following hypotheses arising therefrom:

H1. Researchers strategically publish more novel contributions to the field of Child-Computer Interaction in non-specialised publication venues.

H2. Innovative contributions embedded in conventional knowledge within the field of Child-Computer Interaction achieve greatest subsequent uptake within the field.

H3. Child-Computer Interaction research papers exhibiting greater novelty within the field attain greater scientific impact.

Derived through qualitative analysis (Phase 2) and informed both by relevant theory and empirical evidence (see **Appendix I**), these hypotheses, premised on the characterisation of researchers as agentic actors whose research practices, which are considered observable in actu and materialised within texts, are both structured by and actively (re)structure fields of study, are considered compatible with the assertions of the conceptual framework implemented in the current study (see **Chapter Three**). Investigation of hypotheses draws upon, and extends, methods implemented throughout a burgeoning body of literature concerned with the quantification and measurement of aspects of innovation – particularly novelty – within research (e.g., Boudreau et al., 2016; Foster et al., 2015; Hofstra et al., 2020; Uzzi et al., 2013).

4.4.3.1. Identification of Innovations

Scientific innovation is commonly conceived as the process of addition of novel concepts to the ever-growing "constellation of facts, theories, and methods" (T. S. Kuhn, 1970, p. 1) comprising a field through incremental modification and improvement of prior advancements or recombination (i.e., *recombinant innovation*) of existing, previously isolated or disparate concepts (Muthukrishna & Henrich, 2016; Schumpeter, 1939; Weitzman, 1998). As has become standard in the study of innovation throughout recent decades (see **Appendix I**), the current study conceives innovation as recombinant (Schumpeter, 1939; Weitzman, 1998), involving production of concepts (i.e., ideas, information, knowledge, perspectives) which depart from established knowledge through recombination or reconfiguration of extant concepts, and thus regards novelty, an essential feature of innovations, as the unconventional or unusual (i.e., atypical or creative) recombination of antecedents – here, elements of prior knowledge, or established concepts (Cattani et al., 2015, 2022; Engelhardt, 2015; Fleming, 2001). Researchers (e.g., Boudreau et al., 2016; Dahlin & Behrens, 2005; Foster et al., 2015; Hofstra et al., 2020; Uzzi et al., 2013) have suggested a range of recombination-based measures of novelty and originality, quantifying the unusualness of element combinations. The current study adopts Hofstra et al.'s (2020) approach to identification of scientific innovation within published research and measurement of innovation novelty, quantified as the semantic distality (i.e., unusualness or atypicality) of referenced elements of knowledge (i.e., concepts) (re)combined within the knowledge domain (i.e., vocabulary of a corpus).

Given that not all terms are scientifically meaningful, Hofstra et al. (2020) argue that innovation entails combining relevant, meaningful terms (i.e., concepts) from topical lexicons. A set of prominent, substantive scientific concepts within the field of Child-Computer Interaction was derived based on the outputs of Correlated Topic Modelling undertaken during Phase 1 of this study (see **Section 5.2**), selecting those terms demonstrating greatest relative importance to each latent theme inferred therethrough based on their FREX score (Airoldi & Bischof, 2016; Bischof & Airoldi, 2012), which compounds the weighted frequency and exclusivity of each term within each topic (here, frequency and exclusivity were attributed equal weighting). Such an approach facilitates identification of terms (words and multiword phrases) which are common, yet relatively distinct in relating to latent themes addressed within the field, thereby balancing generality and exclusivity. Initial instances of the cooccurrence of extracted meaningful concepts (i.e., when a pair of concepts are first related to each other) within papers, regarded as recombinant innovations within the CCI field, are identified throughout the corpus. For each identified novel concept (re)combination introduced, subsequent adoption, or uptake, throughout ensuing research papers (i.e., *innovation uptake*) is measured as the number of research papers published following the paper introducing a given concept combination which exhibit this same concept combination. Spurious concept combinations – here, chance cooccurrences, and combinations of highly rare terms, unlikely to represent genuine innovations – were removed through computation of a significance score, based on pointwise mutual information (PMI) for each pairing of concepts and removal of those pairings demonstrating significance below a specified cut-off (here, $pmi(pair) \leq 1.5$; Hofstra et al., 2020; Ramisch et al., 2008; see **Appendix J**). Through this process, 8,215 meaningful individual novel concept combinations (i.e., recombinant innovations) were identified throughout the retrieved corpus – notably, however, only 1,433 (i.e., 30%) of papers in the corpus introduced any (i.e., at least one) novel concept combinations.

The number of identified novel concept (re)combinations (i.e., innovations) introduced within a given research paper is construed as the overall *scientific novelty* of that paper. The number of ensuing papers exhibiting combinations, or links, first introduced by a given research paper, normalised by the number of novel links introduced within that paper (i.e., *scientific novelty*), constitutes the *uptake* per new link, or *impactful novelty* (Hofstra et al., 2020), of that paper.

4.4.3.2. Innovation Distal Novelty

Distal novelty (Hofstra et al., 2020) of innovations, quantifying the unusualness or atypicality of concept combinations in the semantic space of the field of Child-Computer Interaction, was determined, as operationalised by Hofstra et al. (2020), based on the distance between (re)combined concepts as positioned, through word embedding (Mikolov, Chen, et al., 2013), within the semantic space of the field – that is, the conceptual similarity between combined concepts based on their apparent meaning in the context of CCI research. Child-Computer Interaction semantic space, a vector space in which terms in the corpus vocabulary are positioned relative to each other based on semantic similarity, was constructed using the *word2vec skipgram* word embedding model (Mikolov, Chen, et al., 2013; Mikolov, Sutskever, et al., 2013).

The word2vec model "learns a vector representation for each word using a (shallow) neural network language model" (Kusner et al., 2015, p. 2) trained to reconstruct, or predict, the linguistic contexts of words – in the case of the skipgram architecture employed, surrounding words in a sentence or document (Mikolov, Sutskever, et al., 2013). The skipgram model provides an "efficient method for learning high-quality distributed vector representations that capture a large number of precise syntactic and semantic word relationships" (Mikolov, Sutskever, et al., 2013, p. 1). For a given corpus of text, word2vec produces a vector space, with each word in the corpus assigned a corresponding vector, or position, within the space, such that words appearing in similar contexts throughout the corpus – implying a semantic similarity or relationship – are located close to each other. In doing so, word2vec yields semantically rich representations of individual terms within the corpus (P. Wu et al., 2018). Mikolov, Sutskever, et al. (2013) note that semantic relationships are generally preserved in vector operations on word vectors – for example, vec("Germany") + vec("capital") is close to vec("Berlin") – thereby suggesting that distances between word vector representations are, to some extent, semantically meaningful (Kusner et al., 2015).

The present implementation of the word2vec model constructed Child-Computer Interaction semantic space through embedding words in the vocabulary of the corpus in multidimensional (here, 50 dimensions) space based on training context windows of 10 words to either side of each word. Notably, whilst concepts may evolve within the field over time, the current study, in modelling corpus embeddings independent of time, assumes the globally dominant context of concepts within the corpus, as modelling embeddings over time proves computationally intensive and, due to the relatively small corpus analysed, suffers from data sparsity. Semantic distance between embeddings of concept pairs constituting innovations, calculated as cosine distance, represents the *distal novelty* of innovations (Hofstra et al., 2020), such that more semantically unusual or atypical concept combinations demonstrate greater distal novelty. Validating this approach to measurement of concept combination novelty with expert human coders, Hofstra et al. (2020) found moderate, but acceptable (Fleiss et al., 2003), intercoder agreement between distal and proximal assignments to a random set of 100 concept combinations and three coders ($\bar{\kappa}$ = .46), with coder assignments predicting ~95% of 'true' distal links (i.e., distal novelty score > .8). The mean distal novelty of links introduced within a given research paper represents the overall *distal novelty* of that paper. Notably, distal novelty is only calculable for those papers (*n*=1,433) introducing one or more novel concept combinations.

4.4.3.3. Paper Conventionality

In order to investigate the relationship between the conventionality of content addressed in papers within the field of Child-Computer Interaction and the subsequent recognition received by innovations (i.e., uptakes) and research papers (i.e., impact), the current study extends the above delineated word embedding approach (Hofstra et al., 2020), situating research papers, based on their content, within the contrived Child-Computer Interaction semantic space relative to a stipulated 'core' – here, the central, underlying concepts or concerns of the field. A novel approach was thus devised and implemented, intended to quantify the conventionality of the content of each paper through measurement of the (semantic) distance between the content of each paper and the apparent semantic core of the field, thereby intimating the similarity (or proximality) of papers' content to the central concepts of the field (i.e., *centrality,* or *conventionality*, within the field), or conversely the dissimilarity of papers' content to the central concepts of the field (i.e., *peripherality*, or *unconventionality*, within the field).

Papers were positioned relative to each other based on the dissimilarity between their respective constituent words as located within Child-Computer Interaction semantic space (based on word2vec word embeddings; see **Section 4.4.3.2** above), quantified through the *Relaxed Word Mover's Distance* (WMD; Kusner et al., 2015) metric. *Word Mover's Distance* (WMD), proposed by Kusner et al. (2015), is a distance function which measures the dissimilarity between text documents, represented as "weighted point cloud[s] of embedded words" (Kusner et al., 2015, p. 2), as the minimum Euclidean distance the embedded words of one document need to "travel" to reach the embedded words (i.e., match exactly the point cloud) of another document. Thus, building on word2vec embeddings, WMD incorporates the semantic similarity between individual word pairs into the document distance metric, defining the distance between two documents, d_0 and d_1, as the minimum (weighted) cumulative cost (here, Euclidean distance) to move all words from d_0 to d_1. The WMD metric exhibits a number of convenient properties: (a) it is hyperparameter free; (b) it is highly interpretable; and (c) it naturally incorporates knowledge encoded in the word2vec space, leading to high retrieval and classification accuracy, outperforming state-of-the-art alternative document distance metrics in terms of *k*-nearest neighbours (k-NN) classification error across several text corpora (Kusner et al., 2015; L. Wu et al., 2018) and accuracy of similarity, or relevance, scores relative to ground truth (Galke et al., 2017; Gómez & Vázquez, 2022). Atasu et al. (2017) assert that the accuracy of WMD is attributable to its capacity to capture "linguistic similarities of semantic and syntactic nature" and learn "how different writers may express the same viewpoint or topic, irrespective of whether they use same words" (p .2).

However, Kusner et al. (2015) and Gómez and Vázquez (2022) caution that for corpora with many unique words (i.e., high-dimensional) and/or a large number of documents, solution of the WMD optimal transportation problem may become prohibitive due to computational power required.

Consequently, Kusner et al. (2015) introduce “several cheap lower bounds of the WMD transportation problem that allows [users] to prune away the majority of the documents without ever computing the exact WMD distance” (p. 4), thereby alleviating a considerable portion of the computational burden associated with problem solution. One such computation approach, employed in the current study, is that of *Relaxed Word Mover’s Distance* (RWMD; Kusner et al., 2015), which provides a faster, lower-bound approximation of WMD, wherein an optimal solution for each word in d_0 is determined based on identification of the Euclidean distance to the most similar word (or ‘nearest neighbour’) in d_1. RWMD achieves comparable accuracy to that of WMD, outperforming state-of-the-art baselines, whilst reducing computation time (Atasu et al., 2017; Kusner et al., 2015). Pairwise distance between Child-Computer Interaction research papers within the field’s semantic space, as defined by word2vec word embeddings, was thus calculated through Relaxed Word Mover’s Distance.

In order to orient the position of papers relative to the semantic ‘core’ of the Child-Computer Interaction field, there is an implicit requirement to define a central point within the semantic space which may be conceived as denoting the central, underlying concepts or concerns about which the field is broadly structured. Here, determination of such a centre point within the field centre is premised on the following broad assumptions:

I. Concepts addressed throughout Child-Computer Interaction research, and the papers in which they appear, are, to varying extents, oriented towards, and aligned with, relatively stable, common (or conventional) underlying concerns related to children’s interactions with technology (see **Section 2.1**);

II. Papers published in specialised venues associated with Child-Computer Interaction (i.e., IDC and IJCCI), due to the well-defined, specialised aims and scope of these venues, address the conventional concerns of the field in a more consistent, explicit manner than papers published in non-specialised venues (e.g., general HCI venues); and

III. A central point (i.e., centroid) amongst a collection of words embedded in semantic (vector) space, here minimising the sum of the distance to each point, optimally approximates a common underlying semantic concept to which concepts in the field are (more or less) related.

Notably, with regard to assumption II, the proceedings of the Conference on Human Factors in Computing Systems (CHI) may, in addition to IDC and IJCCI, be regarded as a specialised publication venue serving the CCI community due to the establishment of subcommittees therein which, operating independent review processes, cater to research areas commonly of interest in CCI (e.g., *Learning, Education, and Families*)[4]. However, whilst the search query implemented in data retrieval (see **Section 4.4.1**) is likely to have primarily obtained CHI papers approved by relevant subcommittees, those papers retrieved were not implicitly limited to those approved by these subcommittees. Therefore, CHI papers retrieved may include relevant papers considered by other, broader subcommittees (e.g., *Privacy and Security*; *Health*; *Games and Play*; and *Design*), the review processes associated with which may be less representative of research priorities and conventional concerns of the CCI community. Consequently, as in prior reviews (e.g., Barendregt et al., 2017; Giannakos, Papamitsiou, et al., 2020; Kawas et al., 2020), only IJCCI and IDC were, for the purposes of the present analysis, considered as specialised venues associated with the field of Child-Computer Interaction.

Based upon the above intuitions, the current study defines a semantic core of the Child-Computer Interaction field through calculation of the *geometric median* of word embeddings (based on word2vec) of those words in the corpus vocabulary which appear in papers published in specialised CCI venues (i.e., IDC and IJCCI). Notably, whilst it has been demonstrated that, for such a geometric optimisation problem, there "exists *no exact* algorithm under models of computation where the root

[4] Selecting a Subcommittee, CHI 2022: https://chi2022.acm.org/for-authors/presenting/papers/selecting-a-subcommittee/

of an algebraic equation is obtained using arithmetic operations" (Bajaj, 1988, p. 177, emphasis in original), a solution may be obtained through approximation via iterative procedures in which consecutive steps seek to minimise the sum of distances to each point. One such approximation approach, applied in this study in calculating the geometric median of word embeddings, is that of Weiszfeld's algorithm (Weiszfeld & Plastria, 2009), a form of iteratively re-weighted least squares which converges to the unique, optimal solution (Chandrasekaran & Tamir, 1989; H. W. Kuhn, 1973).

Following derivation of the geometric median, represented as a vector within CCI semantic space, a 'dummy' document was contrived, whereby a paper was specified within the corpus constituted by the thirty domain general terms demonstrating greatest semantic similarity to the geometric median (based on cosine distance). Notably, terms exhibiting greatest semantic similarity to the geometric median were manually reviewed and evaluated prior to inclusion in this contrived document, retaining domain general terms considered relevant to underlying concerns addressed throughout the field and excluding highly specific terms regarded as limited in pertinence to such concerns (see **Appendix K** for terms reviewed and subsequently retained to comprise the 'core document'). Through inclusion of this dummy 'core' document in calculation of pairwise Relaxed Word Mover's Distance between documents the distance between respective Child-Computer Interaction papers and the semantic core of the field was measured, such that papers situated closer to this dummy document are understood as embodying the central, underlying (i.e., conventional) concepts or concerns of the CCI field to a greater extent than those papers situated further from this dummy document. Those papers positioned proximally to this stipulated core are therefore conceived as situated *centrally* within the field, addressing conventional concepts and concerns therein, whereas those papers positioned distally are regarded as situated *peripherally* within the field, addressing unconventional concepts and concerns.

4.4.3.4. Control Variables

Based on prior literature (see **Appendix I**), the following covariates – including a range of paper, author and topic attributes – identified as potentially influencing or confounding the relationships of interest were variously calculated and incorporated, as appropriate, into models to investigate and control for such effects:

Publication Age: Time dependence of citations and innovation uptakes, whereby earlier published papers are advantaged in terms of exposure and experience greater opportunity to accrue citations (Trapido, 2015) – and similarly innovations experience greater opportunity to be adopted in subsequent literature – is controlled through inclusion of time (in years) which has elapsed since paper publication. A quadratic term for publication age is included as paper citations (and innovation uptakes) tend to peak and decline over time (Trapido, 2015).

Nonspecialised Venue: A dummy variable indicates publication in a venue other than the field's primary, specialised venues (i.e., IDC and IJCCI) as publication within a field's primary venue has been identified as a major predictor of recognition (i.e., citation count) whilst simultaneously negatively correlated with novelty (Trapido, 2015). In the present study, as in prior studies (e.g., Giannakos, Papamitsiou, et al., 2020; Kawas et al., 2020), proceedings of the Interaction Design and Children conference series and the (IDC) International Journal of Child-Computer Interaction (IJCCI), commonly regarded as the 'primary' or 'flagship' publication venues of the CCI community (Giannakos et al., 2022; Giannakos, Papamitsiou, et al., 2020) and catering to the research interests thereof, are designated as specialised venues.

Author Count: The number of co-authors associated with a paper is included in models in order to account for the greater likelihood – compared to sole- and pair-authored papers – of atypical (i.e., novel) combinations amongst team-authored papers (Uzzi et al., 2013) and increased recognition, or 'citation premium', associated with co-authored works (Trapido, 2015; Wuchty et al., 2007) identified in prior studies.

Author Prominence: Prominence, or visibility, of authors within the field, conceived as the cumulative citation count of papers (published prior to that introducing a given innovation) respective (co-)authors have published in the field's primary venues (i.e., IDC and IJCCI), is controlled as Antons et al. (2019) demonstrate that authors who have previously published well-cited papers in relevant top journals receive, on average, more citations.

Author Productivity: Productivity, measured as the cumulative, time-varying count of papers published by respective (co-)authors, which has been associated both with increased as well as stagnant or declining impact across different fields (Heiberger et al., 2021; Kolesnikov et al., 2018) and proposed as associated with more conventional (i.e., less innovative) research (Foster et al., 2015), is included to control for such relationships in the context of Child-Computer Interaction. Given a potential non-linear relationship between productivity and impact indicated by Kolesnikov et al. (2018), such that, in certain fields, citations tend to peak and decline as productivity increases, a quadratic term for productivity is tested.

Latent Topic Structure: Papers' latent topic structure, identified as "perhaps the most important determinant of knowledge consumption and, therefore, a prime catalyst for future knowledge production" (Antons et al., 2019, p. 3070), is incorporated through inclusion of loadings (θ_d), derived through Correlated Topic Modelling (see above), for all topics associated with each paper (i.e., *K* variables) – however, adopting Antons et al.'s (2019) approach to differentiation of meaningful topic loadings, loadings below a cut-off of θ_{dk}=.1 (i.e., less than 10% of a paper's semantic content addresses a given topic) were replaced by a value of 0.

Primary Topic Trend: General (increasing or decreasing) trends in the relative prevalence (throughout the field) of primary topics addressed within papers at the time of publication, which prior studies (e.g., Leahey & Moody, 2014; Munoz-Najar Galvez et al., 2020) indicate is associated with recognition and interacts with the effect of novelty on impact, are calculated, similar to Leahey and Moody (2014), based on the slope (i.e., trajectory) of the relative prevalence of the primary topic addressed within a paper throughout the field during the preceding 3 years. A dummy variable is constructed to indicate whether, at the time of publication, a paper's primary topic demonstrated an increasing (i.e., positive slope) or decreasing (i.e., negative slope). Notably, as insufficient prior years are available to calculate a slope for the first two years of publications within the corpus, the dummy variable is respectively determined for papers published in each of these years as: (a) whether the relative prevalence of the primary topic throughout the field during this year is above or below the median; and (b) whether the relative prevalence of the primary topic throughout the field has increased or decreased since the prior year.

Topic Focus: Papers' topic focus, considered the extent to which papers focus on a narrow (or broad) set of topics, is operationalised as the relative concentration – or, alternately, diffusion – of topics within a paper, calculated as the Herfindahl-Hirschman Index (Ferguson & Hasan, 2013; Heiberger et al., 2021; Hirschman, 1964) for the discrete probability distribution over topics (θ_d) therein. Studies (e.g., Antons et al., 2019) have identified paper topic focus as associated with significantly greater scientific impact, arguing that concentration on a narrower selection of topics supports content absorption.

4.4.3.5. Novelty and Publication Venue

The relationship between novelty of Child-Computer Interaction research papers – here, the number of novel concept combinations (i.e., innovations) introduced (i.e., scientific novelty) and the unusualness or atypicality (i.e., distal novelty) thereof – and publication venue (**H1**) – here, specialised Child-Computer Interaction venues (i.e., IDC and IJCCI) and non-specialised venues (i.e., general HCI venues) – was examined through a series of regression models. The relationship between paper distal novelty and publication venue is, due to the relative normality of the distribution of distal normality, modelled through linear regression (1), whilst the relationship between scientific novelty, which is a positively skewed count, and publication venue was modelled through negative binomial regression (2), a generalisation of the Poisson model which loosens the restrictive assumption that the variance of the dependent variable is equal to its mean and accounts for overdispersion in the data (Foster et al., 2015; Trapido, 2015). The models, respectively, are:

$$\begin{aligned} distal\ novelty_a = \beta_0 + \beta_1 age_a + \beta_2 venue_a \\ + \beta_3 author\ count_a + \beta_4 productivity_a \\ + \beta_5 prominence_a \\ + \beta_6 topic\ trend_a + \beta_7 topic\ focus_a \\ + \beta_8\ \dots\ \beta_{8+K} topic\ structure_a + \varepsilon_a \end{aligned} \tag{1}$$

$$\begin{aligned} log(scientific\ novelty_a) = \beta_0 + \beta_1 age_a + \beta_2 venue_a \\ + \beta_3 author\ count_a + \beta_4 productivity_a \\ + \beta_5 prominence_a \\ + \beta_6 topic\ trend_a + \beta_7 topic\ focus_a \\ + \beta_8\ \dots\ \beta_{8+K} topic\ structure_a + \varepsilon_a \end{aligned} \tag{2}$$

where *distal novelty*$_\alpha$ represents mean semantic unusualness of novel concept combinations, and *scientific novelty*$_\alpha$ the number of novel concept combinations, introduced in paper α, and *venue*$_\alpha$ is a dummy coded binary predictor indicating paper publication venue (i.e., categorised as specialised or non-specialised venue; Pedhazur, 1997), with specialised venue designated as the reference category. Author and topic attribute variables are included to control for confounding effects: *age*$_\alpha$ indicates time (in years) elapsed since paper publication; *author count*$_\alpha$ indicates the number of co-authors associated with the paper; *productivity*$_\alpha$ is the mean count of papers (within the corpus) published by respective paper (co-)authors throughout previous years; *prominence*$_\alpha$ represents the mean citation count of papers (published prior to that introducing a given innovation) respective (co-)authors have published in the field's primary venues (i.e., IDC and IJCCI); *topic trend*$_\alpha$ is a dummy coded binary variable indicating whether the primary topic addressed within the paper demonstrates increasing or decreasing (reference category) relative prevalence within the field during the years preceding publication; *topic focus*$_\alpha$ indicates the relative concentration of topics addressed within the paper; and a series of (*K*) variables reflecting paper loadings across each topic inferred through

Correlated Topic Modelling which collectively reflect paper *topic structure*$_{\alpha}$. Distal novelty is modelled for papers exhibiting nonzero scientific novelty – that is, those papers demonstrating at least one novel concept combination (i.e., innovation; *n*=1,433) – whereas scientific novelty is modelled for all papers in the corpus (*n*=4,771).

4.4.3.6. Paper Conventionality and Innovation Uptake

Consequences of the conventionality of paper content within the field of Child-Computer Interaction, operationalised as the positioning relative to the semantic 'core' of the field (i.e., centrality/peripherality), for the subsequent uptake of innovations introduced thereby throughout ensuing research in the field (**H2**) are investigated through negative binomial regression – here, a negative binomial model was fitted as innovation uptake is a positively skewed count variable. To ensure robustness of the model in estimating the effect of content conventionality, or paper position (i.e., centrality/peripherality), within the field on the uptake of innovations, as in the previous models (1,2) specified, a set of author and topic attribute control variables are incorporated. Furthermore, distal novelty of innovations is included as a predictor to account for the fact that those more atypical or unusual innovations, by their very nature, are likely to appear less frequently throughout the field (Hofstra et al., 2020). Apart from the main effects of novelty and paper (un)conventionality – here, peripherality, or (semantic) distance from the field's 'core' – on innovation uptake, premised on the assertions of Cattani et al.'s (2015) *optimal network structuration strategy* and, drawing upon Uzzi et al.'s (2013) findings related to the differential effects of novelty of concept combinations based on their framing within conventional knowledge (see **Appendix I**), the effect of distal novelty depending on the conventionality of a paper within the field on innovation uptake was examined through inclusion of an interaction effect therebetween. Moreover, following the findings of Leahey and Moody (2014), interaction between distal novelty and trend in the primary topic addressed by a paper was explored. Thus, the model is specified as

$$
\begin{aligned}
log(uptakes_{a}) = {} & \beta_0 + \beta_1 age_a + \ \beta_2 age_\alpha^2 + \beta_3 venue_a \\
& + \beta_4 author\ count_a \ + \beta_5 productivity_a \\
& + \beta_6 productivity_\alpha^2 + \beta_7 prominence_a \\
& + \beta_8 preripherality_a + \ \beta_9 distal\ novelty_a \\
& + \beta_{10} distal\ novelty_a * peripherality_a \\
& + \beta_{11} topic\ trend_a \\
& + \beta_{12} distal\ novelty_a * topic\ trend_a \\
& + \beta_{13} topic\ focus_a \\
& + \beta_{14}\ \dots\ \beta_{14+K} topic\ structure_a + \ \varepsilon_a
\end{aligned} \tag{3}
$$

where *uptakes*$_\alpha$ denotes the number of uptakes for a given innovation, α, *peripherality*$_\alpha$ the position of the paper in which the innovation was introduced relative to (i.e., distance from) the conceptual core of the field (i.e., unconventionality), and *distal novelty*$_\alpha$ the semantic unusualness of the concept combination constituting the innovation. Innovation uptakes is modelled for all novel concept combinations identified throughout the corpus – however, whilst 8,215 individual novel concept combinations were identified throughout the corpus, duplicates arising due to simultaneous introduction of concept combinations in two or more papers (i.e., a novel concept combination first appeared in multiple articles sharing the same date of publication) resulted in inclusion of 8,960 instances of novel concept combinations in the model.

4.4.3.7. Novelty and Scientific Impact

Further exploring the consequences of novelty within the field of Child-Computer Interaction research, the effect of content novelty on the scientific impact (i.e., citations) of papers therein (**H3**) was investigated. Given that research is "cited overwhelmingly because citers recognize its usefulness rather than deficiencies" (Trapido, 2015, p. 1492), citation counts are – despite various criticisms and caveats (see Bornmann & Daniel, 2008; and Van Dalen & Klamer, 2005 for critical reviews of citation-based metrics) – commonly interpreted as a measure of the scientific recognition, knowledge consumption, and impact associated with academic work (Antons et al., 2019; Waltman, 2016; D. Wang et al., 2013). Prior analyses (e.g., Foster et al., 2015; Trapido, 2015; Uzzi et al., 2013) have indicated complex relationships between the novelty expressed within research papers and the number of citations achieved thereby. Therefore, the relationship between paper novelty, measured both as both distal and scientific novelty, and scientific impact, measured as citation count, are estimated through negative binomial regression (due to the strong positive skew in citation count distribution). Predicated on similar arguments to those supporting exploration of interaction between distal novelty and paper peripherality in the previous model (3; Cattani et al., 2015; Uzzi et al., 2013), differential effects of the number of novel concept combinations introduced within a paper (i.e., scientific novelty) on citations received depending on conventionality, or position (i.e., peripherality), of a paper within the field was explored through interaction effect therebetween. The model is therefore specified as

$$\begin{aligned} log(scientific\ impact_a) = \beta_0 + \beta_1 age_a + \ \beta_2 age_\alpha^2 + \beta_3 venue_a \\ + \beta_4 author\ count_a \ + \beta_5 productivity_a \\ + \beta_6 prominence_a \\ + \beta_7 scientific\ novelty_a + \beta_8 peripherality_a \\ + \beta_9 scientific\ novelty_a * peripherality_a \\ + \beta_{10} distal\ novelty_a \\ + \beta_{11} topic\ trend_a \\ + \beta_{12} distal\ novelty_a * topic\ trend_a \\ + \beta_{13} topic\ focus_a \\ + \beta_{14}\ \dots\ \beta_{16+K} topic\ structure_a + \ \varepsilon_a \end{aligned} \tag{4}$$

where *scientific impact*$_\alpha$ represents the citation count associated with a given paper, *α*, *scientific novelty*$_\alpha$ the number of novel concept combinations (i.e., innovations) introduced within the paper, *distal novelty*$_\alpha$ the mean semantic distance (i.e., unusualness) between concepts constituting novel combinations, and *peripherality*$_\alpha$ the position of the paper relative to the conceptual core of the field (i.e., unconventionality). Scientific impact is, excluding distal novelty as an independent variable, modelled for all papers (*n*=4,771) – however, the full model, which includes distal novelty, is fitted for the subset of papers demonstrating nonzero scientific novelty (i.e., for which *distal novelty* is calculable; *n* = 1,433).

4.4.4. Validity

Generally, methods employed in this study – including topic modelling, clustering, and word embedding – are applied as unsupervised methods in analysing text corpora which are impractical to analyse by other means, such as manual coding, due to the volume of content therein and the extensive domain expertise required in order to do so. Given the consequent absence of an external ground-truth with which to validate the substantive content of latent semantic topics, semantic relations, and trends generated therethrough, validation of the results of such methods remains challenging (Grimmer & Stewart, 2013; Hecking & Leydesdorff, 2018; Lancichinetti et al., 2015). Nonetheless, validation of the latent semantic decompositions and relationships inferred through such methods is a prerequisite of, and thereby intrinsically coupled with, the validity of conclusions drawn from these models. Indeed, "validation of the model becomes even more important when using unsupervised methods for *inference* or *measurement* than it is when used for prediction or exploration" (Roberts, Stewart, & Airoldi, 2016, p. 1000, emphasis in original).

As Quinn et al. (2010) observe, such unsupervised methods shift the user burden from determination and specification of substantive information a priori to validation of model results ex post. In order to validate unsupervised model outputs, "scholars must combine experimental, substantive, and statistical evidence to demonstrate that the measures are as conceptually valid as measures from an equivalent supervised model" (Grimmer & Stewart, 2013, p. 271). Hence, in the current instance, validity of model results – that is, results of Correlated Topic Modelling and word2vec word embedding – is established through *semantic* and *predictive validation* (Quinn et al., 2010).

Semantic validity, in relation to topic models, refers to the extent to which latent semantic topics inferred demonstrate a coherent and internally homogenous, yet distinctive (i.e., from other topics), underlying meaning, such that documents and terms associated therewith may be related to each other meaningfully (Grimmer & Stewart, 2013; Nguyen & Jenkins, 2020; Quinn et al., 2010). Due to the absence of an external ground-truth with which to assess validity of models and associated outputs, internal validation methods are necessary in measuring the adequacy of inferred topics in terms of semantic coherence and interpretability (Hecking & Leydesdorff, 2018). One such, commonly employed, criterion is that of semantic coherence (Mimno et al., 2011), which automatically measures the semantic similarity of terms associated with a topic, with this metric demonstrating broad agreement with human-judged topic coherence (Newman et al., 2010). However, studies (e.g., Aletras & Stevenson, 2014; Roberts et al., 2014; Stevens et al., 2012) have noted the susceptibility of such coherence measures to increase concurrently with number of topics. Therefore, consideration of semantic coherence, a measure of intra-topic similarity, is coupled with that of exclusivity, a measure of inter-topic similarity which reflects the uniqueness of terms associated with topics (Bischof & Airoldi, 2012; see **Appendix G**). Moreover, the labelling procedure implemented, consisting of assiduous evaluation of terms and documents associated with topics, also informs the semantic validity of topics, with Krippendorff (2018) identifying such review as the most relevant form of validity for evaluating a content analysis measure (see **Appendix H** and **Table 5.1**).

In relation to word embeddings, semantic validity concerns the extent to which embedding dimensions represent a reasonable semantic decomposition and constitute an interpretable semantic space (Senel et al., 2018). A number of studies (e.g., Chang et al., 2009; Faruqui et al., 2016; Luo et al., 2015; Murphy et al., 2012) have evaluated interpretability of the semantic space derived through word embedding using the word intrusion task, wherein, for each embedding dimension, human evaluators are presented with a set of the *K* (often 5) top-ranked words (based on the value of the target dimension for each word) along with one bottom-ranked (i.e., intruder) word (which is in the top ranks of a separate dimension) and tasked with determining the intruder word. Performances of human evaluators are used to quantify the interpretability of the embedding. Whilst evaluation based on human judgement is desirable, it often proves prohibitively expensive due to the volume of dimensions to be evaluated (Park et al., 2017; Senel et al., 2018). Therefore, the distance ratio (DR) evaluation metric for word intrusion tasks without human assessment proposed by Park et al. (2017), itself a modification of the metric proposed by Sun et al. (2016), is employed in the present study.

Premised on the intuition that the intruder word ought to be dissimilar from the top-ranked words, the proposed metric quantifies the interpretability of word embedding dimensions as the ratio of the mean (cosine) distance between top ranked words to the mean (cosine) distance between the intruder word and top ranked words (see **Appendix L** for results of this automated word intrusion task). Furthermore, similar to manual evaluation of topics inferred through topic modelling, the interpretability of the semantic space constructed through word embedding is evaluated through inspection of those words situated nearest to an arbitrary selection of concepts within the semantic space (see **Appendix M**; Hofstra et al., 2020).

Predictive validity of topic models refers to the extent to which variation in latent semantic topics inferred corresponds with exogenous events uninvolved in the measurement process (Quinn et al., 2010). Quinn et al. (2010) contend that if topics are valid, relevant external events should be reflected in, and explain, shifts in attention to related topics within documents (Grimmer, 2010; Grimmer & Stewart, 2013). Thus, trends in topic prevalence over time were examined, seeking evidence of shifts in temporal trends which may be, in part, attributable to significant external events, including technological developments (e.g., the widespread adoption of smartphone and tablet technologies from the mid to late 2000s and early 2010s respectively onward, and the broadening availability and use of social media from the mid to late 2000s onwards) and emergence of public health issues (e.g., COVID-19 pandemic; see **Section 5.3** and **Figure 5.15**).

In addition to addressing the above validity concerns, the present study seeks to support replicability and reproducibility of analyses undertaken, both through provision of detailed description of various methods utilised and acknowledgement of R packages facilitating these analyses. Whilst packages employed are indicated, where appropriate, throughout the current chapter, an extensive list of packages utilised throughout the current study – in part produced through the grateful R package (Rodríguez-Sánchez et al., 2022) – is provided in **Appendix N**, including brief notes on their use.

4.5. Qualitative Methods

Within the earlier outlined mixed methods research design (see **Section 4.2**), the second phase (Phase 2) employed qualitative methods in order to investigate processes and practices through which researchers, in contributing to the field, have (re)structured knowledge constituting the field of Child-Computer Interaction over time, including factors influencing research practices therein (**RQs 1.4**, **1.5**) and practices through which such factors are negotiated (**RQ 1.6**). The following sections detail qualitative data collection and analysis methods applied in order to address specified research questions.

4.5.1. Data Collection

Although the present study originally resolved to collect qualitative data through a series of *online focus groups* involving prominent contributors to the field of Child-Computer Interaction, due to issues related to participation and attrition which arose during the data collection process, additional, alternative data collection methods – namely online *dyadic interviews* and *semi-structured interviews* – were necessitated. These methods accommodated interrogation of involved actors – here, contributors to the field – regarding discursive practices through which knowledge constituting the field has been (re)structured (Engelhardt, 2015). Circumstances prompting the unorthodox configuration of methods implemented will firstly be briefly discussed, and respective methods and procedures of qualitative data collection employed detailed in turn throughout ensuing sections.

4.5.1.1. Circumstances Contributing to Revision of Data Collection Methods

In arranging online focus groups (see **Section 4.5.1.2** below), as initially intended, relevant methodological guidance concerning an appropriate number of sessions and participants was consulted.

Halcomb et al. (2007) argue that the "characteristics of the phenomenon under investigation to some extent define the number of groups and participants per group required for a focus group project" (p. 1004). Methodological literature (e.g., Krueger & Casey, 2000; Morgan, 1995, 1997) commonly recommends conducting a minimum of three to four focus groups in order to obtain sufficient data to facilitate identification of patterns and themes within and across groups. Morgan (1998) asserts that an adequate number of focus groups have been conducted when data saturation, whereby no new information or insight emerges through subsequent focus groups, has been achieved. The present study therefore organised three online focus groups.

Focus groups ought to be small enough for all participants to have their voices represented yet large enough to capture a range of voices (Krueger & Casey, 2000), with Santhosh et al. (2021) proposing a "U-shaped" relationship between the number of participants and the volume and depth of insights generated within sessions, such that too few participants may prevent dialogue and limit emergence of insights or progress toward thematic saturation, whereas too many participants may preclude opportunities for exploration and elaboration and limit individual participants' opportunities to contribute. Researchers have variously recommended focus groups comprise between six and twelve (Johnson & Christensen, 2017), six and ten (Langford et al., 2002; Morgan, 1997), six and nine (Krueger & Casey, 2000), and four and twelve participants (Kitzinger, 1995), generally agreeing that fewer than four participants hinders sustained conversation and more than twelve participants tends to limit each participant's opportunity to share insights. However, others (e.g., Fox, 2017; Menary et al., 2021; Poytner, 2010) suggest that synchronous *online* focus groups function most effectively with smaller numbers of participants than traditional, in-person focus groups, with researchers (e.g., Daniels et al., 2019; Fox, 2017; Kite & Phongsavan, 2017) finding small groups sizes in online contexts easier to manage and facilitating dynamic interaction. Consequently, Daniels et al. (2019) advocate organisation of a greater number of online focus groups comprised of fewer participants than when conducting traditional focus groups. Fox (2017) indicates between three and five, and Poytner (2010) between three and eight, serves as a suitable number of participants within online focus group sessions.

Notably, whilst Halliday et al. (2021) found lower attrition rates associated with online focus groups than traditional, face-to-face groups, attributing such improved attendance to increased convenience and accessibility, others (e.g., Daniels et al., 2019; Greenspan et al., 2021; Tuttas, 2015) have found online focus groups more vulnerable to attrition, indicating higher 'no-show', or non-attendance, rates amongst online participants. Tuttas (2015) surmised that, although short notice changes in availability are unavoidable when coordinating geographically dispersed professionals, the virtual methodology may distance participants from a "compelling sense of commitment to attend their scheduled meeting" (p. 129; Stewart & Shamdasani, 2017). Consequently, overrecruiting is commonly recommended by literature (e.g., Daniels et al., 2019; Menary et al., 2021; Tuttas, 2015) to account for attrition. Thus, the present study sought to recruit at least twelve participants (i.e., four per session), but endeavoured to overrecruit in anticipation of attrition.

Whilst the present study succeeded in recruiting (i.e., agreement, and consent, to participate received) twelve Child-Computer Interaction researchers (see **Section 4.5.1.6** below for details regarding recruitment), of those researchers registered to participate, three were indisposed and failed to join their allotted session without prior notice, whilst three cancelled shortly before sessions commenced due to prior appointments or commitments. Amongst those participants unable to join originally scheduled sessions, three indicated willingness, and availability, to participate in a subsequent, rescheduled session – however, two of these participants were unable to join this rescheduled session due to other commitments. Consequently, similar to previous studies (e.g., Daniels et al., 2019; Tuttas, 2015), although the study design had called for three to five participants per online focus group session, due to scheduling conflicts and last-minute attrition between one and three participants attended each session.

As a result of the short notice, or lack thereof, of participants' unavailability, 'on the spot' decisions were made to proceed with scheduled sessions as opposed to cancelling or rearranging sessions – Daniels et al. (2019) argue, should a focus group be cancelled due to insufficient attendance, there is a risk of alienating those participants who were available and rescheduling may prove challenging, potentially causing further withdrawal. Potential challenges and limitations associated with inconsistency in methods of qualitative data collection employed and (relatively) extemporaneous application of alternative methods were, the researcher determined, outweighed by the threat of further attrition posed by cancellation or rescheduling of sessions. Although neither planned nor intended, the researcher was conscious of, and prepared for, the possibility of such an eventuality given the limited number of participants recruited (i.e., failure to overrecruit) and noted likelihood of attrition, and was therefore sufficiently equipped – having consulted relevant literature – and willing to adapt to these emerging circumstances (see, for example, **Section 4.5.1.9**, detailing alterations in the role occupied by the researcher). Thus, whilst one focus group session proceeded as intended (i.e., three attendees), under-attended sessions constituted a dyadic interview (i.e., two participants) and semi-structured interviews (i.e., two single-participant sessions). Whilst there are notable differences between focus groups and both dyadic and semi-structured interviews (noted below), these alternative data collection methods nonetheless generated data concerning practices and processes through which researchers have (re)structured knowledge constituting the field of Child-Computer Interaction.

The following sections detail respective methods – here, online focus groups, dyadic interviews, and semi-structured interviews – of qualitative data collection employed.

4.5.1.2. Online Focus Groups

Focus Groups (FGs), employing a facilitated group interview technique, are exploratory moderated group discussions intended to draw out the perceptions, attitudes, and experiences from an identifiable group and pursue deeper, varied insight regarding specific phenomena (Carey & Asbury, 2016; Halcomb et al., 2007; Halliday et al., 2021; Stewart & Shamdasani, 2017; Wilson, 2016). Associated with a long history in the social sciences and finding application in a wide range of fields and settings (Stewart & Shamdasani, 2014; Stewart & Shamdasani, 2017; Morgan, 2018), focus groups are, Carey (2016) asserts, the most common method of data collection both in qualitative enquiry and as the qualitative component within mixed methods research designs, supplementing and elucidating results of quantitative analyses through addition of contextual meaning (Krueger & Casey, 2000; Tuttas, 2015).

A form of group interview which capitalises on communication between participants, focus groups explicitly incorporate interaction among participants as a core element, and fundamental mechanism, of data generation, facilitating idea elaboration amongst participants, "helping stir or retort ideas that may be missed by other methods" (Halliday et al., 2021, p. 2145), and generating data through the opinions expressed by participants both individually and collectively (Kitzinger, 1995; Morgan & Hoffman, 2018; Stewart & Shamdasani, 2017). As such, focus groups are premised on the assumption that group processes may support individuals in exploring and clarifying their views in forms which would be less easily accessible in one-to-one interview contexts (Kitzinger, 1995). Thus, within focus groups the interaction which normally occurs between an interviewer and participant is, to a considerable extent, replaced by interaction amongst participants, such that participants are encouraged to interact with each other, asking questions, exchanging insights and anecdotes, and commenting on each other's perspectives and points of view (Burton & Bruening, 2003; Kitzinger, 1995; Kitzinger & Barbour, 1999). Consequently, data generated through focus groups represent more than the sum of separate individual interviews (Halcomb et al., 2007; Watts & Ebbutt, 1987).

Group interaction supported within focus groups, Kitzinger (1995) suggests, is particularly appropriate when, as in the current study, seeking to encourage participants to explore "issues of importance to them, in their own vocabulary, generating their own questions and pursuing their own priorities" (p. 299). Adopting a semi-structured approach, focus groups enable participants to steer discussion to "topics relevant to their experiences rather than fitting their experiences into forced-choice responses" (Scott et al., 2007, p. 243). In so doing, focus groups thereby accommodate obtention of in-depth information about phenomena, generating data through, and gaining insight concerning, participants' perspectives and experiences which may be explored and used "to examine not only what people think but how they think and why they think that way" (Kitzinger, 1995, p. 299). Therefore, in comparison to other methods such as observation, interview, and questionnaires, focus groups are particularly well-suited to examination of how knowledge and ideas develop and operate within a cultural context (Kitzinger, 1995), thereby supporting the present study in addressing specified research questions.

Typically, requirements of physical attendance associated with traditional focus groups have precluded recruitment of participants from geographically diverse locations and compounded attrition rates due to inconvenience (Halliday et al., 2021). However, recent technological advancements have, in supporting online, or internet-mediated, focus groups, reduced, if not entirely eliminated, such limitations (Stewart & Shamdasani, 2017). *Online focus groups* (OFGs), internet-mediated 'communication events' which mimic the general format of traditional face-to-face focus groups (Falter et al., 2022; Lobe & Morgan, 2021; Tates et al., 2009), through utilising a variety of online and virtual platforms such as videoconferences and chat rooms, offer an alternative to traditional focus groups which supports participation of spatially, and possibly temporally, distant individuals, thereby broadening the pool of potential participants (Abrams et al., 2015; Deakin & Wakefield, 2014; Janghorban et al., 2014; Jowett et al., 2011; Lobe, 2017; Stewart & Shamdasani, 2017).

In particular, utilisation of synchronous online videoconferencing platforms which, incorporating visual and auditory components, allow for real-time (verbal, non-verbal, written, and visual) communication among multiple users dispersed across various geographical locations, has gained particular prominence as a means of data collection due to its close approximation of the face-to-face interaction characteristic of traditional focus groups (Lobe & Morgan, 2021; Stewart & Shamdasani, 2017). Virtual environments facilitated through videoconferencing are regarded as replicating features of, and closely resembling, face-to-face interactions, transmitting verbal and, to an extent, nonverbal cues, while providing unique advantages, challenges, and considerations (Archibald et al., 2019; Lo Iacono et al., 2016). Empirical research (e.g., Hoffman et al., 2012; Yee et al., 2007) indicates that online interaction tends to be similar to that of face-to-face interaction, characterised by many of the same interpersonal processes and dynamics, and generates data of comparable quality to that of traditional focus groups (Kite & Phongsavan, 2017; Reid & Reid, 2005; Underhill & Olmsted, 2003) – although Stewart and Shamdasani (2017) qualify that there are circumstances in which one form of focus group may prove more appropriate or advantageous than the other.

Although studies utilising online focus groups recognise respectful interactions, including turn-taking, amongst participants (Falter et al., 2022) and observe less 'overtalking' than in traditional focus groups (Halliday et al., 2021), challenges in the conversational flow amongst participants are evident, with participants indicating difficulty in engaging in dialogue and emotionally investing in conversation as, compared to the natural flow of in-person settings, conversation facilitated through the online platform were perceived as awkward (Falter et al., 2022). Perhaps a consequence of such difficulties, Daniels et al. (2019) observed a tendency, in online environments, for participants to produce detached statements as opposed to interactive exchanges. Studies (e.g., Archibald et al., 2019; Falter et al., 2022; Greenspan et al., 2021) also note that a majority of online focus group participants, as well as moderators, experience technical difficulties during online focus groups, including low internet bandwidth, poor connectivity, and limited webcam or microphone functionality, and frequently report inconsistent video and/or audio quality, with such issues disrupting and impeding interaction. Nonetheless, studies (e.g., Archibald et al., 2019; Deakin & Wakefield, 2014; Zwaanswijk & van Dulmen, 2014) indicate that such challenges do not appear to adversely affect perceived quality and experience of online focus groups for moderators or participants, identifying consistent preference amongst participants for synchronous videoconferencing over alternative mediums, including in-person methods. In expressing favour for participation through videoconferencing, participants frequently cite key advantages reflecting interpersonal, technical, and logistical considerations, including forming and maintaining rapport with researchers, convenience in terms accessibility and flexibility in location and scheduling, and simplicity and intuitiveness of common videoconferencing platforms (Archibald et al., 2019; Deakin & Wakefield, 2014).

Given the anticipated geographical dispersion of prominent contributors to the field of Child-Computer Interaction, as well as conditions arising due to the ongoing COVID-19 pandemic, whereby physical facilitation of traditional focus groups was rendered unethical due to potential participant endangerment and physical distancing and travel restrictions, online focus group data collection methods offered an effective means by which to obtain diverse, detailed insights concerning processes and practices through which researchers, in contributing to the field, have (re)structured knowledge constituting the field of Child-Computer Interaction over time.

As earlier noted (see **Section 4.5.1.1** above), although originally intending to collect qualitative data exclusively through a series of online focus groups, due to issues related to attendance and attrition which arose, only one online focus group was completed.

4.5.1.3. Dyadic Interviews

Dyadic interviews consist of facilitated conversation between a pair of participants, whereby participants interact in response to open-ended questions and prompts (Lobe & Morgan, 2021; Morgan et al., 2013). Affording depth and detail comparable to that obtained through individual interviews whilst simultaneously supporting interaction present in focus groups, whereby comments of one participant may draw forth responses from the other (Morgan et al., 2013), dyadic interviews, Lobe and Morgan (2021) propose, are particularly advantageous in instances – such as that encountered in the present study – where it is difficult to recruit large groups or when greater depth and detail is sought from each participant. Thus, dyadic interviews offer opportunities to capture both “social interaction and depth, when narrative is valued” (Morgan et al., 2013, p. 1283) and overcome logistical challenges associated with organisation of larger groups.

Distinct from ‘miniature focus groups’, Morgan et al. (2013) argue that the conversation between pairs of participants accommodated by dyadic interviews represents a notably different form of interaction to that of group discussion supported within focus groups associated with unique opportunities and issues (Morgan, 2015; Morgan et al., 2013, 2016). Dyadic interviews enable interaction which facilitates “sharing and comparisons based on potentially differing experiences from a range of contexts” (Daniels et al., 2019, p. 7). Here, sharing concerns participants’ extension of others’ contributions, whilst comparing involves “a process of differentiation that moves the discussion in alternative directions” (Morgan et al., 2013, p. 1277). As joint consequence of these processes, dyadic interviews produce similarities and differences in participant perspectives concerning phenomena of interest.

Empirical studies (e.g., Morgan, 2015; Morgan et al., 2013) have demonstrated the practical efficacy of dyadic interviews. Morgan and Hoffman (2018), in an investigation of participant interaction within dyadic interviews and focus groups respectively, found that participants within dyadic interviews were more likely to demonstrate explicit connections to the content of the previous speaker’s statement – that is, acknowledge the connection between their statements and those of the previous speaker – and generate more statements of agreement, indicating a higher degree of “mutual attunement” therein. Lobe and Morgan (2021), in an analysis of logistics, moderating, and interaction issues associated with focus groups and dyadic interviews found that most advantages identified – including recruitment, minimisation of distractions, encouraging reticent participants, and restoring off-topic interaction – favoured dyadic interviews, with the notable exception of volume of ideas rated as unique and relevant. Conversations produced within dyadic interviews have also been identified as more informal and free-flowing than those within focus groups (Lobe & Morgan, 2021; Morgan & Hoffman, 2018). Moreover, dyadic interview participants, relative to those participating in focus groups, generally report expressing thoughts and viewpoints with greater honesty and indicate greater comfort in participating online as opposed to face-to-face (Lobe & Morgan, 2021).

As earlier indicated (see **Section 4.5.1.1** above), one impromptu online dyadic interview was completed in the current study.

4.5.1.4. Semi-Structured Interviews

Qualitative interviews, involving interactions (of varying degrees of structure) between an interviewer and a participant, are generally concerned with generating deeply contextual accounts of participants' unique experiences, and interpretations thereof, in order to develop a better understanding of phenomena (Döringer, 2021; Edwards & Holland, 2013; Flick, 2018). Semi-structured interviews, utilised extensively as an interviewing format (Holloway & Wheeler, 2013), are guided, but not constrained, by a series of predetermined, generally open-ended, questions (i.e., interview guide; Bridges et al., 2008; Corbin & Strauss, 2014; Holloway & Wheeler, 2013). Characterised by a flexible and fluid structure, the researcher is free to alter the order, and modify the wording, of questions depending on the direction of the interview, as well as ask supplementary questions devised based on the respondent's answers in order to prompt elaboration, probe for further details and information, or seek clarification (D. E. Gray, 2018). Semi-structured interviews thus offer a means by which in-depth information may be sought in a systematic manner from participants, whilst simultaneously affording investigators the autonomy to explore pertinent perspectives revealed during the course of the interview (Adeoye-Olatunde & Olenik, 2021).

Individual interviews afford the researcher greater control over the session, whereas focus groups and dyadic interviews enable participants to "co-construct" their interpretation of research topics (Morgan et al., 2013). Furthermore, individual interviews allow participants to share information which they may have withheld in more public contexts, whereas dyadic interviews enable participants to stimulate ideas and insights which may not have been recognised or recalled otherwise (Morgan et al., 2013). Morgan et al. (2013) advise the combination of individual and dyadic interviews within the same study, as occurred – although unintended – in the present instance, both due to the differing opportunities afforded by each as well as the flexibility of such a strategy in accommodating situations in which sessions scheduled as dyadic interviews become, by necessity, one-to-one interviews.

As earlier noted (see **Section 4.5.1.1** above), two impromptu online semi-structured interviews were completed in the current study.

4.5.1.5. Technical Equipment

An appropriate videoconferencing platform through which online workshops (i.e., focus groups, dyadic interviews, and semi-structured interviews) may be accommodated for the purposes of this study was identified based on a number of selection criteria employed in previous studies (e.g., Menary et al., 2021; Tuttas, 2015). The platform was required to: (a) support meetings attended by up to six participants; (b) accommodate real-time audio and full-motion video imaging; (c) facilitate audio-visual recording of meetings; (d) offer secure storage of recordings, restricting access to the researcher; (e) require no more than moderate technical competency of participants; (f) be freely available; (g) offer access to meetings through internet browsers (i.e., not require participants to create an account or download software to attend); and (h) limit access to meetings to those invited by the researcher. Following evaluation of various videoconferencing platforms, *Microsoft Teams* (v4.11.12.0) was selected as the hosting platform for focus groups in the current study – alternative platforms considered included *Google Meet*, *Cisco's Webex*, and *Zoom*.

Microsoft Teams – or Teams – is a cloud-based unified communication and collaboration platform which offers a workspace chat environment and videoconferencing system, content sharing and file storage, and application integration (Eagle, 2021; Ilag, 2020; Microsoft, 2022; Rojabi, 2020; Sobaih et al., 2021; Tan et al., 2022). As such, Microsoft Teams brings together people and accommodates collaboration (Eagle, 2021). Microsoft Teams may be freely downloaded as desktop and mobile applications, or accessed through browsers, offering straightforward, user-friendly features and services (Rojabi, 2020). Although Microsoft Teams supports audio-visual recording of sessions, due to student account restrictions imposed by the University, such functionality was unavailable to the researcher. Consequently, sessions were recorded through *Open Broadcaster Software* (OBS) *Studio* (v27.1.3; Bailey & OBS Project Contributors, 2022), with recordings saved directly to a (subsequently encrypted) file on the researcher's device. Participants were made aware of this alternative recording format prior to commencement of recording.

All aspects of equipment and software, including conferencing, audio, and recording tools, were trialled in advance of the focus groups through practice, or mock, sessions to gain familiarity, develop competency in use, and ensure functionality (Forrestal et al., 2015; Santhosh et al., 2021; Tuttas, 2015).

4.5.1.6. Sampling and Recruitment

As in the majority of qualitative investigations, potential participants were selected on the basis of their ability to provide insight and information related to the phenomena of interest (Krueger & Casey, 2000). As asserted within the conceptual framework implemented in the current study (see **Chapter Three**), discourses – construed, following Foucault, as structured practices of sign usage – comprising the field of Child-Computer Interaction are, according to Berger and Luckmann's sociology of knowledge, interpreted by individual researchers as resources and normative rules which inform (more or less creative) (re)production of discourse through discursive practices, with the collective practices of researchers contributing to the field posited as, in turn, proceeding to (re)structure these discourses (Keller, 2011). In accordance with the propositions of SKAD (Keller, 2011), discursive practices, including their rules, resources, and reception in fields of social practice, are conceived as analytically definable and observable (more or less) in actu. Therefore, in seeking to investigate researchers' interpretation and negotiation of the multiple inconsistent, heterogenous discourses, both endogenous and exogenous to the field, which, as per Berger and Luckmann, simultaneously inform and influence discursive practices contributing to, and thereby (re)structuring, knowledge comprising the field of Child-Computer Interaction, individuals possessing abundant applicable experience in interacting with, and contributing to, the field were regarded as best placed to articulate perspectives and provide insights related to research questions addressed (Krueger & Casey, 2000; Morgan, 1997).

Purposive, or purposeful, sampling was therefore utilised in order to identify and select *information-rich* (Patton, 2002) cases – here, researchers experienced, or prominent, within the field of Child-Computer Interaction – with the intention of achieving depth of understanding (Palinkas et al., 2015). Specifically, this study implemented both *criterion-i* sampling (Patton, 2002), whereby cases meeting a pre-determined criterion of importance were identified and selected, and *maximum variation* sampling, whereby key dimensions of variation are identified and cases which vary from each other as much as possible are selected, strategies. Here, researcher percentile rank within the field, based on number of papers within the retrieved Child-Computer Interaction corpus (see **Section 5.1**) (co-)authored (97.5th percentile and above), served as the criterion applied in sampling, such that a sample comprising sufficiently experienced researchers within the field (in terms of volume of published research papers authored) was obtained. Amongst those researchers identified as sufficiently experienced within the field, maximal variance in themes of study associated with papers (co-)authored (inferred through Correlated Topic Modelling; see **Section 5.2**) was sought, such that a sample comprising researchers concerned with a diverse assortment of themes of study within the field was obtained. Such an approach ensured participants possessed sufficient relevant experience and knowledge of the field of Child-Computer Interaction whilst simultaneously accommodating a diverse array of perspectives exemplifying the complexity of the phenomena of interest (Creswell, 2005; Omona, 2013).

Notably, as consequence of the flexibility afforded by online data collection methods, whereby individuals who would otherwise be difficult, if not impossible, to assemble in a single location for in-person sessions may be included (Stewart & Shamdasani, 2017), sampling was not constrained by geographical location (i.e., confined to a particular region). Given the geographical dispersion of prominent researchers within the Child-Computer Interaction field, such an affordance accommodated inclusion of diverse perspectives and experiences.

Potential participants were contacted directly via email (public addresses were obtained, where available, from respective institutional profiles) with invitations to participate (see **Appendix O**). Invitations included a participant information sheet (see **Appendix P**) which described the study and what participation entailed, including details concerning data to be collected (and the means of collection), data storage and access procedures, de-identification of data, intended future use of data, and rights to withdraw. Invitations were also accompanied by an (opt-in) consent form (see **Appendix Q**), the completion and return of which, acknowledging comprehension of study details and agreeing to participate in the study as detailed, constituted a prerequisite for participation (see **Section 4.6**).

Invitations to participate were sent to fifty-two individuals, with a non-response rate of 60% (i.e., 31). Of those prospective participants responding to invitations, nine declined to take part in the study due to various reasons, including lack of availability and perceived lack of relevance of the study's subject matter – the latter of these reasons was most commonly cited amongst those researchers affiliated with industry stakeholders, rather than academic institutions. A number of those respondents declining to participate recommended other community members considered of potential value to the study. Observed high rate of non-response amongst invitees may, in part, be attributed to inopportune timing of invitations, which were sent throughout January 2022, coinciding with paper submission dates for IDC 2022[5] and the commencement of the academic term in many institutions which likely demanded invitees time and attention.

In order to ascertain and accommodate availability of participants, ensuring convenience of focus groups sessions, prospective participants were invited to indicate personal availability or preference for a selection of (three) session dates and times through completion of a poll hosted via Doodle[6], an online polling tool designed to support event organisation and scheduling (Daniels et al., 2019). An encrypted spreadsheet was maintained to manage scheduling data, including relevant time zone conversions (Tuttas, 2015). Based on indicated availability, participants were allocated to sessions, notified of the relevant data and time, and provided with the relevant weblink to join the session (see **Section 4.5.1.8**).

4.5.1.7. Sample

As earlier noted (see **Section 4.5.1.1**), although twelve experienced Child-Computer Interaction researchers indicated agreement, and provided consent, to participate, due to issues related to attendance and attrition, seven researchers participated in four separate workshop sessions (i.e., one focus group, one dyadic interview, and two semi-structured interviews). Participant details, as well as session attendance, are presented in **Table 4.2** below.

Participants (*n*=7), all of whom held academic posts, indicated affiliations with six institutions located in four countries across North America, Europe, and Asia – note, continent, rather than country, in which institutional affiliation is located is presented in order to maintain participant anonymity. Participants indicated a range of academic backgrounds, studying areas including Interaction Design, Learning Sciences, Computer Science, Information Systems, and Cultural Anthropology, and professional experience, including occupations in education, technology industry,

[5] Call for Full Papers and Short Papers: https://idc.acm.org/2022/call-full-short-papers/
[6] https://doodle.com/en/

and government bodies. Participants ranged in experience in the field of Child-Computer Interaction from approximately 5 to over 20 years, and exhibit a broad range of research interests, addressing a range of themes – inferred through Correlated Topic Modelling of the retrieved corpus of CCI research papers during Phase 1 analysis (see **Section 5.2**) – including methodological (e.g., *Design Methods and Techniques*), interdisciplinary (e.g., *Tangible User Interfaces*), and technology (e.g., *e-Learning Environments*) and user-needs (e.g., *Visually Impaired Children*) oriented topics throughout papers (co-)authored.

Table 4.2. *Participant details.*

Participant Code	Experience in Field of CCI [a]	Continent of Institutional Affiliation	Primary Topic Addressed in CCI Papers (Co)Authored [b]	Secondary Topic Addressed in CCI Papers (Co)Authored [b]	Data Collection Method [c]
P1	>5 years	Europe	*Participatory Design*	*Visually Impaired Children*	DI
P2	>10 years	Europe	*Participatory Design*	*Making and Makerspaces*	SSI (1)
P3	>10 years	Europe	*Participatory Design*	*Making and Makerspaces*	FG
P4	~20 years	North America	*Design Methods and Techniques*	*Participatory Design*	SSI (2)
P5	~ 5 years	Europe	*Internet Competencies (Information Retrieval, Privacy, Security)*	*Design Methods and Techniques*	FG
P6	~ 10 years	Asia	*Tangible User Interfaces*	*e-Learning Environments*	DI
P7	>10 years	Europe	*Making and Makerspaces*	*Tangible User Interfaces*	FG

[a] Years since researcher first appeared as a (co-)author of a published research paper in the field of Child-Computer Interaction (based on the corpus retrieved during Phase 1 of the current study; see **Section 5.1**).
[b] Inferred through Correlated Topic Modelling of the corpus retrieved during Phase 1 of the current study (see **Section 5.2**)
[c] Codes: DI, Dyadic Interview; SSI, Semi-Structured Interview; FG, Focus Group.

4.5.1.8. Procedure

Prior to each session, participants were contacted via email in order to confirm attendance of the scheduled focus group session, along with a reminder to complete the consent form (if not yet completed) prior to the session, as well as a weblink to access the scheduled meeting. If participants remained uncertain on the use of Teams, further instruction and assistance was provided. The researcher began the meeting 15 minutes prior to the allocated start time, troubleshooting any technical issues arising.

At the beginning of each session, participants were informed the session would be recorded, and requested to keep their audio and video on, if possible, throughout the discussion in order to facilitate a natural flow of conversation, prevent occurrence of overtalking or interruption, support the capture of both verbal and non-verbal communication, and aid subsequent transcription (Halliday et al., 2021). Relevant details related to informed consent and confidentiality were reiterated at the beginning of each session, inviting questions from participants and providing clarification where necessary (L. Gray et al., 2020; Halcomb et al., 2007). Whilst information concerning the recording of focus groups had been previously disclosed and consented to by participants, participants' consent to be recorded was verbally reconfirmed prior to commencement of recording. Participants were reminded of research objectives and encouraged to talk to each other, rather than address themselves to the moderator, in order to allow the discussion to proceed with limited moderator participation (Burton & Bruening, 2003; Kitzinger, 1995).

Sessions were moderated by the researcher in order to facilitate discussion within predetermined parameters and ensure equitable participation. In order to instigate and direct conversations and elicit germane perspectives and experiences, as well as support consistency and comparability between data generated within each group, sessions were structured by a *discussion guide* (Menary et al., 2021; Stewart & Shamdasani, 2017) or *questioning route* (Krueger & Casey, 2000; see **Appendix R**). As Lunt and Livingstone (1996) argue, "the ideal group should more or less run itself with the interviewer occasionally prodding, provoking, or reorienting the discussion" (p. 88). Therefore, throughout sessions, the researcher strategically engaged in *structured eavesdropping* (Kitzinger, 1995), taking a 'back seat' as participants led the discussion, intervening where appropriate in order to seed and structure conversation; prompt discussion and debate to continue beyond a point at which it might otherwise conclude; stimulate articulation, clarification, and elaboration; and encourage the group to discuss inconsistencies or discrepancies between participants and within their own thinking. Thus, the researcher remained proactive in progressing discussion, probing, and following up on answers to questions with requests for additional information, clarification, and input from other participants (Stewart & Shamdasani, 2017; see **Section 4.5.1.9** below for further discussion concerning the researcher's role throughout sessions). Conscious of relational and power dynamics which may exist, or emerge, amongst group session (i.e., focus group, dyadic interview) participants, contributing to dominance or marginalisation of certain voices therein, the researcher was prepared to intervene, directing prompts and steering discussion in order to ensure equitable participation - however, such action was generally unnecessary, with interaction amongst participants cordial and conversational, and all participants actively contributing to discussion to similar extents.

Written notes were maintained by the researcher throughout sessions. Although recordings of sessions provided data with which verbatim transcripts were produced, note-taking recorded notable quotes and statements for scrutiny during analysis, key points and themes which emerged, and follow-up questions which may be pursued (Krueger & Casey, 2000). Notes thus provided additional context to recordings and highlighted key verbal and non-verbal moments of the discussion to be attended to during analysis (Halliday et al., 2021). Moreover, reflexive journaling, or *self-debriefing* (Falter et al., 2022), was undertaken following each session, detailing experiences of, observations made about, and critical reflections upon, the focus group session (Daniels et al., 2019). Such reflective commentary provided transparency and facilitated reflexive evaluation of the effectiveness of the chosen method (Daniels et al., 2019; Shenton, 2004).

Prior to the conclusion of sessions, the researcher summarised the discussion and invited participants to share any thoughts or ask any questions they had regarding the session, or the study more broadly (Falter et al., 2022; Roulston, 2010). Participants were also invited to contact the researcher privately, via email, should they wish to record private comments after completion of the group session or address further any topic which arose. Following conclusion of the session, the researcher reiterated details regarding confidentiality and anonymity. The researcher remained in the call for a short time after the end of the focus group in order to give participants the opportunity to address issues or concerns (Sim & Waterfield, 2019).

Sessions were undertaken as focus groups (one session, three participants), dyadic interviews (one session, two participants), and semi-structured interviews (two sessions, one participant each), and ranged from 55 minutes to 1 hour 25 minutes in length.

4.5.1.9. Alterations in the Role of the Researcher

Whilst a similar structure, and approach to moderation, was implemented throughout sessions, adaptations were made to account for the differing data collection methods necessitated by attrition and non-attendance (i.e., dyadic and semi-structured interviews; see **Section 4.5.1.1**). In particular, the role the researcher fulfilled throughout workshops was modified in order to capitalise upon the affordances, and minimise the challenges and limitations, of respective methods.

Whereas during the focus group session, as indicated above (see **Section 4.5.1.8**), the researcher primarily engaged in structured eavesdropping and primarily intervened to stimulate discussion amongst participants and ensure equitable participation, during dyadic and semi-structured interviews the researcher sought to proportionately compensate for the reduction in, or absence of, communication and interaction *between* participants which characterises focus groups through engagement as an active conversant. Consequently, in addition to structuring and stimulating discussion based on the questioning route developed (see **Appendix R**), the researcher, where appropriate, acted to probe, challenge, provoke, and seek clarification and elaboration from, participants. Additionally, during the dyadic interview, the researcher, availing of the affordances of this method, directed participant attention towards, and encouraged exploration of, differences and similarities in participant perspectives and interpretations, whilst throughout semi-structured interviews the researcher probed participant responses in order to obtain greater depth and detail.

In so doing, the researcher broadly maintained a conversational dynamic throughout sessions and generated relatively consistent, comparable data – although implicit differences in resultant dynamics pervading sessions cannot be dismissed, with distinct, ineradicable relational and power dynamics inevitably forming between the researcher, a doctoral student and relative newcomer to the CCI community, and participant(s), prominent CCI community members, which inherently differed to those forming amongst group session (i.e., focus group, dyadic interview) participants. Conscious of potential consequences of such dynamics, the researcher remained vigilant towards dominance or marginalisation within sessions, prepared to (re)direct discussion in order to mitigate negative effects which may arise due to emergent dynamics – notably, however, such issues were not perceived to arise in the present study.

4.5.1.10. Transcription

Session recordings were transcribed verbatim by the researcher. Additional reflexive journal entries were made during transcription, recording notable statements and discussions, as well as apparent patterns and nascent themes within the data for consideration during subsequent analysis. Identifiable information was pseudonymised in transcripts in order to maintain participant confidentiality (see **Section 4.6**).

4.5.2. Phase 2 Data Analysis: Thematic Analysis

Thematic analysis (TA) is a method for identification, analysis, and interpretation of patterns of meaning, or themes, within qualitative data (Braun & Clarke, 2006; Clarke & Braun, 2017; Maguire & Delahunt, 2017). Constituting a form of pattern recognition within data, thematic analysis entails searching across data to identify repeated patterns of meaning, or *themes*, which emerge as being important to the description or explanation of phenomena of interest (Braun & Clarke, 2006; Daly et al., 1997). In addition to describing, or summarising, data content, thematic analysis aims to identify and interpret key features and dimensions of the data, guided by research questions, thereby elucidating investigated phenomena (Clarke & Braun, 2017; Gale et al., 2013; Maguire & Delahunt, 2017). As such, Braun and Clarke (2006) argue, thematic analysis serves as a method through which "to reflect reality and to unpick or unravel the surface of 'reality'" (p. 81), although stress the importance of a clear theoretical position in any such analysis. Thus, thematic analysis may facilitate identification of "patterns within and across data in relation to participants' lived experience, views and perspectives, and behavior and practices" (Clarke & Braun, 2017, p. 297; N. King, 2004).

A distinguishing feature of thematic analysis is the flexibility and adaptability associated therewith (Kiger & Varpio, 2020). Generally – although not without contention (e.g., Boyatzis, 1998; Holloway & Todres, 2003) – regarded as providing a method (i.e., a tool or technique, unbounded by particular epistemological or theoretical commitments) rather than a methodology (i.e., a theoretically informed, and constrained, framework for research), thematic analysis is compatible with, and may be applied within, a range of theoretical and epistemological frameworks (Braun & Clarke, 2006, 2014; Clarke & Braun, 2017). In addition to theoretical and epistemological flexibility, Clarke and Braun (2017) identify thematic analysis as flexible "in terms of research question, sample size and constitution, data collection method, and approaches to meaning generation" (p. 297). Consequently, thematic analysis provides a highly flexible approach which can be modified to the needs of a specific study and "potentially provide a rich and detailed, yet complex, account of data" (Braun & Clarke, 2006, p. 78).

Thematic analysis is considered a relatively straightforward form of qualitative analysis, offering a toolkit which, whilst accessible, may support robust and sophisticated analyses of data (Braun & Clarke, 2014). Specifically, thematic analysis provides systematic procedures for generation of codes – the smallest units of analysis which capture features of the data (potentially) relevant to research questions – which, in turn, constitute themes – patterns of meaning underpinned by a central organising, or core, concept (Clarke & Braun, 2017). Resultant themes represent interpretive concepts or propositions which describe or explain aspects of the data with respect to research questions and provide a framework with which analytic observations may be organised and reported.

A variety of approaches to thematic analysis have been proposed within extent literature (e.g., Aronson, 1995; Attride-Stirling, 2001; Boyatzis, 1998; Joffe, 2011; Tuckett, 2005). The current study adopts a systematic approach derived from the analytic process delineated by Braun and Clarke (2006), which offers flexible guidelines which may be applied as appropriate given research questions and data. Although presented here as a linear process of progression through phases, analysis constituted an iterative and reflective process involving constant movement back and forth between phases (Copestake et al., 2019; Maguire & Delahunt, 2017; Nowell et al., 2017). Phases of analysis were as follows:

1. *Familiarisation with Data.* Familiarity with the data was developed through the transcription process, as well as subsequent prolonged engagement (i.e., *immersion*) with data through repeated reading of transcripts, and triangulation of transcript data with contextual and reflective notes recorded during data collection, and reflexive journal entries documented following sessions (Braun & Clarke, 2006; Gale et al., 2013; Nowell et al., 2017). As advocated by Braun and Clarke (2006), an *active* approach to reading the data was employed, searching for meanings and patterns, and noting initial impressions. Notes were archived with dates in order to "provide an audit trail and a means of confirming […] data analysis and interpretations for adequacy" (Nowell et al., 2017, p. 5).

2. *Generation of Initial Codes.* Interesting features of the data were coded in a systematic manner across the entire dataset, whereby a paraphrase or label (i.e., code) was assigned to 'meaning segments' – here, phrases, sentences, and paragraphs interpretated as important in the context of the study – in transcripts, indexing, and subsequently collating, segments related to themes or issues in the data (Gale et al., 2013; N. King, 2004). Initial production of codes, Nowell et al. (2017) argues, represents a theorising activity which requires repeatedly revisiting the data, and proceeds through a process of reflection upon, interaction with, and consideration of, the data. Codes produced therethrough denote semantic or latent features of the data perceived as interesting, and represent "the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon" (Boyatzis, 1998, p. 63). The coding process thus "involved recognizing (seeing) an important moment and encoding it (seeing it as something) prior to a process of interpretation" (Fereday & Muir-Cochrane, 2006, p. 83).

   This study applied Fereday and Muir-Cochrane's (2006) hybrid approach of inductive and deductive coding, integrating data-driven codes, generated through open coding, with pre-specified codes informed by the results of quantitative analysis (i.e., Phase 1) and conceptual framework (see **Chapter Three**). This coding method incorporates both the data-driven inductive approach of Boyatzis (1998) and the deductive, a priori coding approach outlined by Crabtree and Miller (1999). A hybrid approach complemented the research questions specified and the mixed methods research design implemented, enabling exploration of specific issues through deductive coding whilst accommodating discovery of aspects of participants' experiences or ways in which they assigned meaning to phenomena (Fereday & Muir-Cochrane, 2006; Gale et al., 2013). Therefore, systematically working through the entire data set, segments regarded as relevant to, or specifically addressing, research questions were identified and either assigned an existing code or formed the basis for the generation of new codes (see **Appendix S** for codebook developed). Reflexive journaling throughout the coding process recorded emerging impressions and evolution of thoughts and ideas concerning the definition of, and relationships between, codes, establishing an auditable trail.

3. *Identification of Themes.* Codes, and relevant coded data extracts, were collated into potential themes, regarded as substantive concepts which link portions of the data, identified by codes, together and capture “something significant or interesting about the data and/or research question” (Maguire & Delahunt, 2017, p. 6). Themes represent “an abstract entity that brings meaning and identity to a recurrent experience and its variant manifestations”, thereby capturing and unifying “the nature or basis of the experience into a meaningful whole” (DeSantis & Ugarriza, 2000, p. 362). Codes were, therefore, analysed with consideration of relationships therebetween and how they may relate to, or cohere around, shared overarching themes, and were consequently grouped logically, ‘like with like’, such that resultant themes reflected significant concepts which connected substantial portions of the data together (Braun & Clarke, 2006; Harding & Whitehead, 2013). Similar to Nowell et al.’s (2017) approach, themes were generated both deductively, informed by the conceptual framework adopted and research questions specified, and inductively, driven by the data (see **Appendix T** for initial themes).

   A thematic map was devised, proceeding through several iterations, in order to support exploration of relationships between codes, between themes, and between different levels of themes (Braun & Clarke, 2006; Nowell et al., 2017; see **Appendix V**). Notably, the purpose of such diagramming was not to construct a model, but to visualise themes and how they fit together. In so doing, conceptual relationships identified amongst themes established a hierarchy of themes and subthemes (Harding & Whitehead, 2013).

4. *Review of Themes.* Themes were reviewed both in relation to the coded abstracts associated therewith, examining whether collated extracts appear to form a coherent pattern, and the entire dataset, considering the validity of themes in relation to the dataset and whether

themes accurately reflect meanings evident within the dataset as a whole (Braun & Clarke, 2006). During review of themes, Patton's (2002) dual criteria for judging categories, *internal homogeneity* and *external heterogeneity*, were considered, such that data within themes ought to cohere together meaningfully, with discernible distinctions between themes.

Throughout the course of review, inadequacies in initial coding and themes were identified, necessitating various modifications and refinements (Braun & Clarke, 2006; N. King, 2004). Through an ongoing, 'organic process' (Braun & Clarke, 2006), data were recoded as relevant issues inadequately represented within existing codes were identified, requiring insertion of new codes, and codes which demonstrated substantial overlap with others were removed. Upon review, it became evident that some themes were not adequately supported within the data or that data constituting a theme were too diverse, prompting the collapsing of some themes into each other as well as the breaking down of others into separate themes (see **Appendix U** for revised themes).

5. *Definition and Naming of Themes.* Themes were defined and further refined, whereby the 'essence' of what each theme represented was identified and the aspect of the data each theme captures determined through review of collated data extracts for each theme and organisation of extracts into a coherent, internally consistent account, with an accompanying narrative (Braun & Clarke, 2006). Definitions and representative labels were thereby formulated and assigned to each theme.

4.5.3. Trustworthiness

Subject to considerable debate, validity and reliability are generally not held to be applicable in evaluating the findings of qualitative research, due largely to perceived alignment with a positivist paradigm (Cypress, 2017; Harding & Whitehead, 2013). A number of researchers (e.g., Davies & Dodd, 2002; Krefting, 1991; Stenbacka, 2001), whilst maintaining the necessity of rigorous standards, have argued that quantitatively defined terms, and associated indicators, of reliability and validity are incompatible with qualitative research. Consequently, researchers (e.g., Davies & Dodd, 2002; Lincoln & Guba, 1985; Seale, 1999; Stenbacka, 2001) have argued that concepts of reliability and validity ought to be reconceived and redefined in qualitative research. Therefore, the current study, in pursuing rigour, is instead concerned with establishing *trustworthiness* (Lincoln & Guba, 1985), referring to the quality, authenticity, and truthfulness of findings.

Lincoln and Guba (1985) establish a set of criteria for evaluating trustworthiness of qualitative research findings, intended to "aid inquirers in monitoring themselves and in guiding activities in the field, as a way of determining whether or not various stages in the research are meeting standards for quality and rigor" (Guba & Lincoln, 1982, p. 248). Paralleling conventional assessment of rigour, Lincoln and Guba (1985) introduce criteria of: *credibility*, concerned with 'truth value', or confidence in the 'truth', of the findings; *transferability*, concerned with applicability of findings in different contexts or with different subjects; *dependability*, concerning the consistency or stability of findings under replication; and *confirmability,* concerned with establishing findings as clearly derived from the data.

Credibility, addressing the accurate and truthful representation of participants' perspectives and lived experience (Guba & Lincoln, 1989; Tobin & Begley, 2004), was achieved through peer debriefing, conducted through discussion with expert qualitative researchers (here, the researcher's supervisors), thereby providing an external critique of research processes. Transferability, referring to the generalisability of inquiry (Lincoln & Guba, 1985; Nowell et al., 2017), was enhanced through application of purposive sampling methods and provision of thick descriptions of data collection and analysis procedures. Dependability, judged as the adequacy of reporting in presenting a logical, traceable, and clearly document research process (Harding & Whitehead, 2013), and confirmability, concerned with establishing appropriateness of interpretations and findings derived from the data, were determined simultaneously through an *inquiry audit* (Guba & Lincoln, 1982; Lincoln & Guba, 1985). An *audit* (or *decision*) *trail* (Guba & Lincoln, 1982; Sandelowski, 1986) – documentation delineating, and providing evidence of, theoretical, methodological, and analytical decisions and activities throughout the study (e.g., raw data, field notes, findings, process notes, reflexive journal entries) – was maintained throughout the study and subsequently reviewed by expert qualitative researchers (here, the researcher's supervisors), examining the process and product of inquiry and determining the acceptability and internal coherence thereof.

4.6. Ethical Considerations

Ethical approval for the current study was granted by the Departmental Research Ethics Committee (DREC) for the Department of Education, on behalf of the University of Oxford Central University Research Ethics Committee (CUREC; CUREC no.: ED-C1A-19-184; see **Appendices W**, **X**, **Y**, and **Z**). The current study adhered to ethical principles and guidance provided by the Social Research Association (Social Research Association, 2021) and Association of Internet Researchers (Franzke et al., 2020).

A central principle of ethical research concerns the right of prospective participants to make an informed choice regarding their participation (i.e., informed consent), whereby prospective participants are made aware of relevant study information and subsequently indicate whether they wish to participate (Groundwater-Smith et al., 2015; Howe & Moses, 1999). Potential participants were provided with an information sheet which detailed the study, including information concerning data collection, storage, and access procedures; risks to participants; rights to withdraw; confidentiality; and complaints procedures, with relevant contact details for further enquiries (see **Appendix P**). Completion and return of an accompanying (opt-in) consent form (see **Appendix Q**), indicating agreement to participate in the study as detailed (including audio-visual recording of workshops) constituted a prerequisite for participation. In addition to providing information in advance of sessions, a briefing prior to commencement of the discussion reiterated salient information concerning the purpose and recording of sessions, thereby managing participants' expectations for the session, affording participants an opportunity to reflect on, and reconsider, their decision to participate which is closer than the formal consent process to the context of such participation, and providing an opportunity to withdraw less obtrusively than would be the case once the discussion had begun (Sim & Waterfield, 2019).

Confidentiality, relating to the anonymity of participants and non-disclosure of potentially identifying information, is considered an 'endemic' ethical challenge in the context of focus groups and dyadic interviews (Tolich, 2009) due to the researcher's limited control over what participants may subsequently communicate beyond the session. During the briefing prior to commencing discussion, a set of ground rules were discussed and negotiated with participants, wherein the public nature of the focus group or dyadic interview, and the need for confidentiality and anonymity were emphasised, and guidance on subjects which may be unsuitable to address during discussion – here, issues directly related to 'sensitive personal data', as defined within the ESRC's *Framework for Research Ethics* (ESRC, 2010) and European Union's *General Data Protection Regulation*[7] (General Data Protection Regulation, 2016; Hoofnagle et al., 2019) – was provided. In order to maintain confidentiality in analysis and reporting, session transcripts were de-identified through pseudonymisation or removal of any information considered personally identifiable. Removed identifiers were retained in a separate, encrypted file (accessible only to the researcher) to support data linkage if required. Furthermore, video recordings of sessions, which supported speaker identification and accuracy in transcription, were securely destroyed using tools provided by the University IT service following transcription, retaining audio recordings in an encrypted file.

Whilst privacy information was not provided to individuals related to whom data was retrieved from Elsevier's Scopus database (i.e., paper authors) due to the disproportionate effort which would be required to do so, relevant privacy information is assumed to have been provided, or made

[7] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L 119 (Accessed 12/12/2021) <http://data.europa.eu/eli/reg/2016/679/2016-05-04/eng>

accessible, by publishers or editors, and agreed to by individual authors, upon submission or acceptance of manuscripts as Elsevier's *Content Policy and Selection*[8] (Elsevier, 2020) requires all indexed serial content provide clear and publicly available statements of publication ethics. Data retrieval and processing were undertaken pursuant to, and compliant with, the permissions and conditions stipulated by Elsevier's *Text and Data Mining policy*[9] (Elsevier, 2019). As recommended by literature (Buck & Ralston, 2021; Charlesworth & Tonkin, 2016; Cooper & Coetzee, 2020; Zook et al., 2017) concerning the use of (semi-)publicly accessible data, this study places data in the proper context, including documenting the provenance of data (see **Section 4.4.1**) and acknowledging assumptions and biases therein (addressed in **Section 9.2.1**).

Data management procedures adhered to CUREC best practice guidance concerning *Management and Protection of Data Collected for Research Purposes*[10] and Consortium of European Social Science Data Archives (CESSDA) data management guidance (CESSDA Training Team, 2020). A Data Protection Screening (DPS) and Data Protection Impact Assessment (DPIA) were completed and submitted for consultation of the University's Information Compliance Office (ICO), with revisions to data management procedures implemented based on recommendations of the ICO (see **Appendix AA**). Data (i.e., de-identified transcripts, audio recordings, retrieved text corpus) were stored locally in encrypted files on the researcher's personal device (password-protected) and on OneDrive for Business, as provided by the University and approved by the University's Information Security team. Identifiable data (participant details) were stored locally in a separate, encrypted file to transcripts. Data will be retained and stored securely for at least three years following doctoral completion, after which time data may be securely destroyed should they no longer be of use in research.

[8] Elsevier, Content Policy and Selection (Accessed 01/03/2022) <https://www.elsevier.com/solutions/scopus/how-scopus-works/content/content-policy-and-selection>

[9] Elsevier, Text and data mining policy (Accessed 01/03/2022) <https://www.elsevier.com/about/policies/text-and-data-mining>

[10] Central University Research Ethics Committee (CUREC), Management and Protection of Data Collected for Research Purposes, Best Practice Guidance 09_Version 4.5 (Accessed 14/12/2021) <https://researchsupport.admin.ox.ac.uk/files/bpg09datacollectionandmanagementpdf>

Chapter Five: Mapping the Thematic Landscape of Child-Computer Interaction

This chapter presents the results and findings of quantitative data analyses undertaken during Phase 1 of the mixed methods research design implemented in the present study. The chapter begins by introducing the retrieved corpus of Child-Computer Interaction research papers which serves as the subject of analyses conducted during both Phase 1 and 3 of the present study, describing pertinent features thereof, and proceeds to detail the results of topic modelling of the corpus, including trends in, and interactions between, inferred topics of study. In doing so, a number of research questions specified in the previous chapter (**RQs 1.1**, **1.2**, **1.3**) are addressed and an extensive overview of the thematic landscape of the field of Child-Computer Interaction and its development throughout the period 2003 to 2021 is provided. Results of Phase 1 analyses presented serve to inform, and are subsequently integrated during discussion (see **Chapter Eight**) with the results of, succeeding phases.

5.1. Retrieved Corpus

Search queries (see **Table 4.1**) submitted to Elsevier's Scopus on the 8th June 2021 identified, and retrieved bibliographic data related to, 6,158 research papers. Following manual review and curation, a corpus of 4,771 Child-Computer Interaction research papers (842,045 words) was retained for analysis.

The volume of Child-Computer Interaction research papers published annually throughout the period of interest (i.e., 2003 to 2021) demonstrated an increasing trend over time (τ = .82, p <.001; see **Figure 5.1**). On average, 251 CCI research papers were published each year during this period. It ought to be noted that an evident decrease in papers published during 2021 is attributable to the timing of data retrieval, such that papers published in the latter half of the year (i.e., after 8th June) were unavailable at the time of data retrieval.

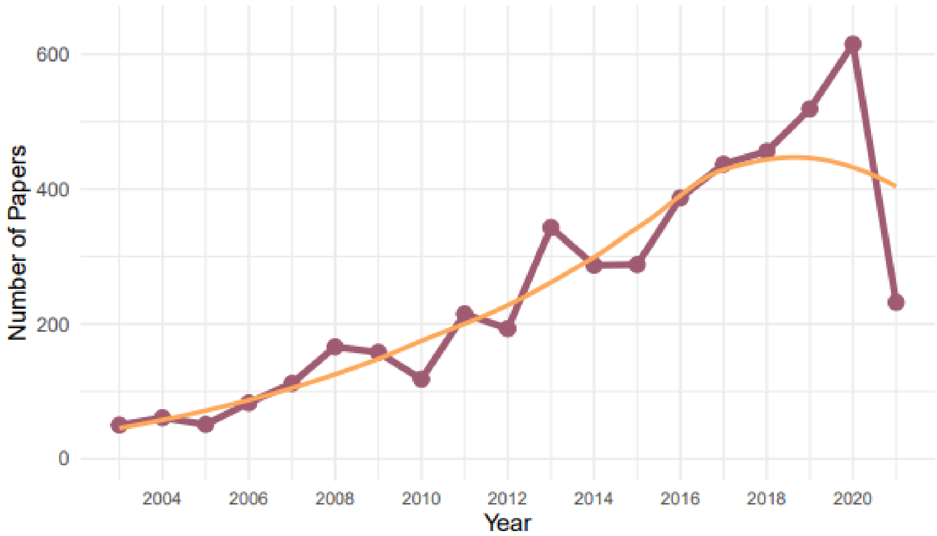


Figure 5.1. *Number of Child-Computer Interaction research papers published annually during the period 2003 to 2021. LOESS smoothed (α=.75) trend in orange.*

5.1.1. Publication Venue

Of the retained papers, 2,706 were published in conference proceedings, 1,536 in academic journals, 507 in book series, and 22 in trade journals. Child-computer interaction papers were published in the field's primary venues, the proceedings of the Interaction Design and Children (IDC) conference (1,209 papers) and the International Journal of Child-Computer Interaction (IJCCI; 168 papers), as well as a range of venues – here, the number of which (135) includes multiple conference proceedings pertaining to the same conference series (i.e., proceedings bearing different names published for different years of the same series) – associated with neighbouring and related fields (e.g., Human-Computer Interaction), including conferences (2,006 papers) and journals (1,388 papers; see **Figure 5.2**).

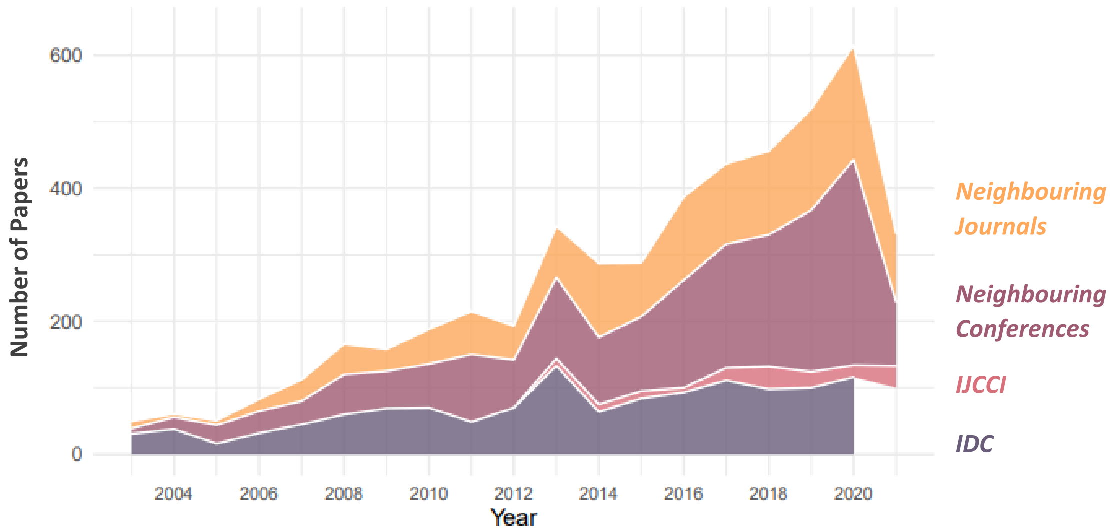


Figure 5.2. *Number of Child-Computer Interaction research papers published annually in different types of publication venue during the period 2003 to 2021. Note, the 2021 proceedings of IDC were not yet published at the time of data retrieval.*

Amongst these publication venues, those which published the greatest number of Child-Computer Interaction research papers during the period of interest were the proceedings of the *Interaction Design and Children* (IDC) Conference (1,209 papers), proceedings of the *Conference on Human Factors in Computing Systems* (CHI; 673), and the *Advances in Intelligent Systems and Computing* book series (355; see **Figure 5.3**).

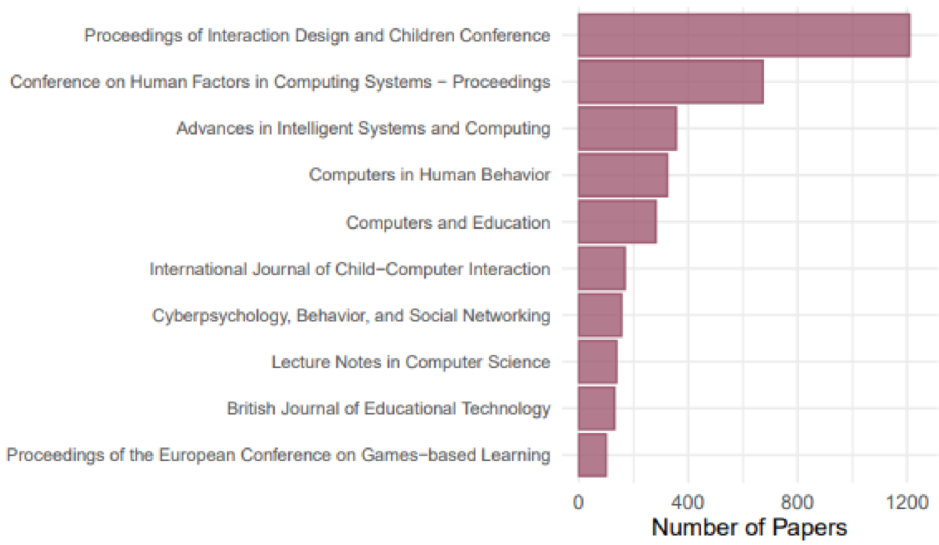


Figure 5.3. *Venues in which the greatest number of Child-Computer Interaction research papers were published during the period 2003 to 2021.*

5.1.2. Authors and Affiliations

10,638 individual authors contributed to (i.e., [co-]authored) Child-Computer Interaction research papers published during the period 2003 to 2021 – however, it ought to be noted that variations of the authors' names arising due to inconsistencies in naming conventions adopted by the author or publication venues, construed as distinct authors, may inflate the apparent number of authors contributing to the field. The number of unique authors publishing CCI research papers each year increased over time (see **Figure 5.4**). Collaboration amongst authors was common throughout the period of interest, with 4,273 (89.6%) of CCI research papers involving two or more co-authors. The average number of authors contributing to each CCI research paper increased steadily over time (see **Figure 5.4**).

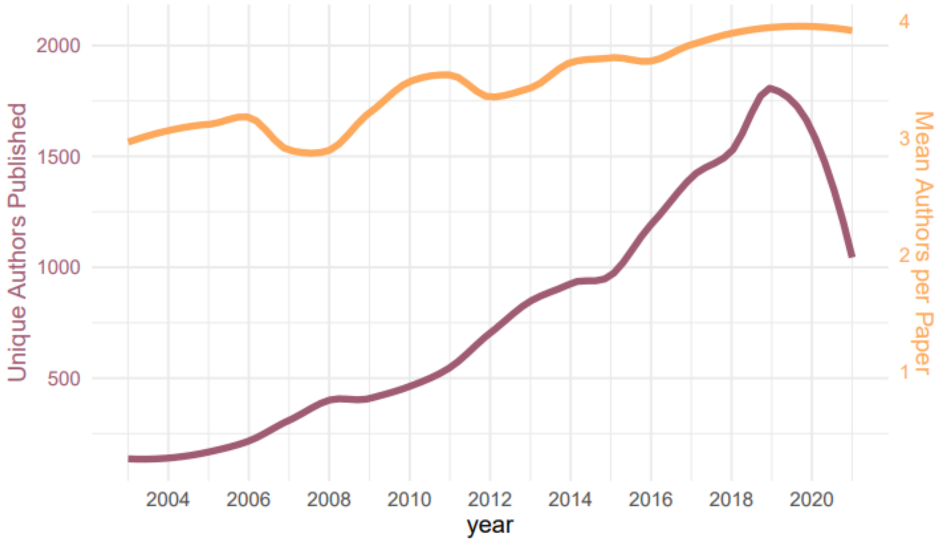


Figure 5.4. *Number of unique authors published annually, and mean number of authors per paper annually, in the field of Child-Computer Interaction during the period 2003 to 2021. LOESS smoothed (α=.4).*

Authors contributing to CCI research papers published during the period 2003 to 2021 indicated affiliations with 2,516 institutions (both academic and non-academic). Of these institutions, authors affiliated with Technische Universiteit Eindhoven (121 author affiliations), University of Central Lancashire (106), and University of Washington (106) contributed to the greatest number of papers (see **Figure 5.5**).

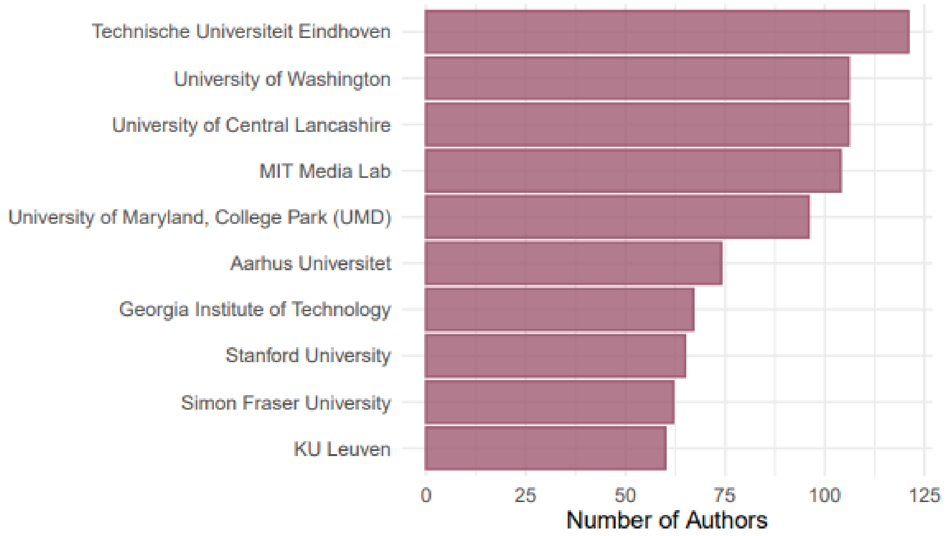


Figure 5.5. *Institutions with which the greatest number of authors of Child-Computer Interaction research papers published during the period 2003 to 2021 indicated affiliation.*

Of the institutions with which authors indicated affiliation, 317 (17.8%) were identified as non-academic – here, non-university – partners, with authors affiliated with these non-academic partners contributing to (i.e., [co-]authoring) 447 CCI research papers throughout the period of interest. A number of categories by which these non-academic partners could be classified were determined, identified through systematic term searches (see **Figure 5.6**). Amongst identified non-academic partners with which authors indicated affiliation, authors affiliated with partners categorised as companies or corporations (226 author affiliations); hospitals, clinics, and health services (100); and research organisations, centres, and groups (64) contributed to the greatest number of papers.

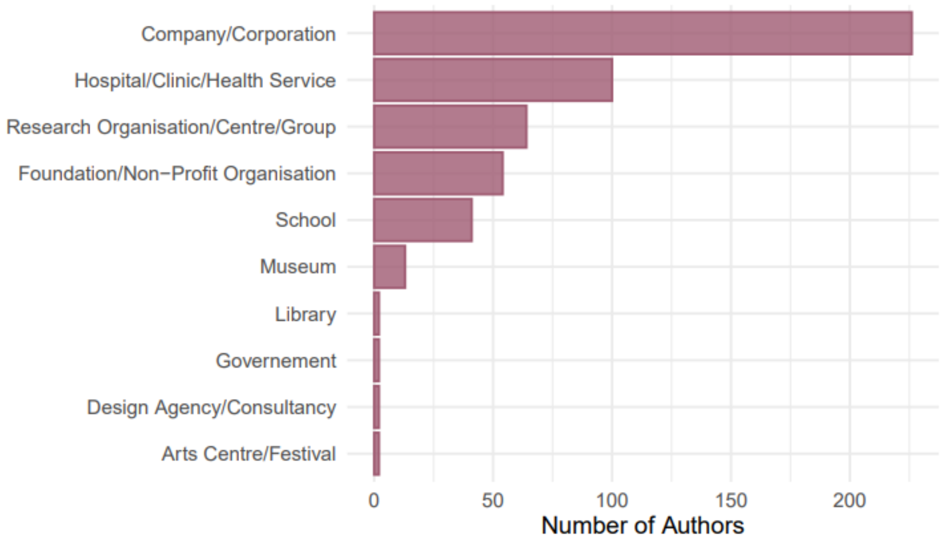


Figure 5.6. *Number of authors contributing to Child-Computer Interaction research papers published during the period 2003 to 2021 affiliated with categories of non-academic partner.*

2,124 (44.52%) CCI research papers published during the period 2003 to 2021 involved inter-institutional collaboration – that is, co-authors affiliated with at least two different institutions. Of these inter-institutional collaborations, the most productive in terms of papers published were those involving authors affiliated with Kobe University and Tama Art University (17 papers co-authored), National University Corporation Tsukuba University of Technology and Tama Art University (12), Technische Universiteit Eindhoven and University of Central Lancashire (11), The University of Edinburgh and University of Sussex (11), Kobe University and Tokyo University of Science (11), and Tokyo University of Science and Tama Art University (11; see **Figure 5.7**).

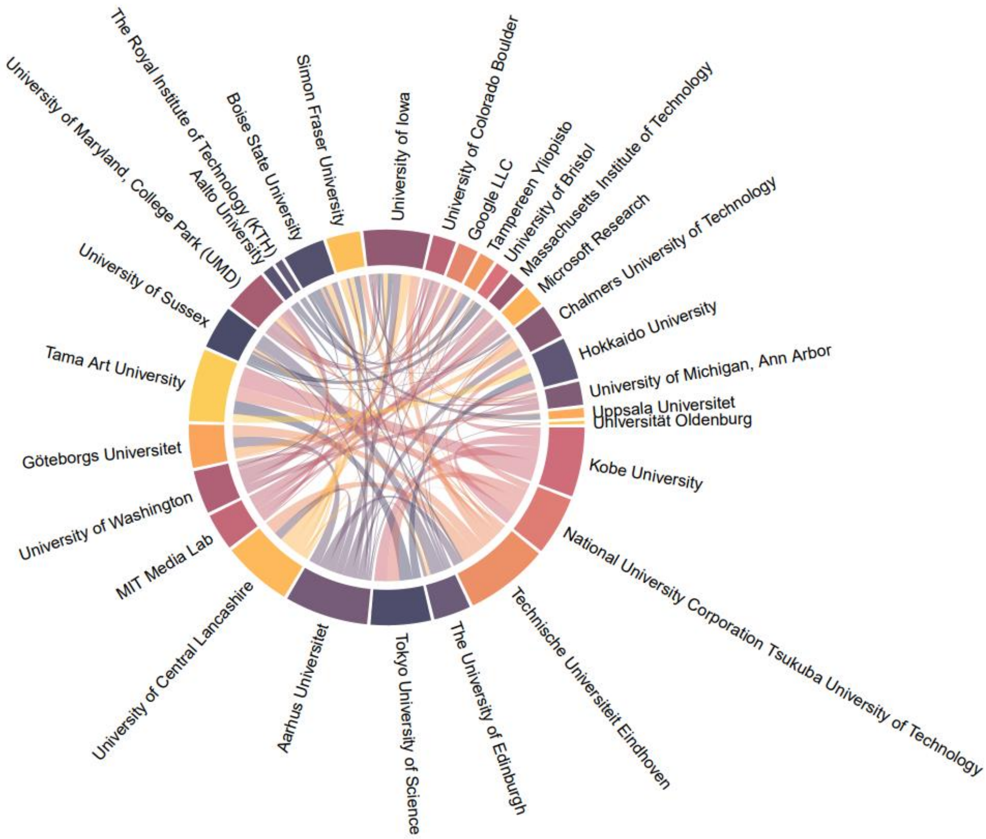


Figure 5.7. *Inter-institutional collaborations in Child-Computer Interaction research papers during the period 2003 to 2021. Institutions (29) which are involved in the 34 most productive collaborations (in terms of papers published) are included. Sectors and chords weighted by number of collaborations.*

Intuitions with which authors contributing to Child-Computer Interaction research papers during the period of interest were affiliated were located in 91 different countries or territories (as defined by Elsevier's Scopus; see **Figure 5.8**).

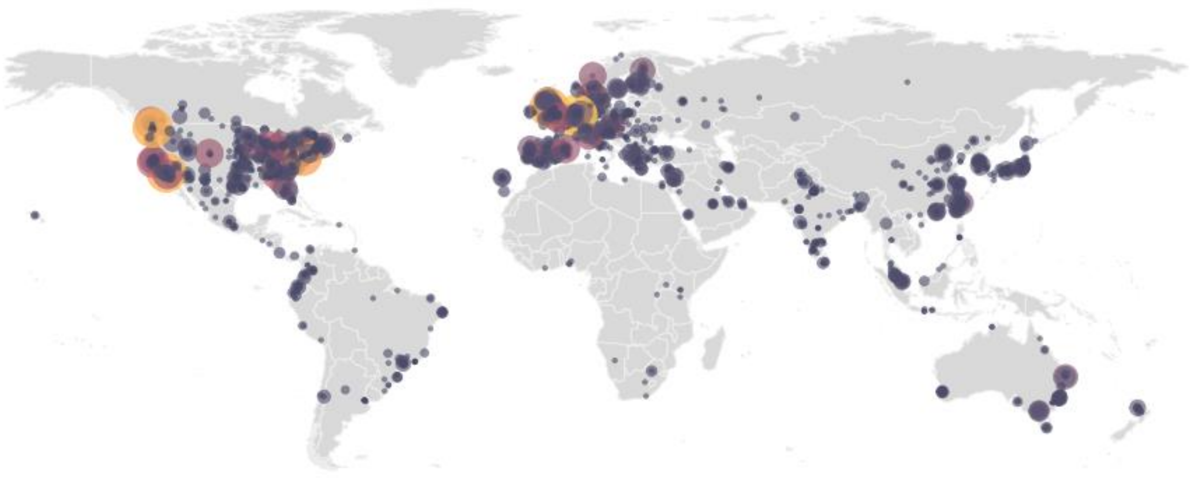


Figure 5.8. *Institutions with which authors contributing to Child-Computer Interaction research papers published during the period 2003 to 2021 were affiliated. Nodes weighted by volume of papers to which authors affiliated with institutions contributed.*

Of the countries and territories in which institutions with which authors were affiliated are located, authors affiliated with institutions located in the United States (2,251 author affiliations), United Kingdom (976), and Netherlands (356) contributed to the greatest number of CCI research papers published during the period of interest (see **Figure 5.9**).

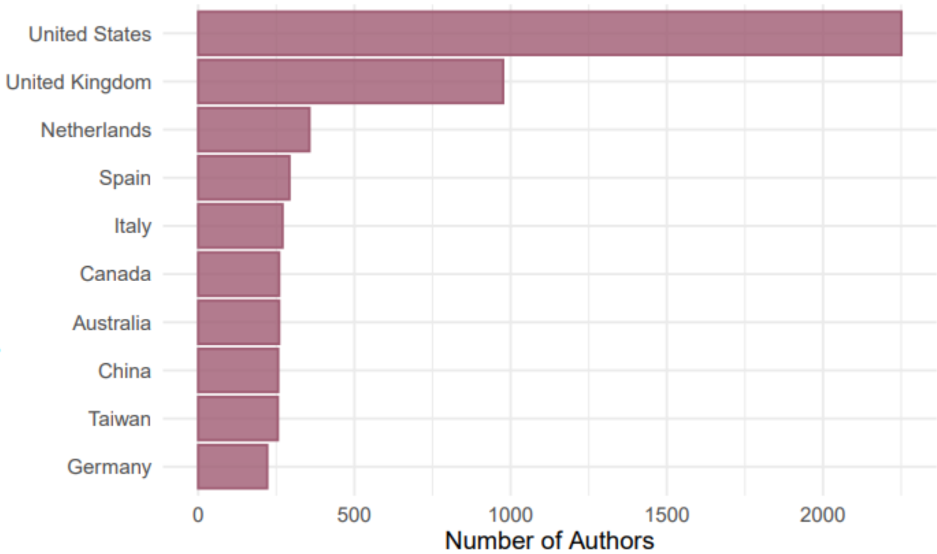


Figure 5.9. *Countries in which institutions with which the greatest number of authors of Child-Computer Interaction research papers published during the period 2003 to 2021 were affiliated are located.*

852 (17.86%) CCI research papers published during the period 2003 to 2021 involved international collaboration – that is, co-authors affiliated with institutions located in at least two different countries or territories. Authors affiliated with institutions in 84 different countries were involved in such international collaborations (see **Figure 5.10**). Of these international collaborations, the most productive in terms of papers published were those between authors affiliated with the United States and United Kingdom (61 collaborations), United States and Canada (42), and United Kingdom and Netherlands (31).

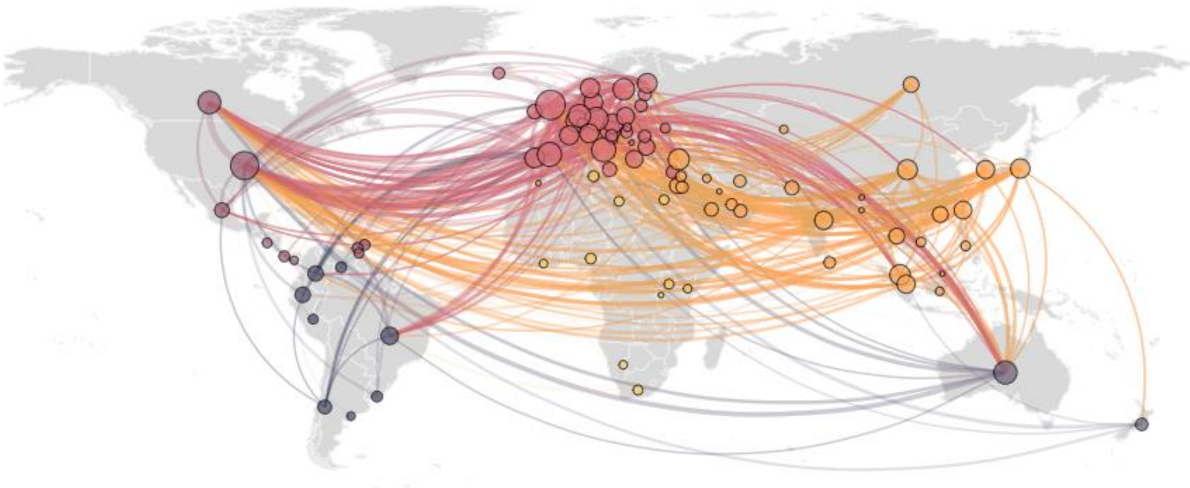


Figure 5.10. *International collaborations in Child-Computer Interaction research papers published during the period 2003 to 2021. Nodes (indicating countries) and edges are weighted by number of collaborations, and coloured by continent.*

5.2. Major Themes of Study in Child-Computer Interaction Research

Following evaluation of candidate models generated at an appropriate level of granularity, identified through the earlier adumbrated processes (see **Section 4.4.2.2**, and **Appendices E** and **F**), based on a number of common topic diagnostic metrics (see **Appendix G**), a Correlated Topic Model (CTM) inferring 48 latent semantic themes, or *topics*, throughout the Child-Computer Interaction research landscape during the period 2003 to 2021 was judged to produce an optimally interpretable solution.

Table 5.1 presents labels assigned to topics elicited – reflecting substantive interpretation following inspection of terms associated with topics (based on topic-word distribution, β_k, and FREX weight) and papers demonstrating greatest likelihood of addressing topics (based on document-topic distribution, θ_d) – and details describing topics' manifestation within the corpus, including a number of terms associated with each topic, topic prominence throughout the corpus, and temporal trends therein. Here, terms (i.e., words and multiword phrases in stem form) represent the most probable terms associated with each topic, indicative of the substantive content thereof. Topic prominence is calculated both as relative prevalence throughout the corpus - the mean estimated probability of papers addressing each topic, reflecting the proportion of semantic content within the corpus related to each topic - and the number of papers in which each topic was the primary (i.e., most probable) topic addressed. Temporal evolution of topic relative prevalence is illustrated and evaluated for demonstration of consistent (i.e., monotonic) trends over time (based on Mann-Kendall trend test) – it should be noted that results of trend tests (*Trend*, **Table 5.1**) are not indicative of the extent to which topics increased or decreased in prevalence, but rather signify whether a consistent increasing or decreasing trend was evident. Note, a decrease (increase) in relative prevalence of a topic over time does not necessarily intimate fewer (more) papers were published addressing this topic but rather that the degree of research attention received by a topic as a proportion of all CCI research published in a given year decreased (increased) relative to the preceding year.

Design methods and techniques was identified as the most prominently addressed topic throughout Child-Computer Interaction research papers published during the period 2003 to 2021, constituting 5.3% of semantic content of research contributions to the field. Terms within CCI research papers associated with this topic include *design*, *prototyp*, *process*, *develop*, and *children design*. The CCI research paper most strongly associated with this research theme (i.e., demonstrating the greatest likelihood of addressing the theme of *design methods and techniques*) describes a technique for product ideation developed to facilitate concept generation during design processes, illustrating the presented technique through a case study involving hearing-impaired children (Slegers et al., 2013) . Other prominently featured topics within CCI research during this period include those relating to *primary education (schools, students, teachers)* (3.7%), *e-learning environments* (3.7%), *educational* *game design and development* (3.5%), and *making and makerspaces* (3.4%; see **Figure 5.11**). Amongst the least prevalent topics throughout CCI research during this period are those concerning *critical and ethical research and design* (1%), *music and movement* (1%), and *augmented and mixed reality* (1%; see **Figure 5.11**).

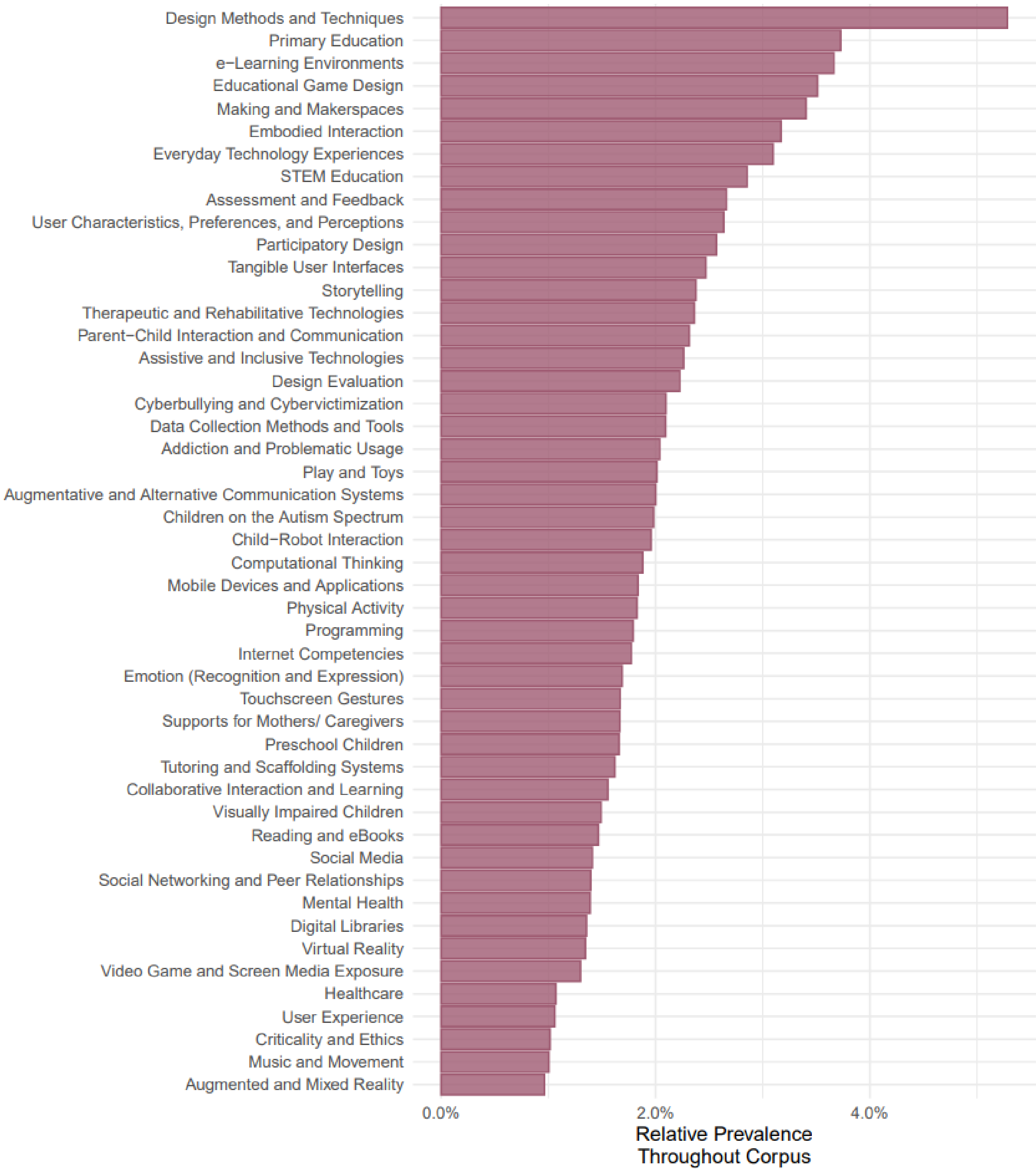


Figure 5.11. *Relative prevalence of inferred topics throughout Child-Computer Interaction research papers published during the period 2003 to 2021.*

Table 5.1. *Topics inferred throughout Child-Computer Interaction research published during the period 2003 to 2021.*

Topic Label	Probable Terms (β_k)	Relative Prevalence (%)	Primary Topic[k]	Trend[l]	Topic Prominence Over Time[m]
Design Methods and Techniques	design, prototyp, process, develop, children design, framework, design process, design children, iter, product	5.28	250	↓***	
Primary Education (Schools, Students, Teachers)	school, student, primari, elementari, primari school, classroom, teacher, elementari school, ict, school student	3.73	222		
e-Learning Environments	learn, environ, learn environ, children learn, teach, experi, gamebas, english, interact learn, enhanc	3.66	144		
Educational Game Design and Development	game, game design, player, comput game, educ game, game children, develop, digit game, gameplay, learn game	3.51	265		
Making and Makerspaces	educ, teacher, technolog, teach, develop, stem, practic, classroom, school, sustain	3.41	160		
Embodied Interaction	interact, embodi, bodi, museum, interact design, exhibit, children interact, experi, concept, environ	3.17	117	↓**	
Everyday Technology Experiences	technolog, engag, cultur, communiti, experi, practic, understand, live, space, context	3.10	145		
STEM Education	student, scienc, model, learn, middl, middl school, knowledg, scientif, school, engag	2.85	184		

[k] Number of documents in which the topic is the most probable, or primary, topic addressed.
[l] Increasing or decreasing trend (monotonic) in topic relative prevelance over time based on Mann-Kendall trend test. Symbols indicate significance and direction of trend (upward arrow indicating significant increasing trend, downward arrow indicating significant decreasing trend). Significance codes: *, p<.05; **, p<.01; ***, p<.001.
[m] Relative (i.e., proportional) prevalence of topic by year. LOESS smoothed, smoothing span(α) set at 0.5. Horizontal(x) axis represents year of publication from 2003 to 2021. Vertical(y) axis represents topic relative prevalence (%), ranging from 0.1% to 8.8%.

Assessment and Feedback	assess, task, perform, test, write, compar, feedback, condit, score, measur	2.66	119		
User Characteristics, Preferences, and Perceptions	motiv, content, person, peopl, influenc, particip, age, perceiv, user, prefer	2.64	69		
Participatory Design	design, participatori, participatori design, process, particip, involv, reflect, design process, pd, challeng	2.57	155		
Tangible User Interfaces	tangibl, interfac, user, user interfac, system, manipul, tangibl interact, tangibl user, tangibl user interfac, tangibl interfac	2.47	162	↓***	
Storytelling	creativ, stori, creat, storytel, tool, construct, creation, narrat, kit, art	2.37	131	↓**	
Therapeutic and Rehabilitative Technologies	train, attent, skill, improv, adapt, therapi, system, motor, function, test	2.36	115	↑***	
Parent-Child Interaction and Communication	parent, famili, home, mediat, child, time, parent children, parentchild, children parent, control	2.32	149	↑***	
Assistive and Inclusive Technologies (Special Needs and Disabilities)	technolog, disabl, assist, special, inclus, access, develop, challeng, technolog children, assist technolog	2.26	84		
Design Evaluation	evalu, child, interact, usabl, design evalu, childcomput, childcomput interact, interact design, comput interact, comput	2.23	77	↓**	
Cyberbullying and Cybervictimization	adolesc, behavior, cyberbulli, victim, gender, relat, age, risk, factor, youth	2.10	105	↑***	
Data Collection Methods and Tools	data, collect, observ, interview, record, data collect, sensor, system, captur, awar	2.09	76		

Addiction and Problematic Usage (Internet, Smartphones)	internet, addict, scale, adolesc, valid, measur, correl, problemat, relationship, mediat	2.04	111		
Play and Toys	play, toy, outdoor, children play, role, observ, explor, age, children age, play learn	2.01	80	↓*	
Augmentative and Alternative Communication Systems	communic, system, languag, speech, softwar, develop, sign, recognit, voic, hear	2.00	73	↓**	
Children on the Autism Spectrum	autism, asd, disord, spectrum, children autism, autism spectrum, spectrum disord, autism spectrum disord, children asd, skill	1.98	186	↑***	
Child-Robot Interaction	robot, interact, social, social robot, human, humanoid, robot interact, companion, humanoid robot, assist	1.96	164	↑***	
Computational Thinking	comput, think, code, solv, comput think, skill, develop, concept, teach, practic	1.88	79		
Mobile Devices and Applications	mobil, devic, applic, phone, mobil devic, mobil phone, mobil applic, mobil learn, rural, user	1.84	80		
Physical Activity	activ, physic, physic activ, encourag, engag, activ children, particip, fit, motiv, balanc	1.83	35		
Programming	program, environ, scratch, block, programm, languag, code, creat, program environ, program languag	1.79	115		
Internet Competencies (Retrieval, Privacy, Security)	inform, web, search, kid, sourc, privaci, knowledg, secur, seek, understand	1.77	69	↓**	
Emotion (Recognition and Expression)	emot, express, agent, anim, intellig, charact, convers, human, affect, facial	1.69	87		

Touchscreen Gestures	adult, gestur, touch, user, input, interact, age, children adult, hand, touchscreen	1.67	65		
Supports for Mothers/ Caregivers	support, share, tool, support children, mother, infant, remot, awar, technolog support, role	1.67	23		
Preschool Children	app, preschool, tablet, draw, math, develop, mathemat, preschool children, age, kindergarten	1.66	58	↑**	
Tutoring and Scaffolding Systems	strategi, cognit, learner, regul, learn, tutor, develop, perform, scaffold, process	1.62	48		
Collaborative Interaction and Learning	collabor, collabor learn, tabletop, pair, children collabor, share, individu, tabl, learn, multitouch	1.55	71	↓**	
Visually Impaired Children	visual, impair, feedback, visual impair, audio, haptic, spatial, map, multimod, vision	1.49	69		
Reading and eBooks	read, book, comprehens, word, text, literaci, print, reader, pictur, children read	1.47	98		
Social Media	social, media, social interact, social media, social skill, children social, share, theori, design social, ecolog	1.41	34	↑**	
Social Networking and Peer Relationships	onlin, peer, network, social network, site, risk, relationship, teen, adolesc, friend	1.39	45		
Mental Health	health, intervent, mental, manag, anxieti, mental health, stress, psycholog, servic, prevent	1.39	64	↑***	
Digital Libraries	digit, literaci, develop, librari, children digit, digit technolog, digit media, skill, design digit, public	1.36	39		

Virtual Reality	virtual, environ, realiti, world, virtual realiti, real, immers, vr, virtual environ, particip	1.35	67		
Video Game and Screen Media Exposure	video, video game, girl, boy, time, aggress, exposur, gender, game, age	1.30	49	↑**	
Healthcare	care, patient, gamif, caregiv, hospit, pediatr, transit, healthcar, medic, clinic	1.07	54	↑**	
User Experience	experi, user, autist, user experi, autist children, evalu, empathi, card, sensori, situat	1.06	43		
Critical and Ethical Research and Design	critic, challeng, ethic, emerg, hci, set, sensit, discuss, reflect, futur	1.01	24	↑**	
Music and Movement	music, movement, sound, control, motion, instrument, composit, sequenc, perform, bodi	1.00	49		
Augmented and Mixed Reality	augment, realiti, augment realiti, ar, mix, realiti ar, augment realiti ar, applic, technolog, experi	0.96	63	↑**	

Educational Game Design and Development appeared most commonly amongst inferred topics as the primary topic of study with which Child-Computer Interaction research papers were concerned, appearing as the primary topic addressed in 265 papers. Other topics which commonly appeared as the primary topic addressed in CCI research papers included *design methods and techniques* (250 papers), *primary education (schools, students, teachers)* (222), c*hildren on the autism spectrum* (186), and *STEM education* (184; see **Figure 5.12**). Inferred topics which appeared least commonly as primary topics addressed in CCI research papers included those related to *social media* (34 papers), *critical and ethical research and design* (24), and *supports for mothers/caregivers* (23; see **Figure 5.12**). As evident in **Figure 5.12**, prevalent methodologic and interdisciplinary topics, such as those concerning *design methods and techniques*, *primary education*, and *embodied interaction*, frequently appear as secondary and tertiary topics of study in CCI research papers, whereas specialised topics of study in CCI, such as those related to *participatory design*, *children on the autism spectrum*, and *child-robot interaction*, appear relatively infrequently as secondary or tertiary topics of study in papers.

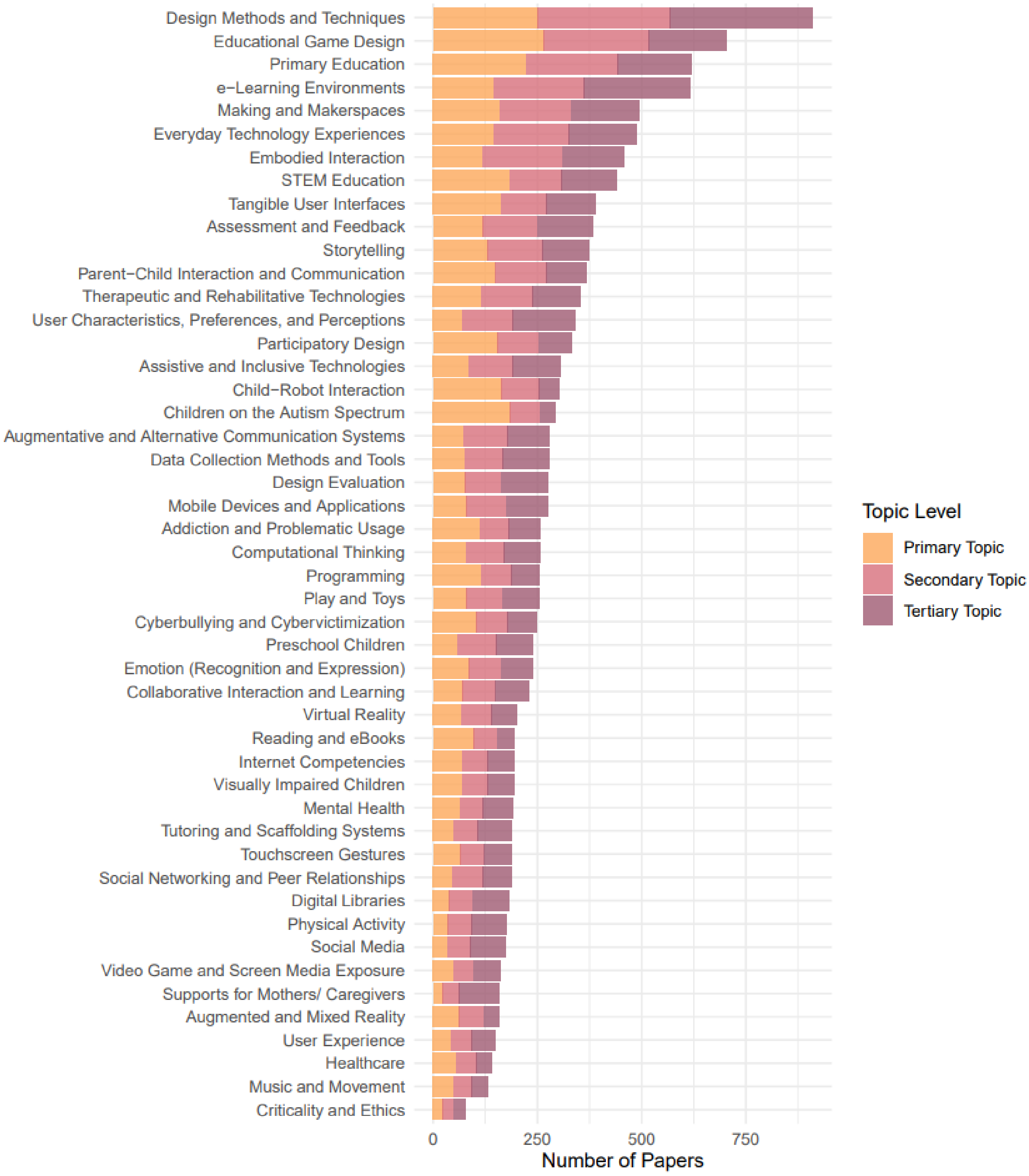


Figure 5.12. *Number of Child-Computer Interaction research papers published during the period 2003 to 2021 in which inferred topics appeared as the primary, secondary, and tertiary topic of study.*

Whilst there is apparent consistency in the relative rank of some topics in prominence throughout Child-Computer Interaction research as measured by both relative prevalence and the number of papers in which topics appear as the primary topic addressed – for example, the topic concerning *design methods and techniques* maintains high prominence, whereas that related to *critical and ethical research and design* demonstrates low prominence, across both metrics – discrepancies between topic ranks based on these metrics are nonetheless evident (see **Table 5.1** and **Figure 5.13**). Inferred topics may, simultaneously, demonstrate prevalence throughout the corpus yet appear relatively seldomly as the primary topic addressed within papers, thereby intimating that such topics are broadly applicable throughout the field, generally appearing as ancillary topics, but are rarely the central subject of study (e.g., topics related to *e-learning environments* and *supports for mothers/caregivers*). Conversely, topics may appear relatively frequently as the primary topic addressed within papers but demonstrate comparatively low prevalence throughout the corpus, suggesting that such topics are seldom incorporated in research in which they do not serve as the primary subject and implying a greater degree of specificity in their study (e.g., *children on the autism spectrum* and *child-robot interaction*).

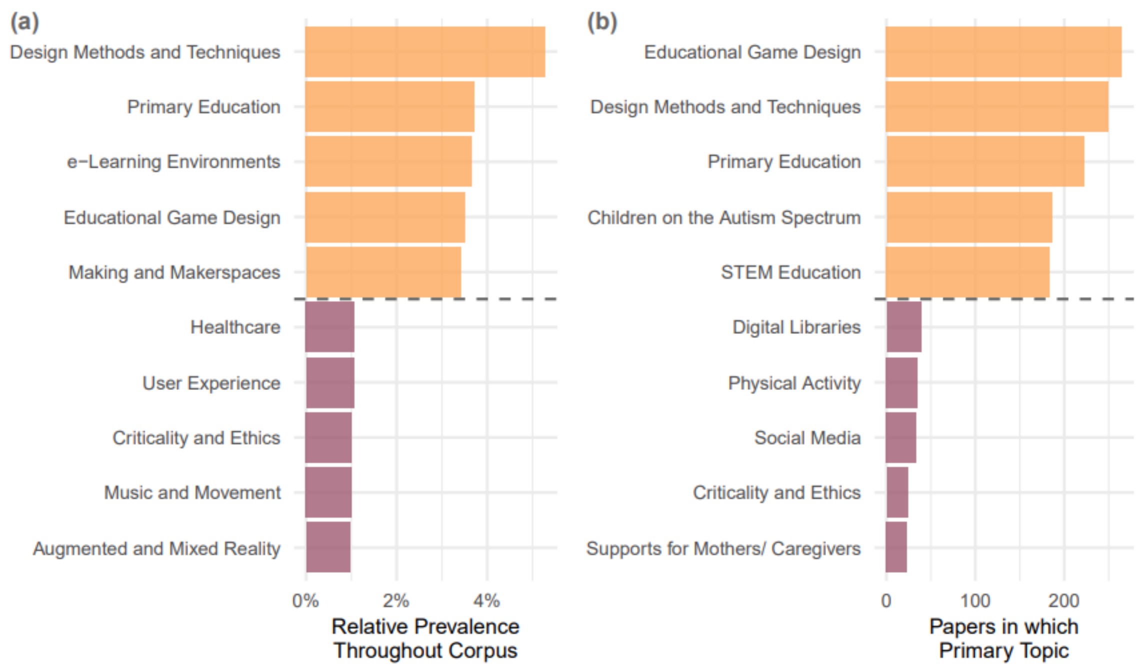


Figure 5.13. *Most and least prominent inferred topics throughout Child-Computer Interaction research papers published during the period 2003 to 2021 as measured by (a) relative prevalence of topics throughout the corpus and (b) number of papers in which topics constitute the primary topic of study addressed.*

5.3. Trends in Major Themes of Study in Child-Computer Interaction Research

Topics of study in Child-Computer Interaction research varied in relative prevalence year-to-year throughout the period of interest, with several demonstrating continuous (i.e., monotonous) trends (based on Mann-Kendall trend tests) of growth or decline in prevalence during this period (see **Table 5.1**). Amongst those inferred topics demonstrating relatively consistent increases in prevalence throughout the period of interest are those relating to *therapeutic and rehabilitative technologies*, *child-robot interaction*, *children on the autism spectrum*, *mental health*, *parent-child interaction* and *communication*, and *cyberbullying and cybervictimization* (see **Figure 5.14a**). Topics demonstrating relatively consistent decreases in prevalence throughout this same period include those relating to *tangible user interfaces*, *design methods and techniques*, *design evaluation*, *storytelling*, *internet competencies (information retrieval, privacy, security)*, *collaborative interaction and learning*, and *augmentative and alternative communication systems* (see **Figure 5.14b**).

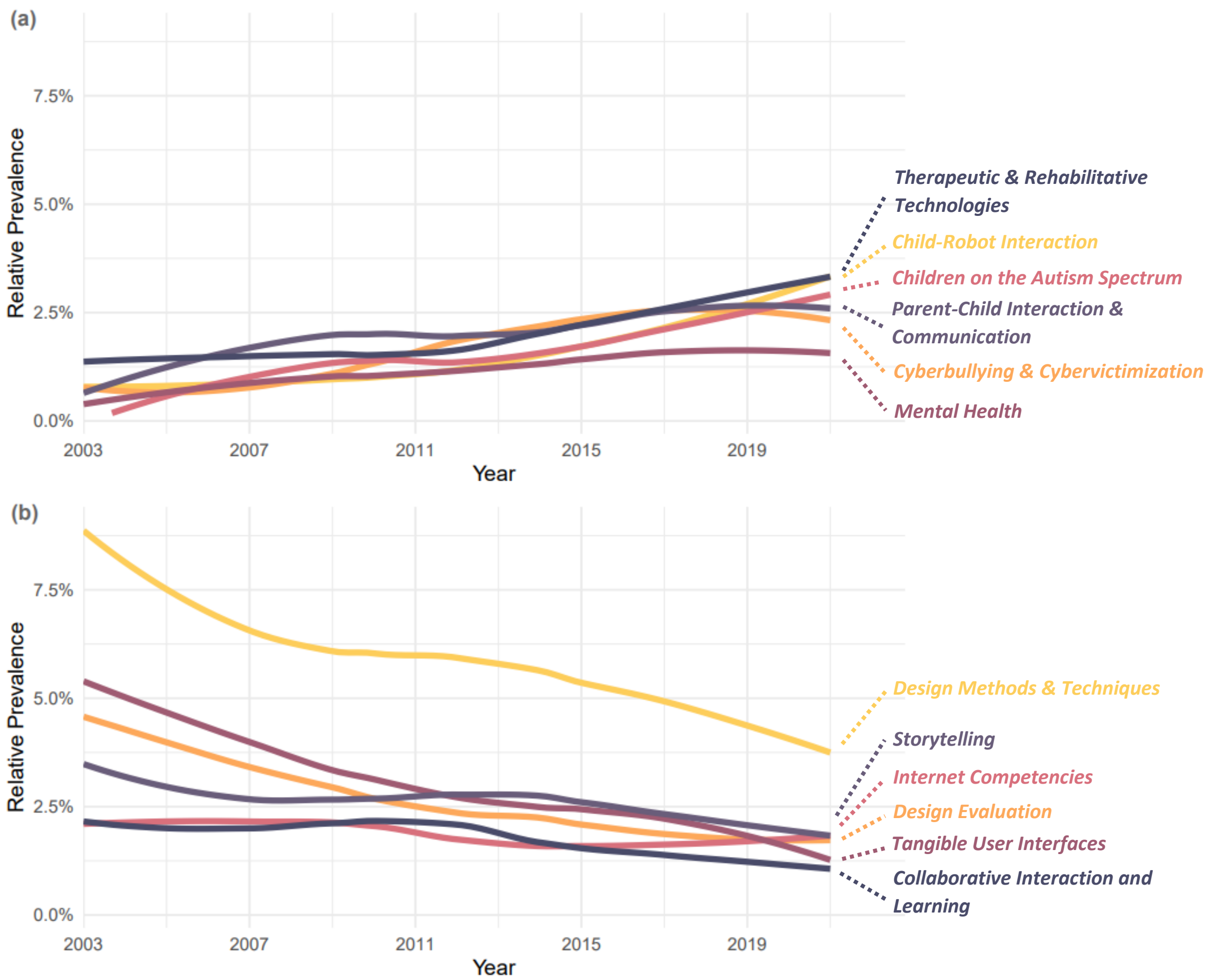


Figure 5.14. *Monotonically (a) increasing and (b) decreasing temporal trends in the relative prevalence of inferred topics throughout Child-Computer Interaction research papers published during the period 2003 to 2021.*

Shifts in trends in relative prevalence of a number of inferred topics throughout Child-Computer Interaction research were observed to coincide with notable external, or exogenous, events – here, events beyond the field of CCI research with potential implications for children's interaction with technologies – suggesting a possible relationship between such events and the extent to which certain topics of study received attention within CCI research. For instance, a number of inferred topics related to social media platforms and children's interactions therewith exhibit increasing prevalence within CCI research following the establishment and adoption of prominent social media platforms (see **Figure 5.15a**). Similarly, several inferred topics related to mobile devices and applications and children's interactions with such technologies demonstrate shifts in prevalence within CCI research paralleling technological developments related to, and broadening availability of, mobile technologies (see **Figure 5.15b**). Such apparent correspondence between shifts in temporal trends evident within inferred topics and exogenous technological developments are illustrative of the predictive validity of the Correlated Topic Model fitted (see **Section 4.4.4**). Note, however, these observations are premised on perceived correlation, and are not intended to imply causal relationships, with empirical investigation of any such relationships proving prohibitively complex.

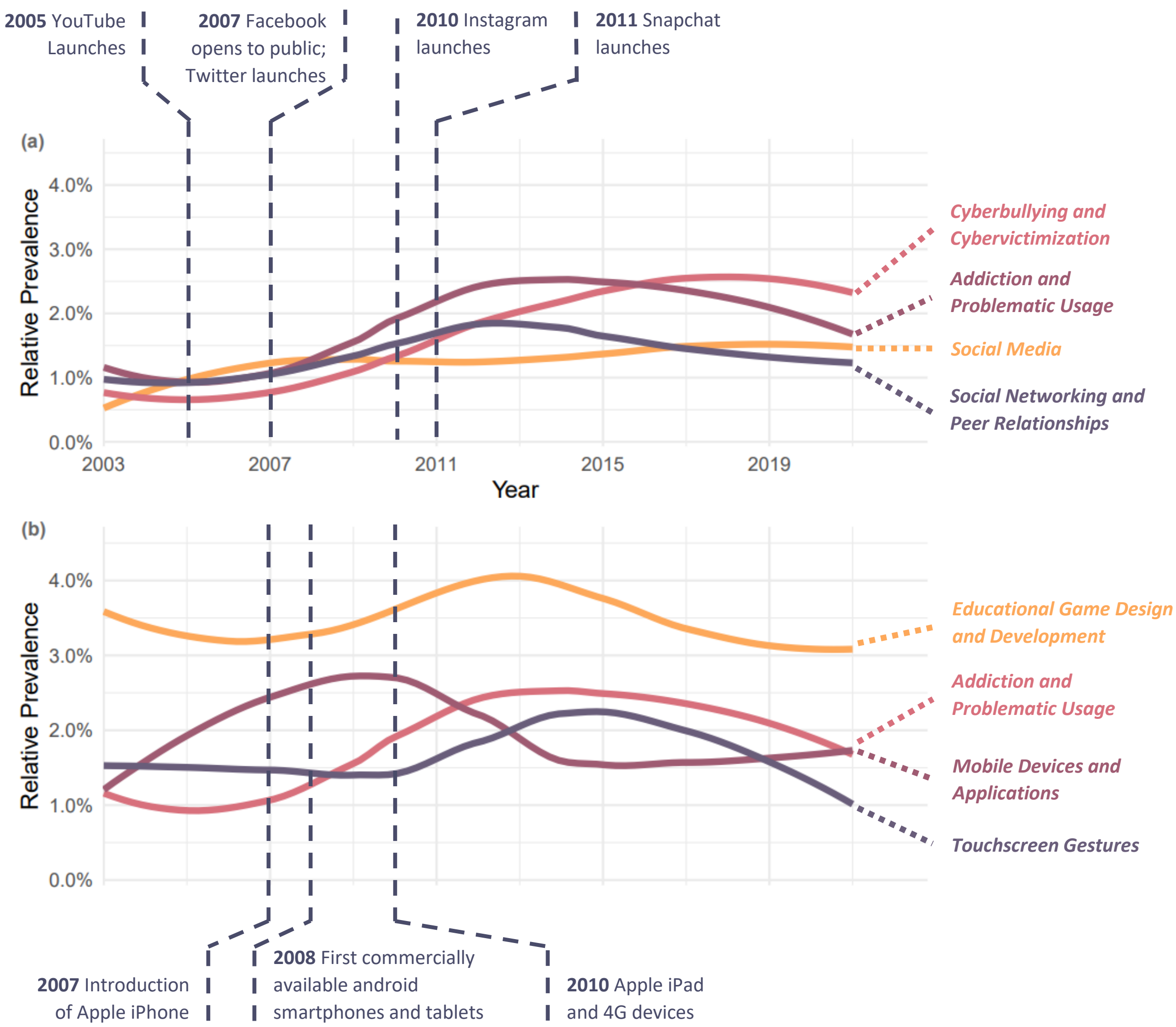


Figure 5.15. *Temporal trends in the relative prevalence of inferred topics throughout Child-Computer Interaction research papers published during the period 2003 to 2021 associated with external events – here, (a) the establishment of prominent social media platforms and (b) developments in mobile technologies.*

In order to identify prospective emerging and future trends in topics of study in Child-Computer Interaction research an approach similar to that employed by Gurcan, Ozyurt, et al. (2021) is applied, whereby the mean annual growth rate (i.e., percentage change in prevalence over the period of a year) of topics, or *acceleration*, over recent years is calculated. Recent growth rates may be considered indicative of the expected trajectory of topics' prominence in coming years, such that *accelerating* topics (i.e., increasing relative prevalence) are anticipated to continue growing and *decelerating* topics (i.e., decreasing relative prevalence) are expected to continue diminishing in prevalence in the near future. Note, acceleration is calculated for the period 2016 to 2020, omitting 2021 as data collected for this year was incomplete as consequence of the timing of data retrieval. Inferred topics related to *augmented and mixed reality*, *digital libraries*, and *child-robot interaction* demonstrate greatest acceleration in recent years, and may therefore be expected to demonstrate continued increases in relative prevalence in coming years, whilst topics related to *touchscreen gestures*, *tangible user interfaces* and *addiction and problematic usage* exhibited greatest deceleration, and thus may be expected to demonstrate continued decreases in relative prevalence in coming years (see **Figure 5.16**).

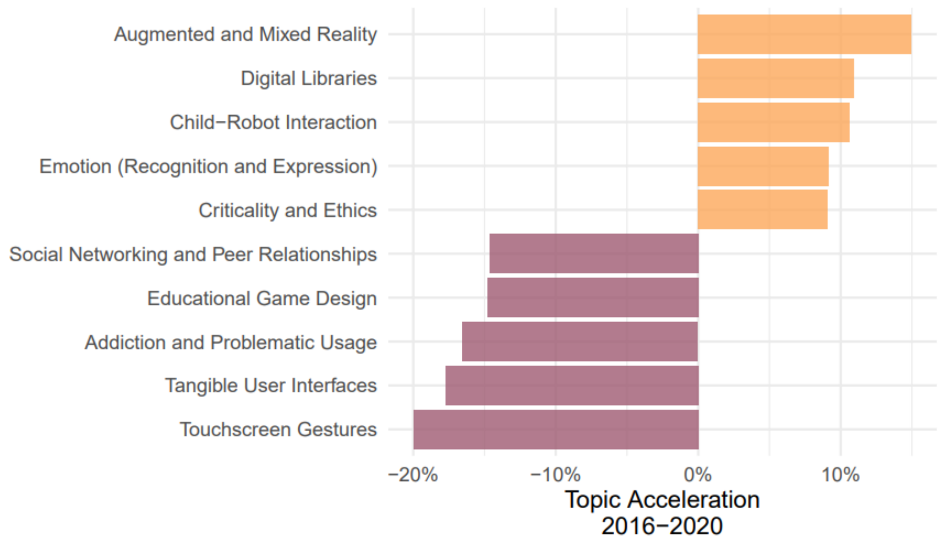


Figure 5.16. *Inferred topics throughout Child-Computer Interaction research papers demonstrating greatest mean annual growth and decline, or acceleration and deceleration, in relative prevalence during the period 2016 to 2020.*

5.4. Combination of Major Themes of Study in CCI Research

The extent to which inferred topics cooccur – or are combined – within Child-Computer Interaction research papers is examined based on the pairwise correlation (r) between document-topic probability (θ_{dk}) of inferred topics, such that topics demonstrating significant, positive correlation tend to cooccur within documents to greater extents and those topics demonstrating significant, negative correlation tend to cooccur to lesser extents. Relationships amongst topics are visualised through a network, or topic graph, wherein nodes represent individual topics (weighted by relative prevalence) and edges, or links, represent significant, positive correlations between topics (weighted by correlation coefficient; see **Figure 5.17**). Amongst those topics which cooccur – or are combined – to the greatest extent within CCI research papers are topics related to *design methods and techniques* and *participatory design* (r = .23, p <.001); *programming* and *computational thinking* (r = .22, p <.001); *e-learning environments* and *primary education* (r = .17, p <.001); and *mental health* and *healthcare* (r = .16, p <.001).

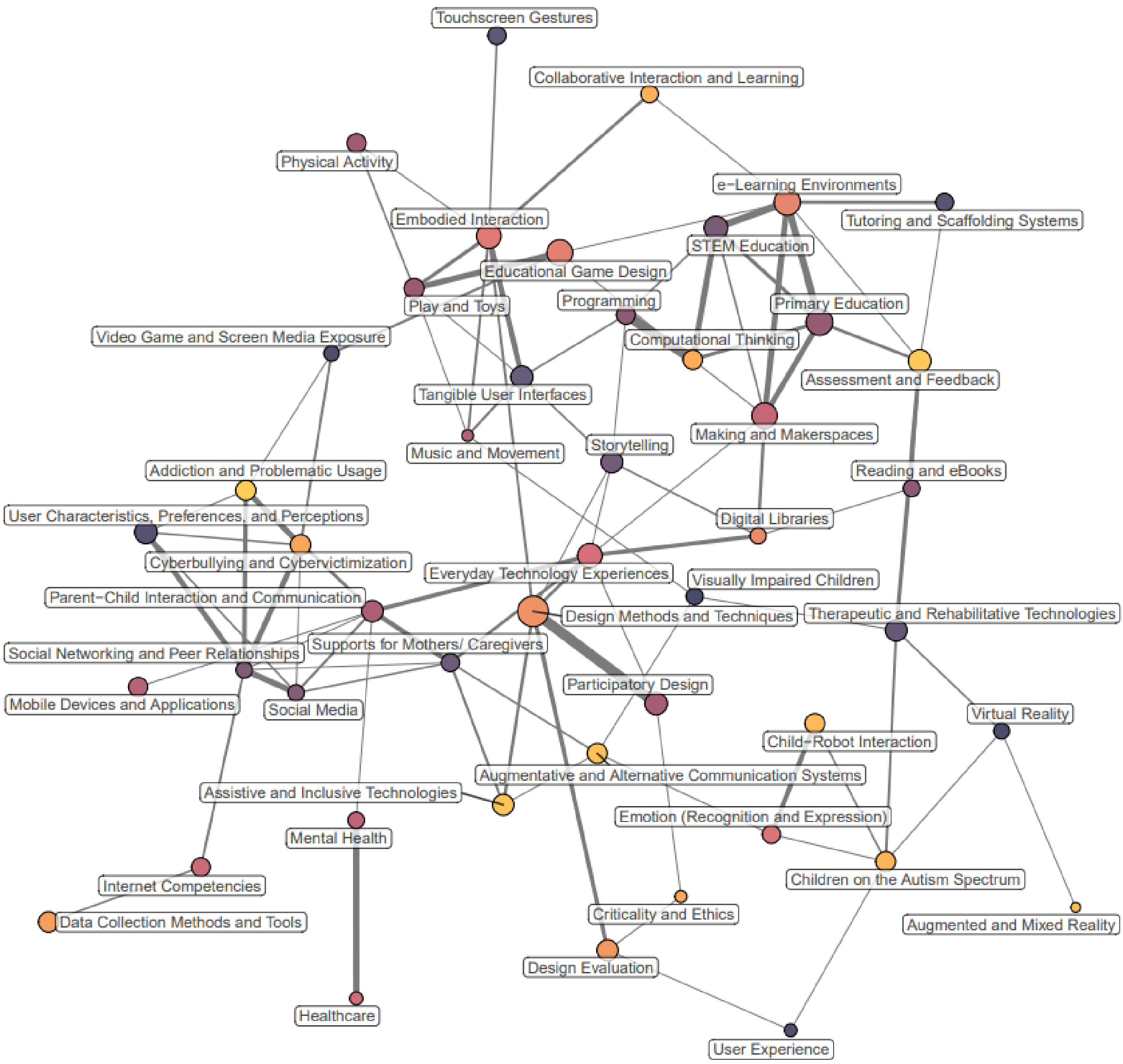


Figure 5.17. *Correlation (r) network for inferred topics throughout Child-Computer Interaction research (nodes weighted by relative prevalence and edges weighted by pairwise correlation). Note, only those edges representing significant, positive pairwise correlation (r > .05) are depicted for purposes of clarity.*

Thematic diversity of Child-Computer Interaction research papers, based on mean (Shannon) entropy of document-topic distributions (θ_d) of papers published each year, demonstrates a negative trend throughout the period of interest (τ = -.59, p <.001; see **Figure 5.18**), indicative of a trend towards focus on fewer topics within research papers over time and thereby suggestive of a shift towards greater topic specialisation therein.

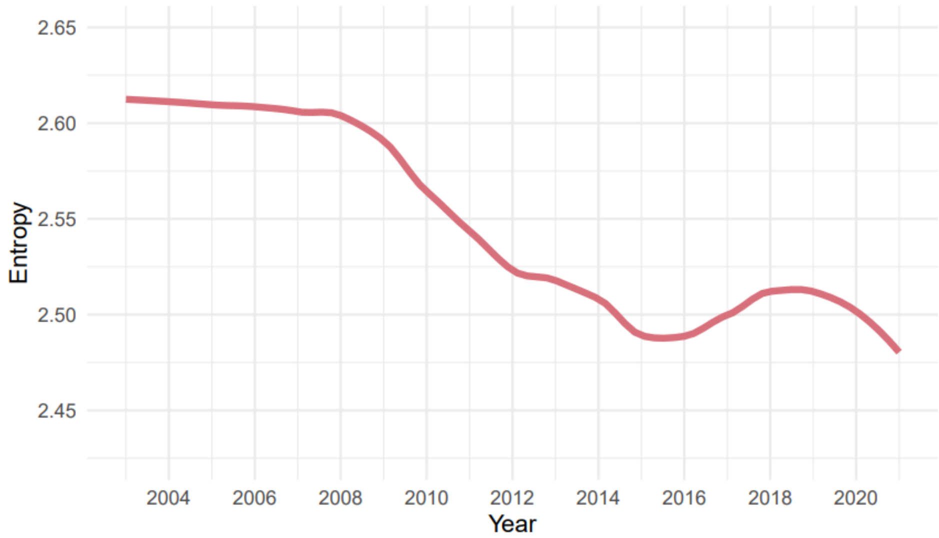


Figure 5.18. *Thematic diversity (Shannon entropy of document-topic probability distributions, θ_d) of Child-Computer Interaction research papers throughout the period 2003 to 2021.*

Notably, Child-Computer Interaction research papers published in the field's primary venues, IDC and IJCCI, exhibit, on average, higher thematic diversity (i.e., higher entropy; $t_{(3009)}$=7.81, p <.001, 95% CI [.07, .12], d =.24), intimating lower topic specialisation therein, than CCI research papers published in venues associated with neighbouring and related fields (see **Figure 5.19a**). Whilst CCI research papers published in the field's primary venues initially demonstrated greater specialisation (i.e., lower average thematic diversity) than those published elsewhere, papers published in venues associated with neighbouring and related fields exhibited a greater increase in specialisation (i.e., decrease in average thematic diversity) over time (see **Figure 5.19b**).

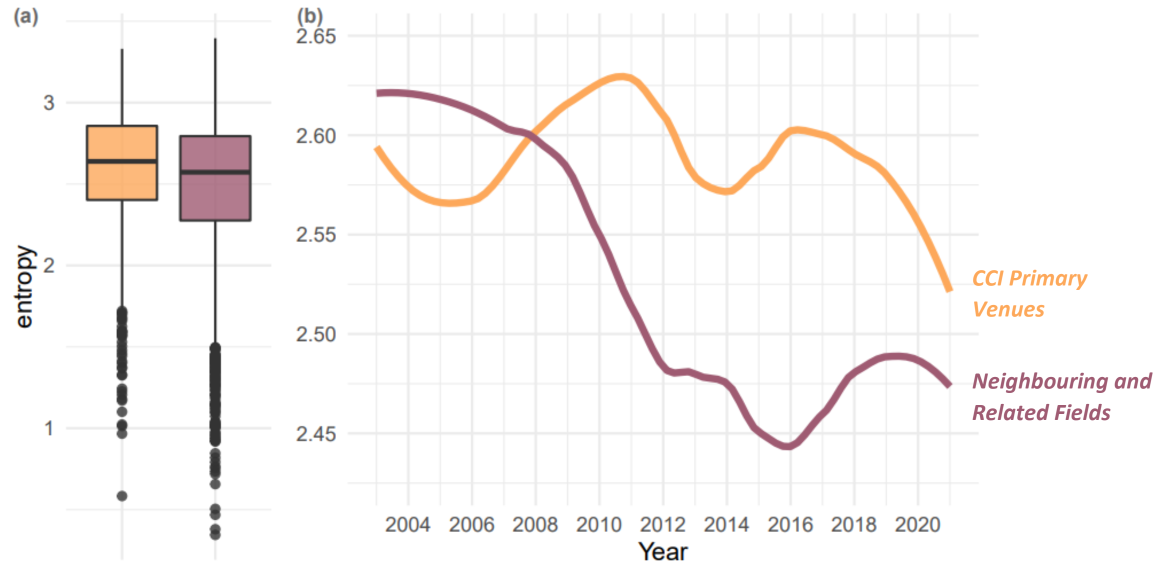


Figure 5.19. *Thematic diversity (Shannon entropy of document-topic probability distributions, θ_d) of Child-Computer Interaction research papers published in the field's primary venues (IDC, IJCCI) and venues associated with neighbouring and related fields throughout the period 2003 to 2021.*

5.5. Summary

An extensive corpus of Child-Computer Interaction research papers, to which a broad range of researchers have contributed, was retrieved. Results of Correlated Topic Modelling indicate a diverse array of thematic areas of study addressed within the field, the prominence of which have varied throughout research over time. Themes, or topics, of study within the field vary in the extent to which they interact, or are combined, with other thematic areas in the field. Critical discussion of findings and results in relation to research questions, supported through integration with results obtained through other phases of the present study, is presented in a later chapter (see **Chapter Eight**).

Chapter Six: Processes of Knowledge (Re)Construction in Child-Computer Interaction

This chapter presents results and findings of qualitative data analysis undertaken throughout Phase 2 of the mixed methods research design implemented in the current study. The chapter firstly describes data collected through online focus groups, and dyadic and semi-structured interviews. Themes evident in participants' experiences of, and perspectives on, processes through which knowledge in the field of Child-Computer Interaction is (re)produced and factors which influence research and publication practices within the field, identified through thematic analysis of data, are then defined and elaborated, thereby addressing a number of research questions (**RQs 1.4**, **1.5**, **1.6**). Results of Phase 2 analysis presented build upon, and serve to explain, results of the preceding phase (Phase 1) and inform the succeeding phase (Phase 3), and are integrated therewith during discussion (**Chapter Eight**).

6.1. Data

Perspectives and experiences of seven experienced Child-Computer Interaction researchers (see **Section 4.5.1.7** for sample details) regarding research practices, and factors which influence such practices, related to the field – which, as proposed by the reciprocally structured and structuring relationship articulated within the conceptual framework implemented within the current study (see **Chapter Three**), constitute processes of knowledge (re)construction – were collected through a series of focus groups, dyadic interviews, and semi-structured interviews (see **Table 4.2** for indication of session attendance) hosted online via the videoconferencing platform *Microsoft Teams*. Notably, although twelve CCI researchers initially agreed to participate, several (5) were unavailable to attend sessions due to scheduling conflicts and last-minute attrition (see **Section 4.5.1.1**). Sessions ranged in length from 55 minutes to 1 hour 25 minutes, with (audio-visual) recordings thereof transcribed verbatim by the researcher thereafter (note, transcripts were de-identified to preserve participant anonymity) for subsequent thematic analysis of content. Notes maintained by the researcher throughout sessions and transcription, recording notable statements and discussions, and apparent patterns and themes, as well as reflexive journal entries detailing the researcher's experiences of, observations related to, and critical reflections upon, sessions also served to inform analysis.

6.2. Evident Themes

Through the previously adumbrated approaches to inductive and deductive coding (Fereday and Muir-Cochrane, 2006) and iterative theme identification and definition (Braun and Clarke, 2006; see **Section 4.5.2**), four distinct themes related to processes of knowledge (re)structuring in the field of Child-Computer Interaction were identified in researchers' perspectives and experiences. Themes evident throughout discussion were labelled and defined as follows:

1. *Developments and Trends in Child-Computer Interaction*, concerning developments and trends in the field of CCI, and research associated therewith, throughout the past two decades, including shifts and future directions in research priorities addressed therein, and factors perceived as influencing (i.e., driving and impeding) such development.

2. *Impact of Child-Computer Interaction Research*, relating to the means by which impact may be achieved through CCI research, as well as the perceived areas and extent of such impact.

3. *Challenges in Knowledge (Re)Construction in Child-Computer Interaction,* regarding factors, such as norms and structures associated with the field, considered to impede (re)construction of knowledge in the field of CCI, as well as approaches (i.e., strategies) employed in negotiating such challenges.

4. *Methodological Challenges in Child-Computer Interaction Research*, concerning methodological limitations and challenges encountered within CCI research, including

issues related to methodological standards, training, and practice, and their consequences for knowledge (re)construction in the field.

Identified themes, along with relevant subthemes, are elaborated in turn throughout the following sections, illustrated through inclusion of (verbatim) extracts and quotations from participants which provide a narrative account of themes and subthemes as realised during discussion.

6.2.1. Developments and Trends in Child-Computer Interaction

The field of Child-Computer Interaction has undergone considerable development throughout the past two decades ("*I think that today it's just exciting to see where we've come… it's really amazing to see where things have come*", P4), with participants implicating a range of relevant factors in influencing the development of research priorities within the field, to varying extents, throughout this period. Such influences on the research field are understood as multifarious, complex, and contextual, and continuously shift in prominence over time (*"in Child-Computer Interaction there are many different kinds of subcommunities, and people are driven by different kinds of things*", P2). Nonetheless, despite the inherently intricate and interrelated network of manifold factors, participants noted a number of distinct factors which exert particular influence on the development of, and trends in, the field of Child-Computer Interaction research, including advancements in technology, funding priorities, knowledge and developments in related fields, government policy, and public and media discourses.

6.2.1.1. Technological Developments and Discourses

Participants consistently identified technology, including advancements therein and industry priorities and public discourses related thereto, as a prominent factor influencing and driving trends within Child-Computer Interaction research ("*conferences, like Interaction Design for Children, are technology-led and not needs-led or not topics-led*", P1). In particular, participants noted that a substantial proportion of research in the field is concerned with the development and prototyping of novel technologies, often in the absence of sufficient consideration of children's needs or adequate theoretical or empirical justification ("*all of the papers published at IDC […] they're pushed by technologies rather than, and like the viability of prototyping technologies, rather than any actual need"*, P1). Within such technology-oriented paradigm, participants intimated, there is a perceived expectation of, or preference for, novelty (i.e., of designs; "*there is this more technology-oriented and fascinated stream in which it needs to be something novel*", P2; "*there is this very strong emphasis on novel stuff. You have to every year do something novel.*", P2).

Consequent trends throughout such technology-oriented research within CCI are suggested to derive, in part, from broader public and technologic discourses and narratives which may, P7 suggested, produce naïve assumptions concerning the potential value of technologic advancements:

> *I do think there are fashions and I think fashions sometimes pick up on what people from the outside see to make sense… I think things can be driven a little bit by a bit of superficial 'what looks exciting and hard to disagree with.*

Similarly, participants propose that such trends are influenced by media discourses and government policy related to emerging technologies ("*So this is also, I think, pushed by the governments or from the policy or from the media*", P6) and industry interests related to cost-reduction and profitability ("*I think it's really pushed by just, like, a feeling that the, this industry might make savings rather than proper usefulness or even* […] *children's interest*", P1), which are regarded as failing to adequately consider, or reflect, children's needs.

Participants posited that such a paradigm throughout the field stems both from an inherent pursuit of innovation within the field through development of, experimentation with, and investigation of, novel technologies ("*of course you want to do something that people haven't been doing before*", P2; "*for most of the people I have met they just want them to try something new*", P6), as well as the multidisciplinary constitution of the field, with expectations of exploration of emergent technologies and related approaches to research (e.g., prototyping) characteristic of engineering, technology, and design fields upon which CCI research has, and continues to, draw:

> *within those* [engineering] *disciplines, you have to be on the cutting edge of technology, you cannot be studying something that was done five years ago … the studies often are more short term, you are building something experimental,* […] *it is something that probably is kind of characteristic to engineering and technology disciplines, rather than human and social sciences* (P2).

Commonly seeking to design – and often develop – functional, feasible technologies, CCI research, participants argue, often requires, and may thus be biased towards, researchers possessing technical and practical knowledge generally associated with technology, engineering, and design fields ("*it's mostly lived in the technology arena because that's where many of us came out of*", P4; "*it's driven a little bit by design … because to be confident creating a new design, especially technology, you have to be, or have to be closely working with, people who know how to create technologies*", P7).

Technology-oriented research within CCI, generally characterised as short-term, prototyping studies involving limited samples, whilst noted as an efficient means by which novel implementations of emerging technologies may be initially trialled, supporting innovation and progression within the field ("*many are doing studies, shorter term studies, which are doable within a shorter timeframe, and that's why it is possible to always find new topics and bring out something new to the table*", P2), presents noteworthy limitations regarding which participants expressed concerns, both with respect to the development of technologies which adequately address children's needs and construction of, or contribution to, cumulative knowledge within the field.

Participants noted that perceived prioritisation of technological novelty within the field inevitably incentivises investigation of emergent technologic advancements, often premised on naïve assumptions regarding children's technology needs, rather than established technologies empirically determined to address children's needs through prior study ("*It's just that the type of technology that address the needs of children are generally not the shiny fancy ones that we might push in like HCI and* *design publications*", P1). In undertaking such research concerning novel technologies, participants argued that researchers may fail to exercise appropriate consideration of risks and harms which may accompany children's interaction with such technologies ("*they're trying to, I think overlook the power of the technology… there was a lot of research that trying to push those things before they're ready to go*", P6) and inadvertently perpetuate problematic or harmful discourses concerning children's interactions with technologies ("*I think disability is one area where you see a lot of gimmicks in terms of* […] *technologies and in fact, a lot of discourses that can be like actively harmful to children*", P1).

Furthermore, participants expressed concerns regarding the extent to which research motivated or dictated, in large part, by technological novelty contributes to, and develops, cumulative knowledge within the field of CCI. Participants indicated that such studies primarily concerned with design and evaluation of novel technologies often fail to contribute knowledge which may be abstracted and generalised beyond the context of initial study, and consequently generate knowledge which is neither developed upon nor develops existing knowledge within the field:

> *you sometimes just set up a series of really, really exciting new experiences but they're isolated. Everyone will look at it and go 'that's lovely' and nod their head, but I don't see us creating knowledge* […]*, I don't see how one builds upon the other. It's just lots of lovely examples of good, of nice practice* (P7);

> *We just repeat the experiments and then they die, so there is very little development on this field and that is some things that I think CCI seriously needs* (P3).

In seeking to effectively construct and contribute to cumulative knowledge concerning children's interactions with technology, participants therefore contended, research ought to, in addition to investigating novel technologies, continue to develop theory within the field and generate intermediate-level knowledge:

> *try to develop the field more theoretically, new steps, going higher and not only kind of doing all those experiments again and again, and again. I think that's a general problem with HCI, but it's also a general problem with CCI if we are talking about the field and field development* (P3);

> *the discussion of intermediate knowledge, I like that idea. I think it's difficult to come up with knowledge that we just don't end up saying things that we could have guessed* (P7).

Notably, however, implicitly influenced by knowledge and developments within other fields, both through the multidisciplinary backgrounds of researchers contributing to the field as well as inspiration and informing of theory and research ("*I can see the other fields development also influence the* […] *research. So, ones I notice about is like, development in cognitive theories, such as embodied cognition*", P6), participants identified emerging emphasis on theory underpinning and justifying the investigation and use of certain technologies for children throughout CCI in recent years – although, such study was noted as typically succeeding, rather than preceding, exploration of novel designs and applications (i.e., prototyping):

> *there are a lot of prototyping stuff, they're just thinking about, 'oh, well, how we can use this technology'. But later on, people, or researchers, tried to figure out how […] tangibles can benefit in learning and at the same time, because of development of the* […] *cognitive theories, such as embodied cognition, people have found the justification for the benefits of this user interface* (P6).

6.2.1.2. Funding Priorities and Opportunities

Participants noted that, whilst not necessarily a primary motivator in dictating the direction and interests of their own research, funding opportunities, the availability of which is often concentrated in certain areas of study, influence trends in priorities within the field ("*what we do, however, it can be driven by funding as well*", P7). Availability of funding is asserted to influence various practical aspects of research undertaken, determining, to varying extents, the resources available to research project ("*funding is of course affecting the situation - you get funding you can recruit new people, there is a stronger group doing particular things*", P2). Consequently, availability of research funding opportunities, themselves subject to priorities and agendas of funding bodies and organisations, may influence both the areas of Child-Computer Interaction which researchers elect to study and the practical capabilities and constraints of research conducted in these areas.

Prototyping and investigation of novel technologies may be one such area of research presenting ample funding opportunities, with P1 proposing that the prevalence of such research in CCI is, in part, attributable to the availability of funding supporting this research, contending that "*it's just not where research should be focusing,* […] *just where there is money*". Similarly, P6 noted a recent trend in CCI research concerning children on the autism spectrum which coincided with a shift in funding priorities ostensibly induced by governmental policy and associated media discourses:

> *I realized because five years ago there is a policy in* [Country] *that … encouraged people to pay attention on the children with autism. So, because of the power of media, and there's a lot of media press that gave* […] *attention to these kind of people. So, for the researchers, it's very easy, at least in* [Country]*, it's very easy to get the funding for this kind of research. And so we can see, there are a lot of papers and publications that focus on this kind of children*.

In this way, funding priorities and consequent opportunities may act as a medium through which various actors' priorities (e.g., government) and discourses (e.g., public, media, technology) may influence and impel research within the field of CCI.

Several participants noted a perceptible shift in funding priorities in CCI over the course of the field's development throughout the past two decades, whereby funding opportunities supporting more varied areas of research within the field have emerged. Whilst initially prioritising research concerning practical aspects of children's interaction with particular technologies, participants indicated recent recognition amongst funding bodies of the value of a broader range of research areas within CCI, particularly development and validation of theory expounding children's interaction with technologies and participation in design processes, including research concerning areas such as ethics, criticality, and empowerment, as well as research concerned with vulnerable and marginalised populations:

> *Actually, funding application-wise we started applying funding for our children and technology related topics around 15 years ago, and it was so challenging to get funding, for many, many years, but at some point of time the calls for funding started to be actually very suitable for us* (P2).

Although research in these areas of CCI evidently preceded availability of, and persisted in spite of limited opportunities to receive, funding, the emergence of greater funding opportunities in these areas may have, in recent years, further encouraged the growth and development of these areas of the field. Participants ascribed this evolution in funding priorities to changes in perceptions beyond the field of CCI (e.g., public discourses) concerning children's interaction with technology and involvement as participants in design processes (i.e., co-design or participatory design):

> *I'm just thinking probably from this funding perspective … the world had developed into such a phase that people understand that 'hey, children-technology, this is somehow really, really important'* (P3);

> *there wasn't a lot of work done on how much voice is enough voice, how much ownership is enough ownership, until the second decade, really, of work in* [CCI]*. And* […] *you saw a lot of this coming out when people had funding for it,* […] *when there were companies that were interested in using the techniques* (P4);

as well as development of knowledge within the field itself such that these areas of study exhibit increasing salience as the field matures:

> *we didn't really change anything,* […] *of course we learned to create better proposals, of course, but other than that, I think that the world was ready for our research at that time. Maybe people who had more, maybe sort of an, in a sense, practical perspective, we were too theoretical,* […] *that might be, of course, one reason* (P3).

6.2.1.3. Continued Development of, and Future Directions in, CCI

Participants commented upon the continued development and growth of the field of Child-Computer Interaction, indicating perceived current, and anticipated forthcoming, trends and progress in research therein as the field matures, often attributing trends to the sustained influence of aforementioned factors identified as having considerably influenced development of the field thus far, including advancements in technology and availability of funding opportunities and resources.

Participants indicated that the emergence, and growing accessibility, of advanced technologies, such as artificial intelligence, voice recognition, and visual and augmented reality, has prompted a recent shift in the forms of technology studied within the field ("*now it is so obvious that artificial intelligence, machine learning, IOT, XR, VR, AR, all these waves are coming in and researchers are starting to explore new things*", P2). In particular, participants asserted that the affordances and utility of such technologies in augmenting established technologies of interest, such as tangible user interfaces and robots, are gaining prominence in CCI:

> *I noticed about a shift in the field of tangible interaction design … there is* […] *much research about designing some tangible robot or voice-based interaction based on this kind of a robot. This is because the development of the AI, right, artificial intelligence, and because of the better technology for the voice recognition* (P6).

As the field of CCI continues to mature, the associated community is, participants believe, exhibiting increasing reflexivity and criticality through concerted engagement in purposeful reflection and deliberative dialogue concerning the field's development, identity, and direction, and crucial issues therein, citing in particular conference workshops as fora in which such dialogues are supported ("*the IDC conference, they have a lot of workshops and … ask people to come together and talk about these important things. I think they also encouraged us to have the more awareness of these important issues*", P6). Consequently, participants note, research within the field demonstrates growing attentiveness and sensitivity towards critical and ethical issues which have arisen, and continue to emerge, therein, citing in particular the recent emergence of distinct areas and methods of study, such as critical design, as illustrative of this trend ("*More interest towards critical and empowering topics*", P2).

Participants anticipate that, whilst research within CCI has thus far endeavoured to include and empower diverse and vulnerable populations ("*it's always had an underlying belief and philosophy that has to do with social justice, okay, the notion that we need to give voice to those that are stakeholders, and even if the stakeholders are younger and shorter*", P4), research will, in coming years, increasingly seek to involve more diverse populations and, thereby, traditionally marginalised or excluded voices:

> *that's the next generation of research that people are doing – […] you're seeing more and more people looking at diverse populations that have not traditionally been included, […] it's an important area that […] is continuing to emerge and get stronger* (P4).

Access to, and inclusion of, such voices may be supported, participants predict, by advancements in remote communication technologies which may overcome "*the challenge of hearing and really having these voices heard*" (P4), although persisting challenges and limitations associated with the use of such technologies are acknowledged ("*as the remote technologies get better, more voices can be heard ... Access to special populations is difficult … But that's the next frontier, is thinking about inclusive methods to bring in the voices of many different populations*", P4).

In addition to trends in topics of, and participants in, research throughout CCI, participants identified apparent and projected methodological shifts within the field, some of which are intended to address recognised issues or shortcomings in studies at present, including an increasing commitment to longer-term and longitudinal studies ("*Longitudinal studies are hard to do … they're hard to find people, they're hard to get people to open up in a way that is rigorous* […] *and truly expressive* […] – *more work needs to get done there*", P4) and adoption of rigorous, empirical study ("*there is more interest in the, kind of, very thorough empirical studies*", P2). Moreover, participants indicated that challenges introduced or exacerbated by the COVID-19 pandemic have prompted, by necessity, methodological progression and innovation, involving development and exploration of alternative research methods:

> *There is a increased trend in our community where we are trying to explore alternative methodologies to engage children now, because the pandemic partially … we are starting to explore a lot of online co-design activities where we try to bring a lot of learning theories into the process, trying to truly get children engaged in the process* (P5).

6.2.2. Impact of Child-Computer Interaction Research

Intended and realised impact of research in the field of Child-Computer Interaction varies throughout the field, with participants identifying a broad range of potential beneficiaries of research (e.g., children, parents, educators, and industry) and conceiving impact as constituted by, and achieved through, both the process and outcome of research, recognising and distinguishing the characteristics of these respective forms of impact ("*half of my* […] *publications were in the process, in developing co-design methods, and the other half were in* […] *the kinds of technologies we developed*", P4). Reflecting upon the impacts achievable through CCI research, participants identified challenges and limitations within the field which may impede realisation of such impact.

6.2.2.1. Limitations in Impact of CCI Research

Although participants identified considerable capacity for Child-Computer Interaction research to generate impact, a number of participants expressed scepticism regarding the extent to which such impact is realised in practice, indicating concerns related to the utility of knowledge produced through academic research and a perceived dissociation between priorities espoused within published research and practice, including technologies studied ("*I'm very sceptical of academia … in a way there's an expectancy that knowledge will be useful. I'm sometimes sceptical whether how useful it is*", P7; "*like many, I have to publish, and you do that, but then the jump between publishing and what I actually think will ultimately help children, I'm very interested in how we address that*", P7).

Due to the tendency to prioritise technological novelty throughout the field, participants suggested that CCI research often neglects widely accessible technologies with empirically evidenced impact on children's lives, and consequently achieve limited impact ("*the type of technology that address the needs of children are generally not the shiny fancy ones that we might push in like HCI and design publications*", P1). Moreover, participants indicated that methodologies and research designs implemented throughout the field, commonly involving small-scale, short-term qualitative study, may impede the generalisability, and thereby restrict the impact, of research outcomes ("[We] *look very closely and deeply into the issues and how we design for it, but obviously we are not going to have a product that's probably designed for everyone and works for everyone*", P5).

Despite espousing the potentially mutually beneficial relationship between CCI research and industry ("*I think some of the knowledge that happens in the lab can be really beneficial to* [industry], *to probably help them to revise their product and make better design*", P6), participants identified the limited impact of research throughout CCI on practice in industry, asserting that commercial technology designers, developers, and producers seldom consider research ("*I just feel that I don't see many companies really drawing on research*", P7; "*I think there is a deep gap between the industrial and research*", P6). Participants ascribe this lack of impact on industry, in part, to a lack of incentive in industry to heed CCI research as commercial success of products is not regarded as contingent upon support or validation through empirical research ("*people don't go into shop and try and look at the research behind the product, … the reason things make success in the market is not because they've, they're founded on great IDC research*", P7). Thus, in spite of an apparent abundance of studies introducing and investigating novel technologies within CCI, industry rarely develops upon, or incorporates, resultant research outcomes, and rather, P7 argued, technological advancements and innovations are often introduced by industry which researchers in the field subsequently hasten to study following broad availability and adoption amongst children:

> *But whilst we're doing all this, companies are just going ahead and creating things that children are using every day … We'd be sitting there and someone might publish something about augmented reality, it'll be a little study, and then next thing you know, Facebook will launch augmented reality for children, and everyone would be using it. When you look at the impact of the iPad you know, I don't think Apple sat there and worked with lots of CCI researchers to work out what they should do, they just did it, and suddenly massively changed everything, so we ran off to catch up* (P7).

Impact of CCI research, P1 contended, is inherently limited due to the negligible impact of developments in many of the technologies studied in the field on aspects of children's lives, and therefore, should genuine impact on the lives of children be sought, resources may be better allocated to other areas of study evincing greater impact:

> *Sometimes I'm not sure why we focus so much money on, like, VR for children when there are many other issues that we're facing right now and what could be solved with that money* [...] *technologies are not where we're going to have the most impact on the lives of children.*

Arguing that researchers in the field are conscious of the limited impact of research therein, P1 asserts that researchers often exaggerate anticipated or accomplished research impacts in pursuing funding opportunities:

> *I think we're pretty aware of the fact that our research doesn't necessarily have the broad-scale impact, and I'm not saying that all research will have broad-scale impact, I'm just saying that we all know that we're over-inflating things in like funding proposals, but also that's how the game is played*.

6.2.3. Challenges in Knowledge (Re)Construction in Child-Computer Interaction

In contributing meaningfully to, and (re)constructing, knowledge within, the field of Child-Computer Interaction, participants recognised various impediments and tensions to be negotiated, with challenges associated therewith inherently influencing, and often hindering, the continued development of knowledge within, and maturation of, the field. Considering impediments and tensions apparent within the field, as well as consequences for knowledge construction thereof, participants cited a range of norms, conventions, and mechanisms associated with the field regarded as inhibiting expression of particular perspectives and impeding certain contributions to knowledge which may act to hamper progress and development therein.

6.2.3.1. Politicisation of Issues in CCI

Noting a distinct lack of debate or disagreement within the field of Child-Computer Interaction ("*That's what I feel I lack in* [the] *field, is a bit of contested thinking and counter thinking*", P7), a number of participants argued that, due the politicisation ("*there's a slight political aspect*", P7) of prominent or contentious issues within the field – such as children's role and influence in design processes – and social consequences of researchers' positioning associated therewith, dissenting and contrary perspectives (i.e., relative to conventional or broadly accepted positions) are implicitly discouraged within the field:

> *questioning certain things like 'is it always good for children to be equal participants in design process?', you know, some things that I'd be careful about, I wouldn't want to publish that. It could be taken really wrong. I wouldn't want to be in that situation. And even I'd be careful about who I shared it with, because it could be,* […] *I mean, you could be ostracised quite a lot. I mean, when you go to conferences, you can definitely see there are groups of thinking* (P7).

Such purportedly politicised issues amongst CCI researchers – including respective roles of children and adults in design, and research and design contexts – are, participants assert, commonly misconstrued as "*false dichotomies*" (P7) consisting of accepted positions regarded favourably within the community and antithetical positions regarded negatively ("*you either work with children as equal participants or you ignore them completely – but there's other ways*", P7; "*a dichotomy on the field has been* […]*, like, working in schools is difficult, so it's better to work in lab because, because then, there is not like, for example, child-teacher, a student-teacher, hierarchy*", P3), with expression or adoption of the latter within research perceived as necessitating explicit justification and potentially accompanied by negative social consequences:

> *So, the kind of positioning ourselves that, okay, you work there and it's fine, but we work here and that is fine too … our world looks like this and we are here, you are there, and then trying to say politely, 'yeah, you are doing good stuff too, but it is just in different contexts'* (P3, referring to research in school, rather than lab, contexts);
>
> *the question of children should be equal participants in designs,* […] *I love working with children, but it's not my methodology. But I would feel quite worried about saying that to some in the community, because it's always presented like you either want to work with*

> *children as equal participants or you don't really respect children. I'm exaggerating for effect, but it can be slightly politicised* (P7).

Consequently, participants believe, CCI researchers may be dissuaded from entertaining and expressing differing, nonnormative, or unconventional, perspectives and engaging in critical dialogue or debate, potentially limiting construction and development of knowledge within the field ("*I think we benefit from differences of opinion. But I think it's dangerous when I'm in a conference and everyone is agreeing, I just think* […] *it doesn't further my thinking. I like to be challenged*", P7).

However, emergence of such politicisation of issues within CCI, a number of participants contested, is inevitable, both as such political tensions and conflicts are intrinsic to fields of academic research in general and given the firm philosophical commitments and epistemological assertions upon which research therein is commonly premised. These participants, therefore, argued that politics pervading the field are not inherently problematic, but rather the identified lack of balanced debate related to contested issues within the field is symptomatic of a failure to develop and practice appropriate strategies to communicate, and maintain fora which accommodate, contrasting viewpoints and critical dialogue ("*I don't think there is necessarily an issue with – I mean, sure, it's difficult, but any field has its politics, any domain has its politics, and it's more about the question of having adequate strategies*", P1). Participants suggested that in order to instigate and support changes to existing norms and practices which may constrain debate and discourse in the field, researchers must engage to a greater extent with the community and processes by which it is regulated (e.g., peer-review; "*try to engage with more stakeholder*[s]*, and try to, like, more people to play in, go to this field and speak out their voices and maybe try to* […] *change some of the mechanics*", P6).

6.2.3.2. Publishing Norms and Processes in CCI

Norms and processes associated with publication of Child-Computer Interaction research in peer-reviewed venues (i.e., journals and conference proceedings) were identified by participants as impeding (re)construction of knowledge within the field. In particular, participants indicated preferences (or biases) apparent in editorial and peer review decisions, through which prospective contributions to the field are regulated, as bearing notable consequences for (re)construction of knowledge within the field.

A number of participants identified, and shared experience of, an ostensible disinclination or aversion to publication of unconventional or atypical research contributions within the field of Child-Computer Interaction, whereby research perceived as "*risky*" or "*controversial*" (P6), due to adoption of nonnormative positions, perspectives, or approaches and deviation from, or disagreement with, established knowledge (i.e., tradition) within the field, is often excluded in favour of research regarded as "*safe*" or "*correct*" (P6), considered generally complimentary to, or compliant with, accepted norms and established knowledge within the field:

> *when we were starting to engage with Child-Computer Interaction, research community, it was kind of challenging. And we were probably doing something somewhat unusual or there were a couple of years that it wasn't that easy to publish those papers* (P2);

> *in the publication areas or academia […], I feel there's trends, sometimes we try to encourage something that's safe but not contribute too much. I think this should be changed. We need to encourage something that,* […] *even they're a little bit* […] *controversial, but still very important things that will need to be discussed, not just something that seems very correct* (P6).

Peer review and editorial processes, which regulate and gatekeep the field, may implicitly discourage incorporation of knowledge generated through research regarded as unconventional or atypical within the field, P6 suggested, through prioritisation of methodological rigour over contributions to knowledge ("[Publication venue] *has changed* […] *the reviewing process and the evaluation method … I think a lot of reviewer has mentioned, this is not a good change because it's encouraged the reviewer to only pass the paper who are safe*", P6). Consequently, it is asserted, researchers are tacitly exhorted to adopt and implement methods and procedures established within extant CCI literature rather than seek to adapt existing, or develop novel, approaches:

> [Papers] *are trying to use very solid, kind of, method that has been used by others. And you try to use the same procedure, … citing some already published paper and try to use exactly the same thing because they are safe, right, it has been tested* (P6).

Participants argue that such a trend, whereby research considered atypical or nonnormative is excluded or omitted from the field, may impede continued progression of knowledge within the field of CCI, contending that creative and innovative research, which often serves to catalyse advancement in knowledge, frequently entails, if not necessitates, a degree of risk and unconventionality:

> *it's not a good way to encourage innovation or whatever, something new, right? Because people always want to try something safe that has already been tested ... But sometimes I feel that important knowledge always come with the controversial or risks* (P6).

Furthermore, the field of CCI, a number of participants indicate, exhibits publication biases whereby the field, relative to other fields of study, demonstrates limited tolerance or appreciation of negative results, or "*failure stories*" (P2), and methodological limitations accompanying, and often qualifying, research ("*every time we're trying to acknowledge* […] *there's some biases, but still the fact is that when you acknowledge that it's very, you have to face a challenge that the reviewers may not publish this kind of paper*", P6). Notably, participants assert that research implementing innovative approaches are frequently subject to a range of limitations, with the likelihood of peer review rejection attributable to recognition of such limitations acting to deter formulation and adoption of novel and innovative approaches within the field ("*when you're encouraged* [to] *acknowledge more limitation or acknowledge the more flaws of your work, then you get more risk to be passed at the* […] *first round. So, no one wanted to* […] *try to do the risks",* P6). These biases, such that the field exhibits limited tolerance for negative findings, may, P2 suggested, derive from the influence of engineering and technology fields, wherein functionality and utility of products or artefacts produced through research are prioritised ("*I would say that in human or in information systems, even, it's failure stories are kind of appreciated, but I would say that in engineering disciplines, it might be difficult to publish stuff like 'we tried to build this novel technology, but it doesn't work'",* P2).

Thus, participants indicated an inherent tension within the field, arising as consequence of these apparent publication biases, to be navigated in undertaking, and publishing, Child-Computer Interaction research, whereby researchers are required to pragmatically judge and moderate the extent to which research deviates from existing norms and knowledge in seeking to contribute meaningfully to the field, maintaining sufficient familiarity, or alignment with tradition, to be accepted as legitimate within the field whilst nonetheless progressing knowledge through novelty and innovation:

> *when you are doing something very obvious for the research community, it's kind of banal even, and it's not interesting even, but the farther you go, it's becoming absurd, […] it's too weird, it's too far away from what they are doing* (P2).

However, a number of participants contested that such regulatory processes are inevitable within academic fields, and that implicit challenges associated therewith may be successfully navigated or overcome by various means and mechanisms, typically involving researcher employment of certain "*strategies*" (P1) and maintenance of adequate standards in reviewing throughout the field ("*I think people are already have lots of strategies to publish more risky stuff*", P1).

Participants commonly stressed the need for researchers, in seeking to engage with, and contribute to, the field, to familiarise themselves with the "*genre*" (P2), or tradition, established therein, acclimatising to, and adopting, the methods and modes of communication ("*when* [researchers] *want to enter a new research community, they start reading the papers and figure out the genre, how to write stuff. Every community has is its genre, and you have to know it*", P2) and establishing and positioning contributions relative to extant knowledge and prominent discourses within the field:

> *as a newcomer, you don't know what are the relevant discourses ongoing right now, and it is so much easier, of course, to write your papers because when you know them, so it's so easy to tap into these – what is relevant? What is kind of interesting right now?* (P2).

In order to overcome challenges encountered in peer review related to perceived absence of, or insufficient, extant empirical literature within the field supporting atypical or unconventional research contributions, P1 detailed a publication strategy which they had successfully employed involving pursuit of publication in venues exhibiting higher acceptance rates or addressing knowledge on the periphery of the field of CCI – often at the intersection with related, or neighbouring, fields – in order to establish legitimacy and validity of knowledge produced therein and support subsequent publication efforts in more central, specialised CCI venues:

> *In any field,* [researchers] *go for a slightly less, like a journal with a higher acceptance rate, get part of their arguments published, and then they can refer to that in their final argument in a more central conference* […] *And I think there's lots of strategies around* […] *publishing papers with venues where these things can proceed, such as at* [general HCI publication venue]*, which is more for thought provocations* (P1).

Participants also asserted the necessity to maintain adequate reviewing standards throughout the field, and, where appropriate, instigate and support progress and change within the field through engagement with, and service to, the community ("*And I think this is more about getting involved with service, getting involved in the community, getting involved with reviewing and being the change that you want to see*", P1).

6.2.3.3. Marginalisation and Exclusion of Non-Western Voices

Voices of researchers hailing from non-Western nations (e.g., countries in Asia, Africa, and South America) are, according to a number of participants, underrepresented within the field of Child-Computer Interaction, asserting that Western culture, manifested in norms and conventions throughout the field, is dominant therein ("*I can see currently the research has already, or still being dominated by the Western culture*", P6). In particular, participants identified reliance on English as a lingua franca throughout the field as marginalising and excluding researchers from non-Western nations who may have limited fluency therein and lack familiarity with academic conventions thereof, recognising that this is a prevalent issue throughout academia more broadly:

> *in* [non-Western nation]*, we* […] *do research, but we don't publish in, most of our researchers they don't have the strong English writing skills* […] *I think there's, the research convention is not the same, still the conventions are dominated by Western countries, like how to write this paper, like the structure, all these things* […] *grow from the Western culture* (P6).

In addition to impeding contribution to knowledge, participants suggested that such challenges associated with difference in language and conventions may prevent meaningful participation in the CCI community, including membership of committees, further prohibiting non-native English speakers' involvement in the development of the field and community in a manner more inclusive of diverse researchers ("*most of committee member, they are from the UK or US. So basically, because we're not in the committee, so for the* [nationality] *researchers, they haven't had enough voices to speak, to help them to speak themselves*", P6). Thus, researchers from non-Western nations are often required to study and replicate established conventions and norms within the field in order to publish in prominent CCI venues:

> *currently we have to try a lot of things, try to learn how the Western people write papers, how we do research, try to learn this kind of methodology … to help us to speak out, but still I think it's a long way to go* (P6);

or publish research in national – rather than international – venues, reducing the reach and reception of knowledge generated and thereby producing, or exacerbating, a gap between knowledge accumulated in CCI across languages and cultures:

> *we publish a lot of like* [non-English language] *kind of thing, but it's not really, the words haven't been heard by the international platform or conferences. So basically, I think still there is gaps on this, the voice of* [non-English language] *words of researchers haven't been heard by the Western culture* (P6).

However, P2 argued that such challenges are currently pervasive throughout academic fields of study and that, relative to other research communities, the CCI community exhibits strong commitments to inclusion of diverse voices ("*I would say that Child-Computer Interaction, as far as I have been involved, it really aims to be inclusive. So, comparing to some other communities, it really aims to be welcoming to different voices*", P2).

6.2.4. Methodological Challenges in Child-Computer Interaction Research

Various methodological challenges, limitations, and tensions commonly encountered and navigated throughout research within the field of Child-Computer Interaction were identified by workshop participants, with such challenges regarded as acting to impede or qualify (re)construction of knowledge therein. Amongst notable challenges cited by participants were those related to identification and application of appropriate research methods within the field, noting common methodological misconceptions and associated misapplications prevalent throughout CCI; negotiation of tensions emerging within co-design processes, particularly concerning positioning of adult and child participants; and a dearth of genuine, meaningful collaboration, despite the field's multidisciplinary foundations and influences. Participants proposed a range of factors contributing to such challenges, including a lack of appropriate research training and inadequate reporting standards within the field.

6.2.4.1. Standards and Conventions in Methods

Implicit challenges in establishing and maintaining standards and conventions related to methods within Child-Computer Interaction were indicated by participants, attributed both to the "*messiness*" (P4) inherent in many methods commonly utilised within the field (e.g., co-design methods) and the disciplinary variety characterising methods throughout the field ("*a lot of the HCI methodologies have been quite have been quite influenced by, requirements engineering, software engineering, kind of methodology*", P5). Whilst participants note the impracticality of imposing distinct CCI conventions on methods within the field due to the multidisciplinary origins and diverse realisations of such methods, the implementation of which often abiding by established conventions within their discipline or field of origin ("*different fields, different kinds of disciplines, they have their very established convention or methodology, but currently, because we need to do a lot of like cross- or multi-disciplinary research, … we cannot really follow that kind of a convention*", P6), participants nonetheless assert a need to establish and abide by consistent standards, conventions, and practices within the field in order to ensure high-quality research therein ("*I think having established practices, it's not always upheld by every research group in our own community*", P5).

Moreover, due to the multitude of methods applied in various contexts throughout CCI research, owing, in part, to the range of research interests and disciplinary backgrounds of researchers contributing thereto, participants expressed a difficulty in selecting appropriate methods to employ in undertaking research within the field ("*we are still struggling, in a day-to-day research process, … to identify, in a very a systematic way, to identify what would be the right methodology for us to use in each different research task*", P5). In sharing experiences of such difficulties, P5 suggested that difficulty in identifying appropriate methods through review of literature may be a consequence of the distributed, if not fragmented, nature of methodological knowledge in the CCI field, whereby researchers are generally required to draw upon methodological literature primarily situated in, and oriented towards, neighbouring and related fields, with an apparent scarcity of methodological literature intended to cater specifically to CCI research contexts upon which researchers in, or entering, the field may rely:

> *we are just always constantly researching to see whether there is a better process of engaging children,* […] *we still don't have a very nice recipe book for us to say this is the kind of methodology* […] *It's just all very scrappy – we have to look for literature from psychology, literature from education, literature from, medical science, as well as the literature from our own HCI literature, and most of the time, we're never happy with those literature.*

6.2.4.2. Shortcomings in Methodological Training

Several participants ascribed many of the methodological issues and challenges prevalent throughout the field, in large part, to deficiencies in methodological proficiency amongst researchers contributing to the field and a lack of availability of, or inadequate, methodological training for researchers established within, and joining, the field.

In particular, participants identified a lack of adequate training in social science research methodologies as a source of methodological challenges in Child-Computer Interaction, arguing that researchers with computer science backgrounds contributing to the field often have not received such training and noting the significance of sensitivity implicitly inculcated through such training in undertaking CCI research:

> *I think it also comes from the issue with our methodological training of researchers* […] *especially for this qualitative interpretation of children's views and interests. I think, well, if the majority of researchers are coming from the computer sciences and not the social or human sciences, they just miss the sensitivity to do it right* (P1).

Participants also attributed issues in methodological training within the field to the relative nascence of methodological traditions therein:

> *we have been teaching qualitative, traditional qualitative methods, traditional quantitative methods, for hundreds of years, longer than we've been doing, co-design. So obviously you've got a longer traditional, more powerful tradition than you have of a few of us pulling together these methods in ways that are not traditional* (P4).

Thus, P4 asserted, methods within the field are still evolving as researchers continue to develop, adapt, and "*make processes their own*" (P4).

Due to apparent shortcomings in methodological training of researchers contributing to the CCI field and perceived issues arising therefrom, participants therefore advocated for concerted effort amongst researchers in the CCI community in organising training events and workshops intended to develop relevant methodological proficiency and sensitivity ("*I also think through the organising of* *events aimed at changing the values and aimed at training people* […] *We actually need to be collaborative in figuring out how we can do this better*", P1).

6.2.4.3. Tensions in, and Misapplication of, Co-Design Methods

A common area of the field of Child-Computer Interaction in which participants identified distinct tensions is the participation of children in design processes, generally facilitated through application of co-design methods. In particular, participants identified persistent challenges and tensions encountered throughout implementation of co-design methods related to issues of the respective roles and positioning of participating children and adults, and the power relations therebetween. Participants also proposed issues within the field which may give rise to, and exacerbate these perceived tensions in the field, citing misunderstandings and misapplication of co-design, as well as challenges in accurately representing and reporting co-design processes.

Several workshop participants indicated perceived tensions and challenges to be negotiated in seeking to involve children as "*equal partners*" (P3) in design processes, with the parity of power and influence between child and adult participants in co-design contexts regarded as "*an age-old question*" (P3) in CCI. As earlier noted, participants expressed perceived politicisation of the issue of children's role and influence in design processes within the field (see **Section 6.2.3.1**), whereby the positioning of children as equal partners (i.e., exerting influence within design processes comparable to adult counterparts) in co-design contexts is regarded throughout the field as favourable and unequal partnerships – invariably adult-dominated – viewed negatively. However, several participants argued that the positioning of children as equal partners in design processes may be inappropriate, impractical, or unfeasible – if not "*impossible*" (P3) – in many co-design contexts ("*It's not easy to achieve* [equal partnership] *and I don't think we have been able to realise it in all senses because it's very demanding. So, I don't think we do it perfectly in Child-Computer Interaction*", P2). Whilst often striving "*to keep children as equal as possible* […] [and] *trying to minimise the influence* [researchers] *would impose on the process*" (P5), workshop participants argued that inherent power disparities between child participants and adult researchers or designers inevitably inhibit equal partnership ("*we may never be able to treat them as our equals, just as we do with grown up study participants, because they're study participants*", P5).

These perceived tensions and challenges encountered in undertaking co-design processes in CCI, P4 contended, arise as consequence of common miscomprehension and misapplication of co-design methods within the field ("*If I were to go around and say what really is co-design, I would say only two-thirds of it is truly co-design*", P4). The intention or objective of co-design, P4 argued, is not to achieve *equal* partnership, involving prescription and expectation of child partners contributing to design processes to an extent comparable adult partners ("*Equality says everybody's got to do the same thing, which is stupid, it's not what you're supposed to do*", P4), but rather to facilitate *equitable* partnership, whereby all design partners are afforded equal "*opportunity to do what is needed in a particular situation that makes sense for them*" (P4).

Pursuit of equal partnership between adult and child design partners within co-design processes, it is argued, is generally unreasonable due to inherent limitations in children's knowledge and abilities ("*Kids are experts at being kids, but they're not experts in being educators, they're not experts in being programmers, they're not experts in being scientists*", P4), and in practice may prompt excessive demands upon child partners and exacerbate disparities in power and influence between adult and child partners ("*what* [researchers] *are doing is either having the adults specify too much, too many parameters, or they're having the kids try and do it all – and you can't have either*", P4). Consequently, application of co-design methods with the explicit intention to accomplish equal partnership is regarded as failing to generate "*the impactful, important ideas we need to move the field forward, not in the methods as much as in the outcomes*" (P4), and may thereby contribute to negative perceptions concerning the value or efficacy of co-design methods ("*And so if you have lousy or mid-range outcomes, where people go, 'eh, so? Big deal. So they made it pink because that's what* *the kids said', then people are not going to take co-design seriously*", P4). Conversely, P4 proposed, co-design processes seeking to facilitate equitable partnership promote processes of elaboration, in which both adult and child partners have adequate opportunity to continuously interact and develop upon design proposals and suggestions, emphasising collective, rather than individual, contributions and collaborative processes in generating outcomes ("*it is not about whose voice is louder. It's not about whether we have to make sure that the kids come up with all the good ideas. It's about the process of elaboration*", P4).

Such misunderstanding, and consequent misapplication, of co-design methods, P4 suggested, may be ascribed to challenges associated with implementation and reporting of co-design methods and processes in a manner regarded as scientifically rigorous, citing in particular the "*messiness*" inherent in co-design processes as an impediment ("*Because* [co-design is] *messy people have shied away from it*", P4). P4 noted the challenge associated with reporting "*messy*" co-design processes in a representative manner within academic fora, with published accounts of such methods often presenting simplified, linear portrayals of complex, and often disorderly, design processes in order to comply with academic norms or standards established within the field ("*how do you write about this messy process in a way that people don't think that you do this, and then you do this, and then you do this?*", P4). Resultant moderated or sanitised reports of co-design methods and processes, it is proposed, may contribute to, or perpetuate, identified misconceptions and misunderstandings related to co-design processes in CCI.

6.2.4.4. Lack of Meaningful Multidisciplinary Collaboration

Whilst participants identified the importance of multidisciplinary collaboration within the field of CCI, noting the 'multidisciplinarity' characterising the field and the backgrounds of researchers contributing thereto, and shared positive experiences of multidisciplinary collaboration in undertaking CCI research ("*we have* […] *a very cross-disciplinary team, and we found this is quite essential for our* *technology work... we've found it's been a very effective and informing process for us*", P5), several participants noted challenges in, and consequent lack of, meaningful multidisciplinary collaboration in CCI ("[trans- and cross-disciplinary research] *is difficult. It's not like it's happening by itself, actually it requires hard work*", P2). In particular, participants identified methodological challenges associated with multidisciplinary research in CCI, with such research typically requiring adoption of methods, and conformity to conventions, established within the respective relevant disciplines in order to accommodate subsequent publication of research in relevant venues:

> *I think methodology is very important … but currently because we need to do a lot of like cross- or multi-disciplinary research, so that means we cannot really follow that kind of a convention … people still wanted to follow their convention,* […] *it's hard to try something new because it will have to follow whatever has already been established in your field* (P6).

A number of participants expressed concerns that the evident challenge associated with undertaking multidisciplinary collaboration alongside policy initiatives and ample funding incentives to engage in multidisciplinary and collaborative research ("*Of course in Europe, these funding models like Horizon Europe type of projects are expecting oftentimes there is multidisciplinary collaboration*", P2) may inadvertently prompt researchers to engage in "*superficial*" (P6) collaboration, whereby ostensibly collaborating researchers work largely independent of each other, with limited collaboration therebetween:

> *it's very superficial – it's like, 'oh, we have the team that is the made up by people from different backgrounds', but actually do people really believe this is going to happen, that really believing this kind of collaboration is going to benefit the children? I don't think so for most of the cases* (P6).

In order to support genuine, meaningful collaboration in CCI, P6 argued, there is a need for further development of multidisciplinary knowledge within the CCI community ("*So, I mean, we need actually deeper collaboration* […] *We really need the people who have the multidisciplinary knowledge, who can understand what are other people talking on*", P6).

6.3. Strategic Publication Practices

In reflecting upon processes of knowledge (re)construction within the field of Child-Computer Interaction, several participants noted publishing norms and biases perceived as impeding or limiting contribution of nonnormative or unconventional novel knowledge, whereby such contributions, deviating from established knowledge within the field, are considered at greater risk of rejection in peer review and editorial processes (see **Section 6.2.3.2**). In navigating and negotiating challenges and tensions within the field arising due to such norms, participants identified the utility of several strategic publication practices. Representing an unanticipated finding of the current phase (Phase 2) of analysis, the theoretical bases of, and empirical evidence related to, indicated tensions and respective strategies detailed were investigated through critical review of relevant literature (see **Appendix I**). These findings are briefly discussed, with reference to relevant literature, below.

Tensions in the field of Child-Computer Interaction articulated by participants are evident within extant literature throughout various fields (e.g., Boudreau et al., 2016; Foster et al., 2015; Trapido, 2015), with scientific audiences, despite commonly espousing expectations of original and transformative contributions and regarding novelty as a criterion of merit, typically recognising and valuing contributions consistent with the dominant knowledge canon or paradigm in the field and evaluating novelty negatively. Participants' characterisation of this implicit tension, and their experiences thereof, resembles Foster et al.'s (2015) proposition that decisions concerning research problems and strategies are generally patterned by an *essential tension* (T. S. Kuhn, 1978) between low-risk – or "*safe*" (P6; i.e., more reliably achieve publication) – adherence to the established research tradition within the field and high-risk – or "*risky*" (P6; i.e., greater likelihood of failure to achieve publication) – pursuit of impactful innovation. Empirical studies suggest that such negative dispositions towards novelty may be attributable to implicit psychological biases against the ambivalence or uncertainty novelty may induce (Mueller et al., 2012) and perceived threats to the social structure of the field, which may privilege or prove advantageous for established community members, which such contributions may pose (Cattani et al., 2015, 2022).

Strategic practices for publication of nonnormative or unconventional novel knowledge applied in order to navigate and resolve such tensions within the field of Child-Computer Interaction indicated by participants included the following approaches:

a. Publication of research in venues exhibiting higher acceptance rates or addressing knowledge on the periphery of the field (i.e., venues associated with neighbouring and related fields, such as HCI), regarded as less likely to reject submissions on the basis of deviation from traditional Child-Computer Interaction convictions or conventions, in order to attain recognition and legitimacy, and thereby support subsequent acceptance and integration within the conventional core of CCI. Premised on the integration of knowledge contributions into the (conceptual) core of the field from initial publication in the field's periphery, such a strategy is here termed an *outside-in* strategy.

b. Embedding novel or atypical contributions within conventional (i.e., established) Child-Computer Interaction knowledge in order to demonstrate compatibility of contributions with, or basis in, the dominant knowledge tradition in the field. Premised on the integration and proliferation throughout the field of novel contributions initially introduced through grounding in established knowledge within the field, such a strategy is here termed an *inside-out* strategy.

Contentions of the *outside-in* strategy proposed by participants, whereby the (social and epistemic) periphery of the field is regarded as more amenable to unconventional, novel contributions, align with the propositions of the *core-periphery* conceptualisation of the structure of scientific fields advanced by Cattani et al. (2015, 2022). Within such a core-periphery conception of the field of Child-Computer Interaction, research positioned at the periphery of the field – here, beyond those venues which primarily serve the field (i.e., IDC and IJCCI) – may elude homogenising influences and normative pressures to conform associated with the dominant culture and established conventions of the field, and therefore may entertain more unconventional concepts and incorporate ideas from external domains. Demonstrative of this assertion, empirical studies (e.g., Painter et al., 2021) indicate that innovative publications (i.e., those introducing novel knowledge) tend to be concentrated in the periphery of a scientific field's conceptual landscape. However, whilst evidently a feasible strategy through which tensions within the field may be navigated, the efficacy of such a strategy in achieving impact and integration of novel knowledge contributions into scientific fields is yet to be investigated.

Reminiscent of McLaughlin's (1998, 2000, 2001) concept of *optimal marginality* and Cattani et al.'s (2015) *optimal network structuration strategy*, the *inside-out* strategy participants articulated posits that novel knowledge contributions benefit from the relevance and familiarity positioning relative to, and embedding within, conventional and established knowledge may afford. Such a strategy enables interposition of novel contributions into prominent, contemporary discourses within the field whilst maintaining distinctiveness and originality. Illustrative of the efficacy of an inside-out strategy in practice, empirical evidence (e.g., Antons et al., 2019; Foster et al., 2015; Safadi et al., 2021; Uzzi et al., 2013) indicates that innovative contributions generally attain greatest recognition and impact when grounded in, and aligning with, the dominant knowledge canon within a field.

Based on these findings related to strategic publication practices within the field of Child-Computer Interaction, as well as supplementary review of relevant literature (see **Appendix I**), the following hypotheses are proposed:

H1. Researchers strategically publish more novel contributions to the field of Child-Computer Interaction in non-specialised publication venues.

H2. Innovative contributions embedded in conventional knowledge within the field of Child-Computer Interaction achieve greatest subsequent uptake within the field.

H3. Child-Computer Interaction research papers exhibiting greater novelty within the field attain greater scientific impact.

In order to explore the veracity, generalisability, and efficacy of identified strategies throughout the field of Child-Computer Interaction, proposed hypotheses were investigated through a further quantitative analysis phase (Phase 3; see **Section 4.2** and **4.4.3**), the results of which are presented in the following chapter.

6.4. Summary

Diverse perspectives and experiences of a number of experienced Child-Computer Interaction researchers were obtained through a series of online workshops and discussions (i.e., focus groups, dyadic interviews, and semi-structured interviews). Results of thematic analysis indicate several distinct themes, and associated subthemes, by which participants' experiences of, and perspectives on, processes and practices through which knowledge in the field of Child-Computer Interaction has been (re)structured over time may be broadly categorised. Various tensions and challenges evident within the field related to these themes, and specific research and publication practices and strategies through which these may be negotiated in (re)structuring knowledge in the field, were elaborated. Critical discussion of findings and results in relation to research questions, supported through integration with results obtained through other phases of the present study, is presented in **Chapter Eight**.

Chapter Seven: Strategies for Knowledge Innovation in Child-Computer Interaction

This chapter presents the results and findings of quantitative data analyses comprising Phase 3 of the mixed methods research design implemented in the present study. The chapter begins by detailing variables relevant to the present analysis through descriptive statistics, describing the distributions of, and relationships (i.e., correlations) between, variables of interest. Results of regression analyses investigating strategic publication practices utilised in in negotiating challenges and tensions related to knowledge (re)construction within the field of Child-Computer Interaction, hypothesised following Phase 2 qualitative analysis (see **Section 6.3**) and informed by relevant literature (see **Appendix I**), are presented. The following hypotheses are explicitly tested:

H1. Researchers strategically publish more novel contributions to the field of Child-Computer Interaction in non-specialised publication venues.

H2. Innovative contributions embedded in conventional knowledge within the field of Child-Computer Interaction achieve greatest subsequent uptake within the field.

H3. Child-Computer Interaction research papers exhibiting greater novelty within the field attain greater scientific impact.

In so doing, **RQ 1.6** is further addressed, with the feasibility and efficacy of proposed publication strategies in the field of Child-Computer Interaction empirically examined and evidenced within an extensive corpus of relevant research papers. Thus, results of Phase 3 analyses serve to explore and empirically test, and are subsequently integrated during discussion with, results of the preceding phase of analysis (Phase 2).

7.1. Descriptive Statistics

Descriptive statistics related to two datasets analysed in the current analysis, both derived from the retrieved corpus of Child-Computer Interaction research papers previously detailed (see **Section 5.1**), are presented, concerning research papers and individual innovations introduced throughout the corpus – the identification of which has been previously detailed (see **Section 4.4.3.1**) – respectively.

7.1.1. Research Paper Descriptive Statistics

Table 7.1 presents means, standard deviations, and medians, as well as number of missing cases, associated with variables related to Child-Computer Interaction research papers retrieved (*n* = 4,771). On average, papers within the corpus, the majority (71%) of which were published in nonspecialised venues (i.e., venues other than IDC and IJCCI, the field's primary publication venues), received 14 citations and were written by 4 (co-)authors who had collectively contributed to (i.e., [co-]authored) 6 previously published papers (within the retrieved corpus) and cumulatively received 60 citations for papers previously published in the field's primary venues (i.e., IDC and IJCCI). Papers, on average, introduced two novel concept combinations, or (recombinant) innovations (i.e., *scientific novelty*), with innovations introduced within papers subsequently appearing in 20 papers each (i.e., *uptakes*) – notably, however, only 30% of papers in the corpus (i.e., 1,433) have introduced any (i.e., at least one) novel concept combinations. For those papers which failed to introduce novel concept combinations (*n* = 3,338), *distal novelty* and *uptakes* associated with innovations introduced therein were inherently incalculable and therefore classed as missing. Whilst descriptive statistics related to the latent topic structure of papers (based on topic loadings derived through Correlated Topic Modelling; see **Sections 4.4.3.4** and **5.2**) were also calculated, these are not presented here for purposes of clarity, but are made available in **Appendix BB**.

Table 7.1. *Descriptive statistics of Child-Computer Interaction research paper variables*

	Mean	Standard Deviation	Minimum	Median	Maximum	Skewness	Kurtosis	Missing
Publication Age	5.87	4.47	0.00	5.00	18.00	0.76	-0.26	0
Nonspecialised Venue	0.71	0.45	0.00	1.00	1.00	-0.93	-1.13	0
Author Count	3.65	2.14	0.00	3.00	33.00	2.28	14.71	0
Author Prominence	59.93	172.94	0.00	0.00	2552.00	5.68	46.39	0
Author Productivity	6.37	14.52	0.00	1.00	229.00	5.99	56.50	0
Increasing Primary Topic Trend	0.53	0.50	0.00	1.00	1.00	-0.11	-1.99	0
Topic Focus	0.17	0.10	0.05	0.14	0.91	2.46	8.37	0
Distal Novelty	0.61	0.09	0.23	0.60	1.01	0.09	1.10	3338
Scientific Novelty	1.88	6.61	0.00	0.00	146.00	7.63	91.28	0
Paper Peripherality	0.31	0.05	0.15	0.31	0.47	0.20	0.14	0
Innovation Uptakes	19.54	16.95	0.00	15.20	133.91	1.76	4.39	3338
Citation Count	13.95	29.17	0.00	5.00	718.00	7.31	103.74	0

Distal novelty, measuring the mean unusualness, or atypicality, of novel concept combinations within the semantic space of Child-Computer Interaction introduced in a given paper exhibits a relatively normal distribution (see **Figure 7.1a**) – although it is noted that distal novelty values are calculable only for the subset of papers which introduce novel concept combinations (n = 1,433). In contrast, however, *scientific novelty*, indicating the number of novel concept combinations introduced in a paper, demonstrates a highly (positively) skewed, Poisson distribution (see **Figure 7.1b**).

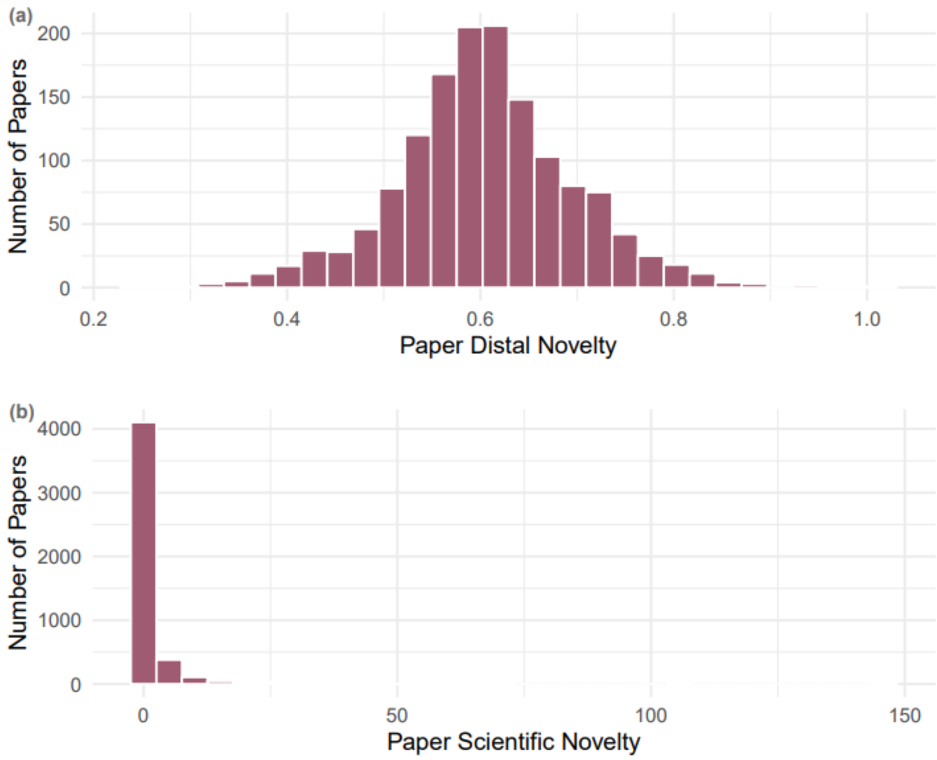


Figure 7.1. *Distribution of (a) distal novelty and (b) scientific novelty amongst retrieved Child-Computer Interaction research papers.*

Semantic distance, measured as Relaxed Word Mover's Distance (RWMD), of paper content from central concepts evident throughout the Child-Computer Interaction field, quantifying paper conventionality (i.e., *centrality*) – or unconventionality (i.e., *peripherality*) – within the field, demonstrates a normal distribution (see **Figure 7.2**). Papers in which content demonstrates greater (semantic) distance from core concepts evident throughout the field (see **Section 4.4.3.3**) are regarded as unconventional in the context, and thus positioned peripherally in the conceptual space, of CCI research, whereas papers demonstrating less (semantic) distance from core concepts are considered conventional, and thus positioned centrally, therein.

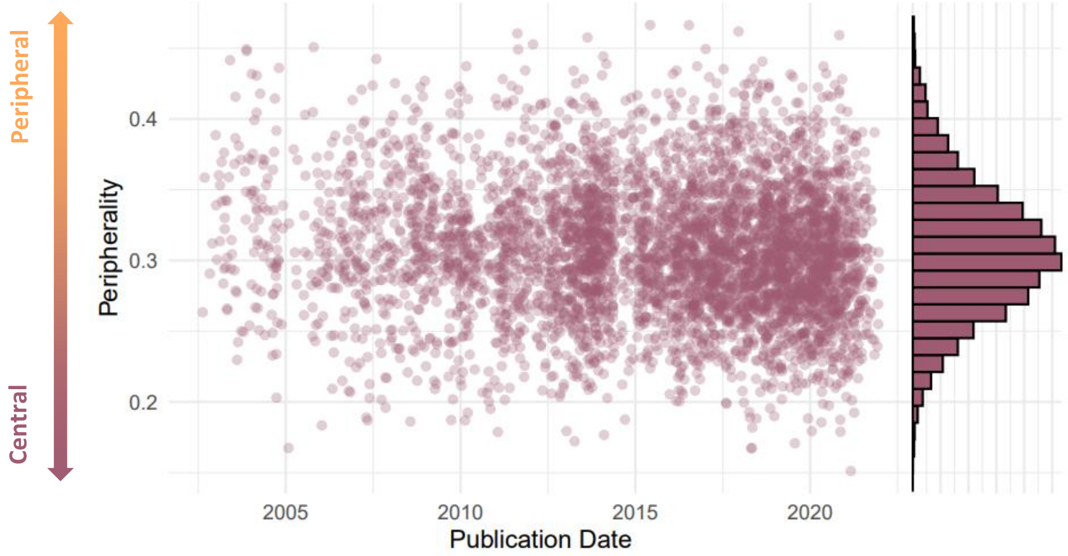


Figure 7.2. *Distribution of peripherality amongst retrieved Child-Computer Interaction research papers.*

Citation count of papers (i.e., the number of papers which have cited a given paper), representing *scientific impact*, exhibits, similar to *scientific novelty*, a highly (positively) skewed, Poisson distribution (see **Figure 7.3**). Amongst retrieved Child-Computer Interaction research papers, 20% had failed to achieve citation in subsequent research (at the time of data retrieval), with 54% of papers attaining five or fewer citations.

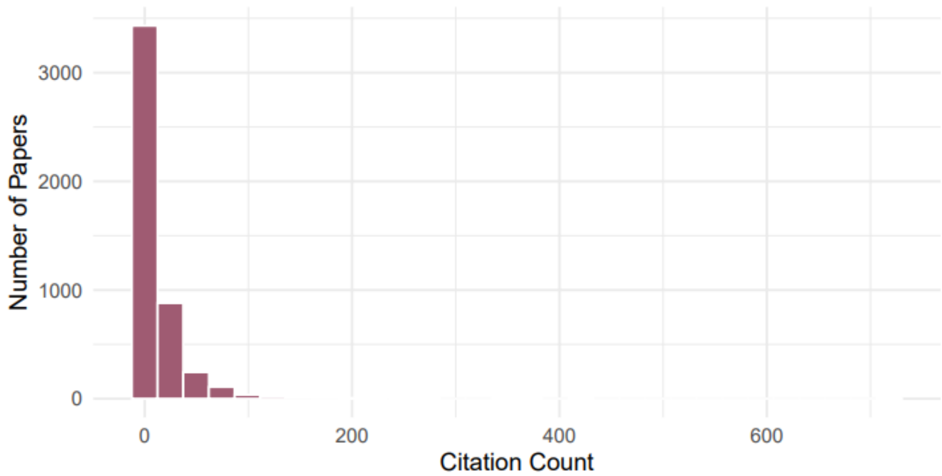


Figure 7.3. *Distribution of citation count amongst retrieved Child-Computer Interaction research papers.*

Figure 7.4 portrays pairwise correlations (r) among variables related to Child-Computer Interaction research papers retrieved (n = 4,771). *Publication age* exhibits a strong, positive correlation with *innovation uptakes* (r = .76, p <.001) and moderate, positive correlation with *citation count* (r = .31, p <.001; Cohen, 1988, 1992), indicating a tendency amongst papers to accrue greater recognition and impact over time. *Scientific novelty* demonstrates strong, positive correlations with *innovation uptakes* (r = .60, p <.001) and *publication age* (r = .54, p <.001), implying that papers published earlier in the field's development generally introduce a greater number of novel concept combinations and that such concept combinations introduced in papers exhibiting greater numbers thereof (i.e., *scientific novelty*) tend to achieve greater subsequent uptake throughout the corpus – however, it may be that the latter relationship is, to some extent, attributable to the former, given that, as noted, innovations attain greater uptake over time. In contract, *innovation uptakes* demonstrates a weak, negative association with *distal novelty* (r =-.16, p <.001), such that innovations introduced in papers in which innovations typically exhibit greater atypicality or unusualness tend to attain fewer subsequent uptakes throughout Child-Computer Interaction research. A moderate, positive correlation between paper *topic focus* and *peripherality* within the field (i.e., semantic distance of paper content from the core, underlying concepts evident throughout the field, indicative of unconventionality; r = .30, p <.001) is evident, intimating that a focus on fewer topics within papers is associated with greater divergence from the central concepts and concerns of the CCI field. Rather logically, *author productivity* and *author prominence* demonstrate strong correlation (r = .85, p <.001), such that as the number of published CCI research papers to which (co-)authors have previously contributed increases, so too does the combined number of citations received by papers previously published in the field's primary venues (i.e., IDC and IJCCI) to which (co-)authors have contributed – potential multicollinearity among author attributes in models will be scrutinised.

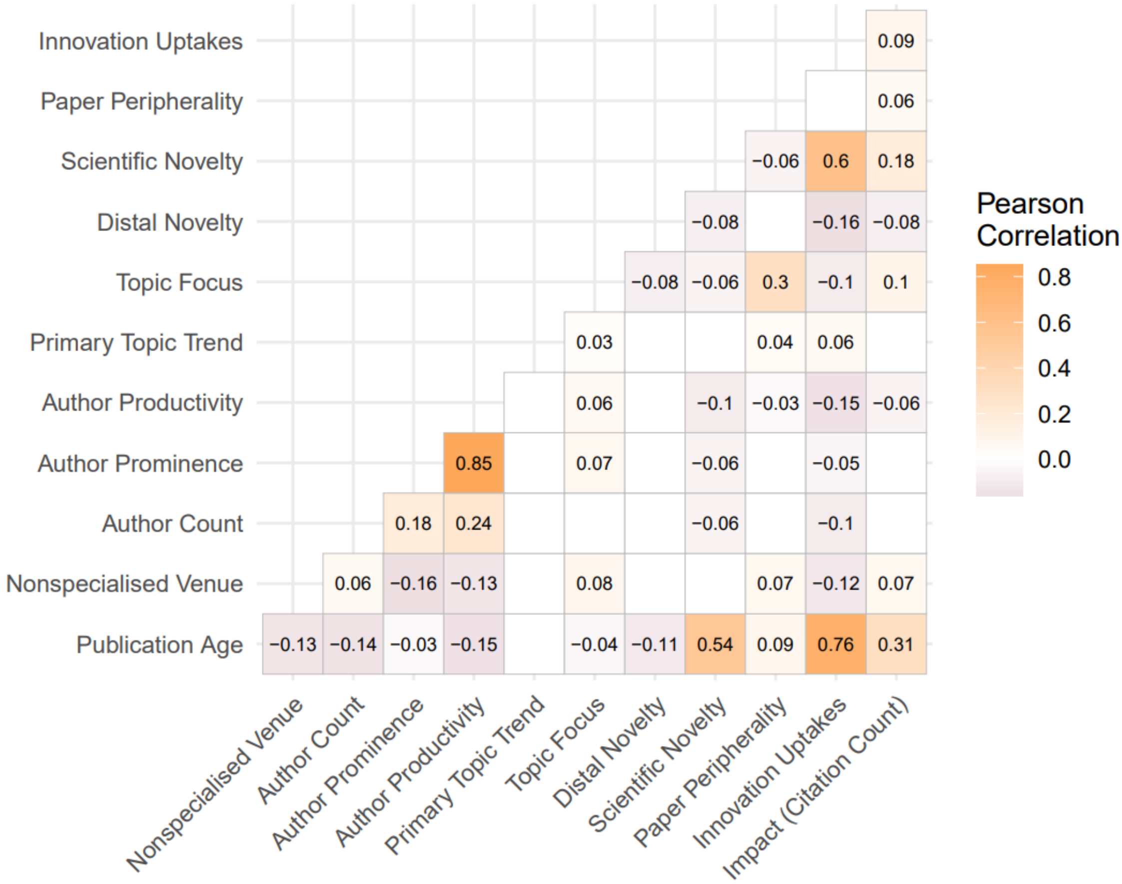


Figure 7.4. *Correlations (r) among variables of interest in Child-Computer Interaction research papers. Note, only those significant associations (*p *< .05) are depicted.*

7.1.2. Innovation Descriptive Statistics

Table 7.2 presents means, standard deviations, and medians, as well as number of missing cases, associated with, and **Figure 7.7** portrays pairwise correlations (r) among, variables related to individual novel concept combinations, or innovations (n = 8,215), identified throughout Child-Computer Interaction research papers retrieved. Paper-level variables – here, all those variables of interest apart from *distal novelty* and *innovation uptakes* – are calculated for the subset of papers within the retrieved corpus which introduce innovations (n = 1,433). On average, innovations, following introduction, appeared throughout ensuing CCI research papers within the corpus (i.e., *innovation uptakes*) 37 times (see **Figure 7.5** for illustration of innovation uptake), although the distribution of innovation uptakes demonstrates a substantial positive skew (see **Figure 7.6**).

Papers within the corpus introducing innovations, the majority of which were published in nonspecialised venues (68%), on average introduced 25 novel concept combinations, received 33 citations, and were written by 3 (co-)authors who had collectively contributed to (i.e., [co-]authored) 1 previously published paper (within the retrieved corpus) and cumulatively received 24 citations for papers previously published in the field's primary publication venues (i.e., IDC and IJCCI). Although descriptive statistics related to the latent topic structure of papers (based on topic loadings derived through Correlated Topic Modelling; see **Section 4.4.3.4**) were also calculated, these are not presented here for purposes of clarity, but are made available in **Appendix CC**.

Table 7.2. *Descriptive statistics of Child-Computer Interaction innovation variables.*

	Mean	Standard Deviation	Minimum	Median	Maximum	Skewness	Kurtosis	Missing
Publication Age	14.31	3.36	0.00	15.00	18.00	-1.07	0.82	0
Nonspecialised Venue	0.68	0.47	0.00	1.00	1.00	-0.76	-1.43	0
Author Count	3.21	1.97	0.00	3.00	15.00	1.51	3.22	0
Author Prominence	23.66	94.07	0.00	0.00	1871.00	7.23	74.91	0
Author Productivity	1.48	4.27	0.00	0.00	125.00	8.99	145.53	0
Increasing Primary Topic Trend	0.58	0.49	0.00	1.00	1.00	-0.31	-1.90	0
Topic Focus	0.15	0.08	0.05	0.12	0.88	2.90	14.02	0
Distal Novelty	0.59	0.13	0.07	0.60	1.06	-0.19	0.13	0
Paper Peripherality	0.30	0.05	0.17	0.30	0.47	0.13	0.15	0
Innovation Uptakes	37.29	41.62	0.00	26.00	582.00	3.88	25.99	0

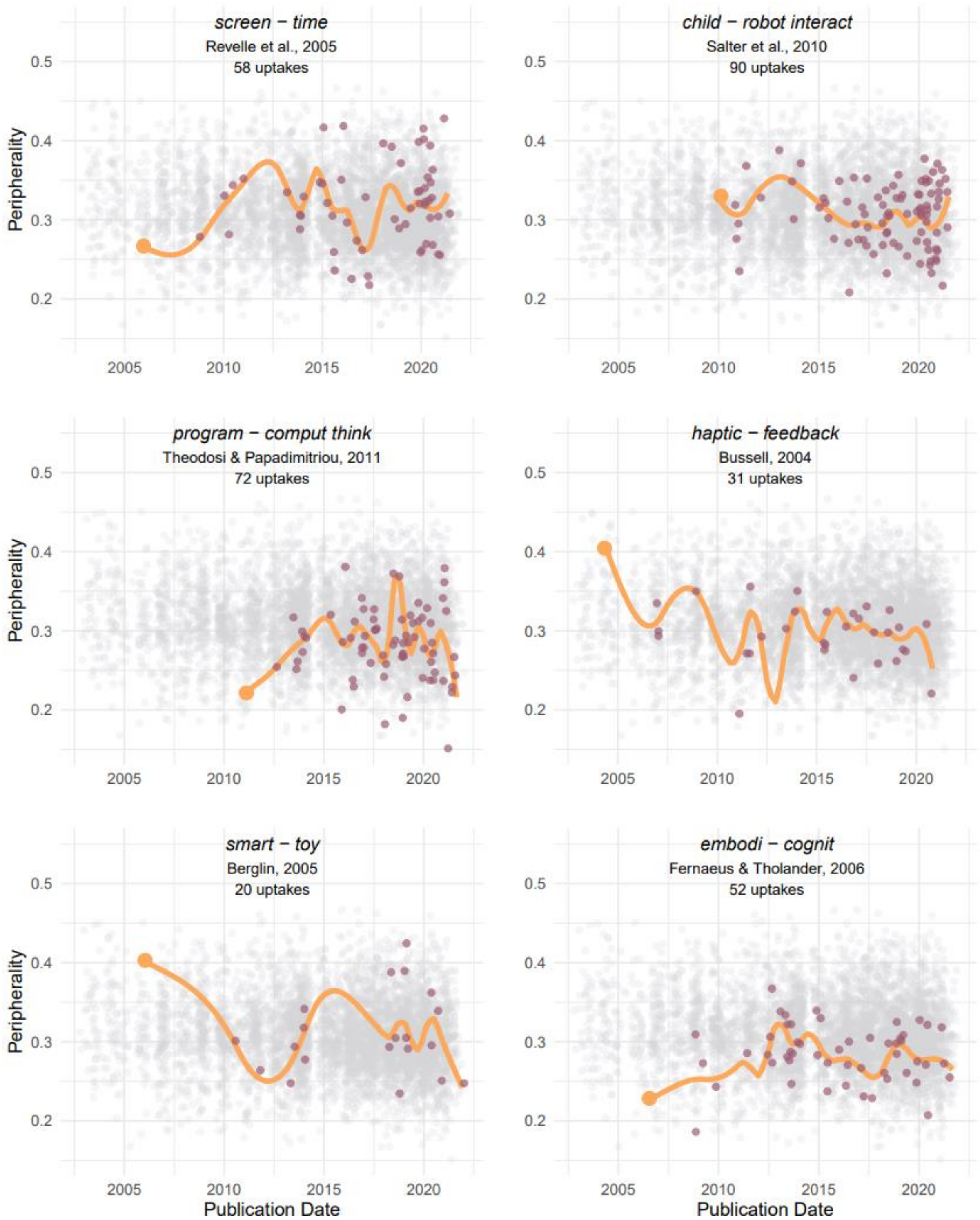


Figure 7.5. *Introduction of novel concept combinations (i.e., innovations) and their subsequent uptake throughout the Child-Computer Interaction field. Papers are positioned by peripherality within the field (lower values indicate conceptually more central content) and publication date. Papers introducing innovations are indicated in yellow, whilst papers in which this same innovation subsequently appears are indicated in purple.*

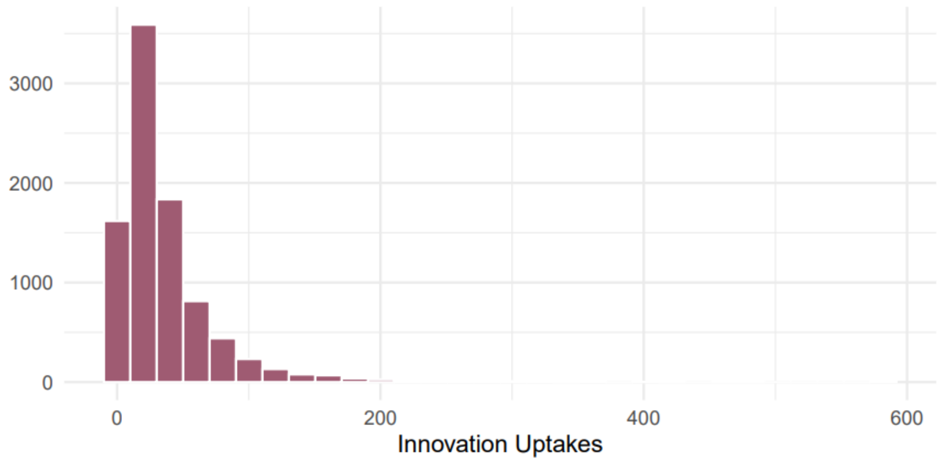


Figure 7.6. *Distribution of uptakes amongst identified novel concept combinations (i.e., innovations) throughout Child-Computer Interaction research papers.*

Relationships between paper-level variables in the subset of those Child-Computer Interaction research papers identified as introducing innovations broadly align with those evident throughout the corpus as a whole (see **Section 7.1.1** above; see **Figure 7.4**). *Distal novelty* of innovations (i.e., the relative unusualness of concept combinations with the semantic space of the Child-Computer Interaction field) demonstrates a weak, negative correlation with the number of subsequent *uptakes* of an innovation within the field (r = -.23, p <.001), such that concept combinations exhibiting greater atypicality tend to attain fewer subsequent uptakes throughout the Child-Computer Interaction research.

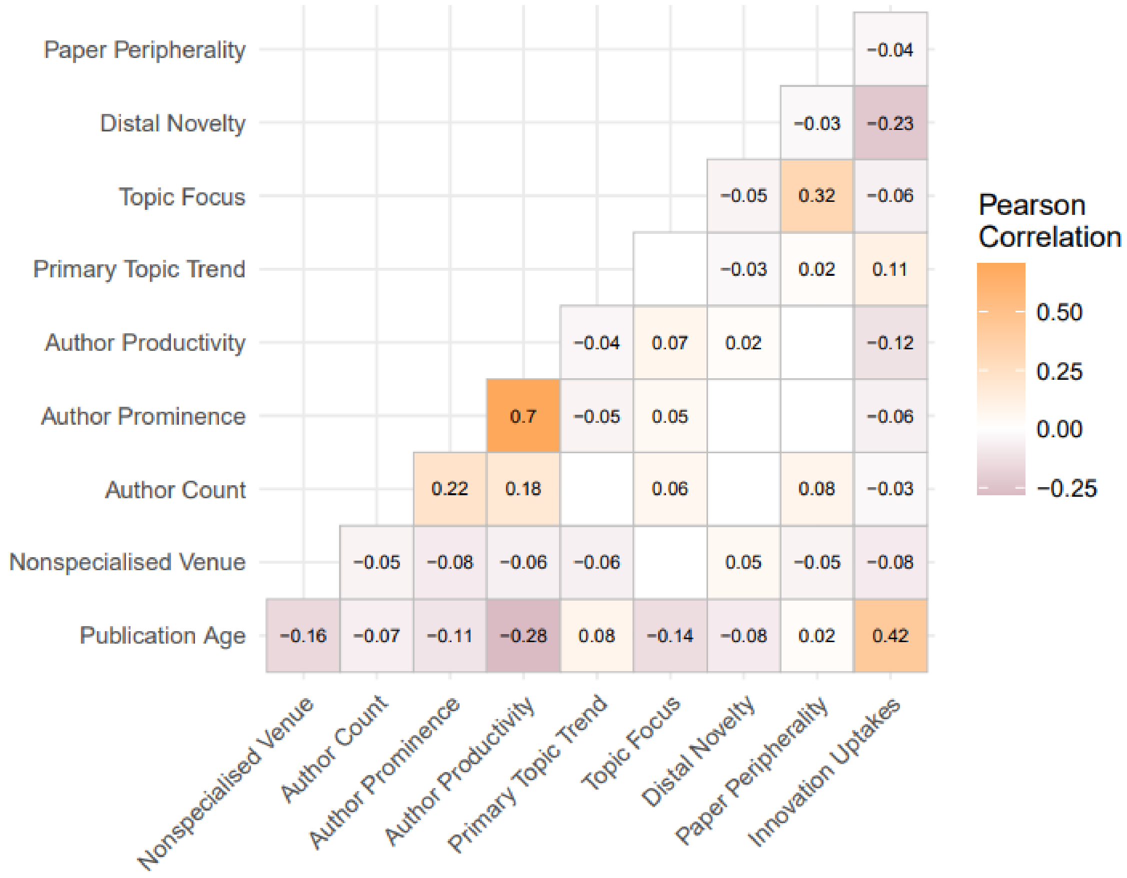


Figure 7.7. *Correlations (*r*) among variables of interest related to novel concept combinations (i.e., innovations), and the research papers in which they were introduced, throughout Child-Computer Interaction. Note, only those significant associations (*p *< .05) are depicted.*

7.2. Relationship between Novelty and Publication Venue in CCI

Results of regression analyses examining the relationship between *publication venue* and paper *distal* and *scientific novelty* respectively (Models 1 and 2) are presented in **Table 7.3**. In modelling this relationship, analyses investigate the assertions of **H1**, which proposes that *researchers strategically publish more novel contributions to the field of Child-Computer Interaction in non-specialised publication venues*.

Models were constructed – and are presented – in a stepwise manner through sequential addition of sets of relevant predictor variables and review of goodness of fit statistics (e.g., *F*-test, likelihood-ratio test, AIC). Model 1, modelling the relationship between predictors, including *publication venue*, and paper *distal novelty*, is specified as follows, with indicated sets of predictors added in turn:

$$distal\ novelty_a = \beta_0$$

(1) Intercept (Null Model)

$$\begin{aligned} &+ \beta_1 age_a + \beta_2 venue_a \\ &+ \beta_3 author\ count_a + \beta_4 productivity_a \\ &+ \beta_5 prominence_a \end{aligned}$$

(2) Publication and Author Attributes

$$+ \beta_6 topic\ trend_a + \beta_7 topic\ focus_a$$

(3) Topic Attributes

$$+ \beta_8 \ \dots \ \beta_{8+56} topic\ structure_a + \varepsilon_a$$

(4) Topic Structure

Due to heteroscedasticity of residuals in Model 1 (Breusch-Pagan Test, $\chi^2_{[1]} = 33.32$, $p < .001$; see residual plots in **Appendix DD**), robust standard errors (heteroscedasticity-consistent [HC3] standard errors) are calculated for ordinary least squares regression estimates (Long & Ervin, 2000; White, 1980). Unstandardised coefficient estimates (β) are reported for Model 1.

Model 2, modelling the relationship between predictors, including *publication venue*, and paper *scientific novelty*, is specified as follows, with indicated sets of predictors added in turn:

$$log(scientific\ novelty_a) = \beta_0$$

(1) Intercept (Null Model)

$$\begin{aligned} &+ \beta_1 age_a + \beta_2 venue_a \\ &+ \beta_3 author\ count_a + \beta_4 productivity_a \\ &+ \beta_5 prominence_a \end{aligned}$$

(2) Publication and Author Attributes

$$+ \beta_6 topic\ trend_a + \beta_7 topic\ focus_a$$

(3) Topic Attributes

$$+ \beta_8 \ \dots \ \beta_{8+56} topic\ structure_a + \varepsilon_a$$

(4) Topic Structure

As previously noted, *scientific novelty*, a positively skewed count (see **Figure 7.1b**), is modelled through negative binomial regression in order to account for overdispersion in the data (with respect to a Poisson distribution) – a likelihood-ratio test comparing the negative binomial model to a Poisson model indicates that the dispersion parameter (φ) is significantly different from zero, with the negative binomial model providing a better fit to the data ($\chi^2_{[1,56]} = 2255.1$, $p < .001$; see **Appendix EE** for plot comparing respective model prediction). Coefficient estimates are presented as incidence rate ratios (IRR), the exponents of unstandardised estimates, for Model 2 for purposes of interpretability.

In order to support model interpretability, a number of variables which exhibit a range of less than 1 (*distal novelty*, *topic focus*, and *topic structure* variables) were standardised (i.e., converted to z-scores) prior to analysis – however, it is noted that these variables are retransformed to their original metrics in depicting predicted marginal effects. Multicollinearity in both models is examined based on variance inflation factors (VIF <3.5 for all variables), suggesting no evidence of multicollinearity (Hair et al., 2010; Marcoulides & Raykov, 2019; Chatterjee & Simonoff, 2013).

Results offer partial support for the assertions of **H1**, indicating that, although papers published in nonspecialised publication venues (i.e., venues other than Child-Computer Interaction's primary publication venues, IDC and IJCCI) do not appear to introduce novel concept combinations (i.e., innovations) which differ in their unusualness (i.e., *distal novelty*) from those introduced in papers published in specialised venues (β = .003, p = .55; see **Figure 7.8a**), papers published in nonspecialised venues introduce a significantly greater number of such innovations (i.e., *scientific novelty*; IRR = 1.288, p <.001; see **Figure 7.8b**). Papers published in nonspecialised publication venues introduce, on average, 29% more novel concept combinations than those published in Child-Computer Interaction's primary venues, IDC and IJCCI.

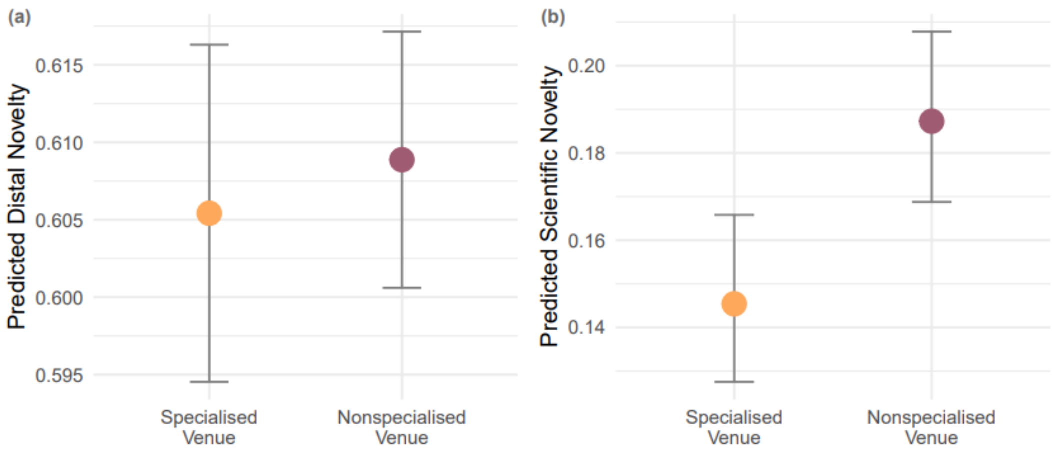


Figure 7.8. *Predicted marginal effect of publication venue on Child-Computer Interaction research paper (a) distal novelty and (b) scientific novelty. Error bars indicate 95 percent confidence intervals.*

Several other notable effects were evident in models. Paper *publication age* is negatively associated with *distal novelty* (β = -.003, p <.001), yet positively associated with *scientific novelty* (IRR

= 1.543, p <.001; see **Figure 7.9**), indicating that, on average, papers published earlier in the field's development introduced a greater number of novel concept combinations, whereas those novel concept combinations introduced in papers published more recently exhibit greater unusualness or atypicality in the context of Child-Computer Interaction. Latent *topic structure* of papers evidently explains a relatively noteworthy proportion of variance in paper distal and scientific novelty, with the adjusted coefficient of determination (i.e., R^2) increasing by .01 and .02 in Models 1 and 2 respectively with the introduction of topic loadings. Results demonstrate that the extent to which papers address a number of identified Child-Computer Interaction research themes is associated with the *distal* and *scientific novelty* thereof (see **Appendices FF** and **HH**), with these effects – particularly in relation to *distal novelty* – commonly negative. Suggested by the effect of *topic focus* on *distal novelty* prior to introduction of topic structure variables in Model 1 (β = -.080, p <.01), such effects imply greater focus on particular topics within CCI research papers tends to be associated with less unusual, or atypical, concept combinations.

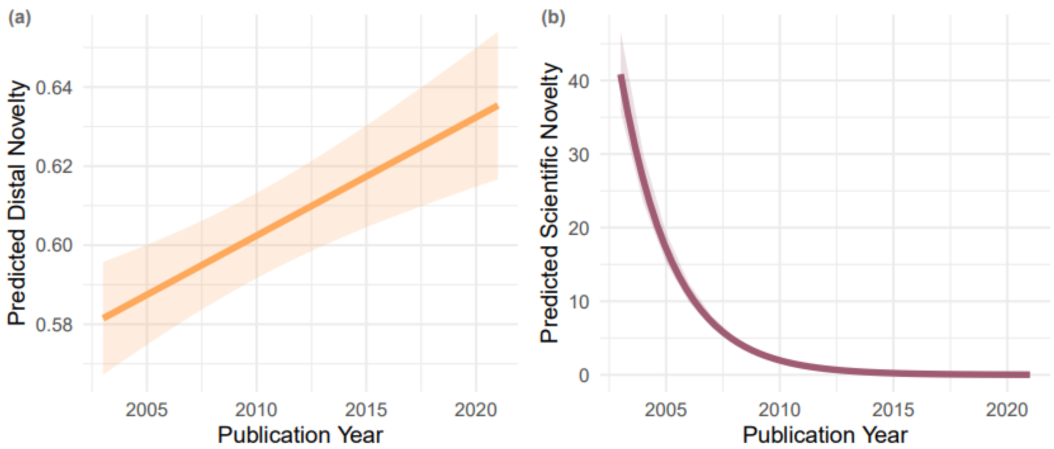


Figure 7.9. *Predicted marginal effect of publication age (reverted to publication year) on Child-Computer Interaction research paper (a) distal novelty and (b) scientific novelty. 95 percent confidence intervals are shaded.*

Table 7.3. *Results of ordinary least squares (with robust standard errors) and negative binomial regression investigating the relationship between paper novelty and publication venue (Models 1 and 2).*

Level of Analysis:	Paper					
Dependent Variable:	Distal Novelty [a]			Scientific Novelty		
Model/Estimation:	Model 1 Robust Standard Errors (HC3)			Model 2 Negative Binomial		
	β (SE)	β (SE)	β (SE)	IRR (SE)	IRR (SE)	IRR (SE)
Intercept	.622*** (.010)	.638*** (.010)	.672*** (.015)	.019*** (.099)	.019*** (.110)	.025*** (.131)
Publication Attributes						
Publication Age	-.002*** (.001)	-.002*** (.001)	-.003*** (.001)	1.512*** (.006)	1.511*** (.006)	1.543*** (.006)
Nonspecialised Publication Venue	.003 (.005)	.004 (.005)	.003 (.006)	1.402*** (.054)	1.410*** (.054)	1.288*** (.055)
Author Attributes						
Author Count	.002 (.001)	.002 (.001)	.002 (.001)	1.030* (.013)	1.029* (.013)	1.019 (.012)
Author Productivity	.000 (.001)	.000 (.001)	.001 (.001)	.986* (.006)	.986* (.006)	.994 (.006)
Author Prominence	.000 (.000)	.000 (.000)	.000 (.000)	.999 (.001)	1.000 (.001)	1.000 (.001)
Topic Attributes						
Topic Trend (Increasing)		-.003 (.005)	-.003 (.005)		1.150** (.049)	1.054 (.048)
Topic Focus [a]		-.080** (.026)	.052 (.026)		.681 (.247)	.787 (.346)
Topic Structure [a b]			Yes ***			Yes ***
Observations	1433	1433	1433	4771	4771	4771
F	3.9***	4.48***	1.87***			
Loglikelihood Ratio				-4574.74***	-4569.68**	-4450.83***
R^{2} [c]	.013	.022	.069	.298	.298	.317
Adjusted R^2	.010	.017	.032			

[a] Variables standardised in order to support interpretability. Coefficient estimates represent the change in the outcome associated with a 1 standard deviation change in the predictor.
[b] Latent topic structure is investigated through 48 variables representing paper topic loadings associated with each topic identified through Correlated Topic Modelling (see **Section 5.2**). Significance here indicates the highest level of significance achieved amongst topic variables.
[c] Pseudo-R^2 (McFadden; R^2_{McF}) for negative binomial regression models. * *p* <.05; ** *p* <.01; ****p*<.001.

7.3. Relationship between Paper Conventionality and Innovation Uptake

Results of regression analysis examining the relationship between conventionality of content presented within papers in the context of the field of Child-Computer Interaction, operationalised as the position of papers within the field of Child-Computer Interaction relative to the field's core, underlying concepts or concerns (i.e., relative *peripherality*), and the subsequent *uptake* of innovations – here, novel concept combinations – introduced therein (Model 3) are presented in **Table 7.4**. In modelling this relationship, analysis investigates the assertions of **H2**, which proposes that *innovative contributions embedded in conventional knowledge within the field of Child-Computer Interaction achieve greatest uptake within the field*.

Model 3 was constructed – and is presented – in a stepwise manner through sequential addition of sets of relevant predictor variables and review of goodness of fit statistics (e.g., likelihood-ratio test, AIC). Model 3, modelling the relationship between predictors, including paper *peripherality*, and *innovation uptakes*, is specified as follows, with indicated sets of predictors added in turn:

$log(uptakes_a) = \beta_0$	*(1) Intercept (Null Model)*
$+\ \beta_1 age_a + \beta_2 venue_a$ $+\ \beta_3 author\ count_a\ + \beta_4 productivity_a$ $+\ \beta_5 productivity_a^2 + \beta_6 prominence_a$	*(2) Publication and Author Attributes*
$+\ \beta_7 topic\ trend_a + \beta_8 topic\ focus_a$	*(3) Topic Attributes*
$+\ \beta_9\ \dots\ \beta_{9+57} topic\ structure_a$	*(4) Topic Structure*
$+\ \beta_{58} peripherality_a$	*(5) Paper Field Position*
$+\ \beta_{59} distal\ novelty_a$	*(6) Innovation Attributes*
$+\ \beta_{60} distal\ novelty_a * peripherality_a$ $+\ \beta_{61} distal\ novelty_a * topic\ trend_a + \varepsilon_a$	*(7) Interaction Effects*

Innovation uptake, as a positively skewed count (see **Figure 7.6**), is modelled through negative binomial regression in order to account for overdispersion in the data (with respect to a Poisson distribution) – a likelihood ratio test comparing the negative binomial model to a Poisson model indicated that the dispersion parameter (φ) is significantly different from zero, with the negative binomial model providing a better fit to the data ($\chi^2_{[1,60]}$ = 133288, *p* <.001; see **Appendix JJ** for plot comparing respective model prediction). In order to account for interdependence of, or correlation, in errors within papers, standard errors are clustered by paper (i.e., cluster-robust [HC3] standard errors; Liang & Zeger, 1986; Abadie et al., 2017; MacKinnon et al., 2022; Jackson, 2019).

Both the quadratic term for *author productivity* (i.e., *author productivity²*) and interaction term between *distal novelty* and *peripherality* (i.e., *distal novelty*peripherality*) were removed from final models due to inferior model fit associated with their inclusion (*author productivity²*: $\chi^2_{[1,8952]} = 1.837$, $p = .175$; *distal novelty*peripherality*: $\chi^2_{[1,8899]} = .333$, $p = .563$). In order to support model interpretability, a number of variables (innovation *distal novelty*, paper *peripherality*, paper *topic focus*, and paper *topic structure* variables) were standardised (i.e., converted to z-scores) prior to analysis – however, it is noted that these variables were retransformed to their original metrics in depicting predicted marginal effects. Multicollinearity was examined based on variance inflation factors (VIF <3 for all variables, excepting those involved in interactions and quadratic terms), indicating no issues. Coefficient estimates are presented as incidence rate ratios (IRR; based on unstandardised estimates).

As hypothesised (**H2**), results indicate a relationship between the conventionality of papers in which innovations are introduced within the field of Child-Computer Interaction (i.e., position relative to the field's conceptual core) and subsequent uptake, or recurrence, of innovations throughout the field, such that the more unconventional (i.e., peripherally positioned) content presented in papers is within the field the fewer subsequent uptakes innovations introduced therein tend to achieve (IRR = .935, $p < .001$; see **Figure 7.10**). Results intimate that, on average, the number of CCI papers in which innovations appear following their introduction within the field (i.e., *innovation uptakes*) decreases by 6.5% for each standard deviation increase in distance between the position of the paper in which the innovation is introduced within the field and the field's semantic core (i.e., *peripherality*).

Table 7.4. *Results of negative binomial regression (with cluster-robust standard errors) investigating the relationship between paper peripherality and innovation uptakes (Model 3).*

Level of Analysis:	Innovation		
Dependent Variable:	Innovation Uptakes		
Model/Estimation:	Model 3 Negative Binomial (Cluster-Robust [Paper, HC3] Standard Errors)		
	IRR (SE)	IRR (SE)	IRR (SE)
Intercept	2.816*** (.025)	2.330*** (.214)	2.354*** (.213)
Publication Attributes			
Publication Age	1.156*** (.016)	1.183*** (.017)	1.191*** (.017)
Publication Age^2	1.001* (.001)	1.001 (.001)	1.000 (.001)
Nonspecialised Publication Venue	1.034 (.020)	1.168** (.024)	1.051* (.022)
Author Attributes			
Author Count	.992 (.004)	.999 (.004)	.999 (.004)
Author Productivity	.999 (.004)	.999 (.004)	1.000 (.004)
Author Prominence	1.000 (.000)	1.000 (.000)	1.000 (.000)
Topic Attributes			
Topic Trend (Increasing)	1.095*** (.019)	1.113*** (.019)	1.089*** (.019)
Topic Focus [a]	.981* (.008)	.962** (.008)	.968** (.012)
Topic Structure [a b]		Yes ***	Yes ***
Paper Field Position			
Peripherality [a]			.935*** (.010)
Innovation Attributes			
Distal Novelty [a]			.876*** (.011)
Interaction Effects			
Distal Novelty [a] x Topic Trend (Increasing)			.915*** (.015)
Observations	8960	8960	8960
Loglikelihood Ratio	-39146***	-39016***	-38682***
Pseudo-R^{2} [c]	.053	.056	.064

[a] Variables standardised in order to support interpretability. Coefficient estimates represent the change in the outcome associated with a 1 standard deviation change in the predictor.
[b] Latent topic structure is investigated through 48 variables representing paper topic loadings associated with each topic identified through Correlated Topic Modelling (see **Section 5.2**). Significance here indicates the highest level of significance achieved amongst topic variables.
c Pseudo R2 (McFadden; R^2_{McF}) for negative binomial regression models. * *p* <.05; ** *p* <.01; ****p*<.001.

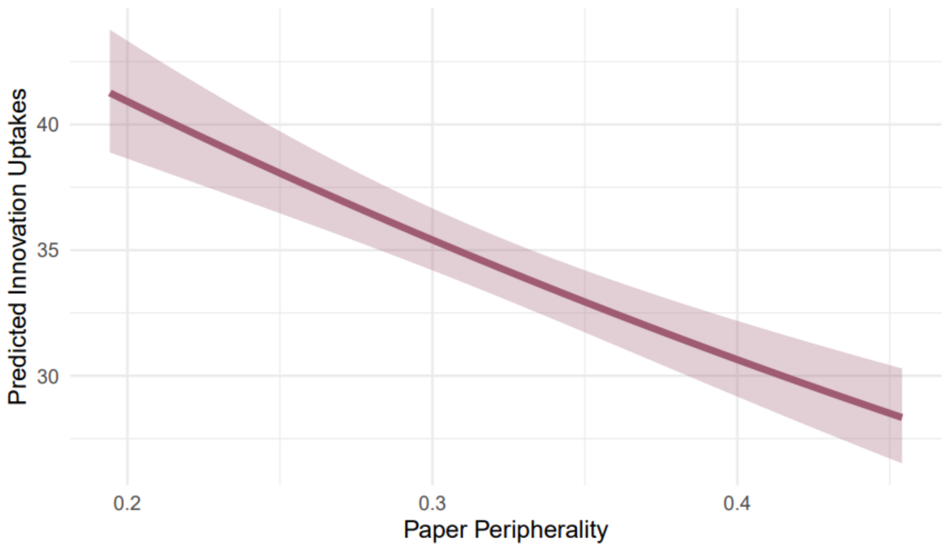


Figure 7.10. *Predicted marginal effect of paper peripherality in the field of Child-Computer Interaction on the uptake of innovations introduced therein throughout subsequent CCI research.*

Similarly, innovation *distal novelty*, as suggested in earlier reported correlations (see **Figure 7.7**), evidences a negative relationship with *innovation uptake* throughout the field of Child-Computer Interaction, such that, on average, those novel concept combinations demonstrating greater semantic atypicality in the context of CCI research achieve fewer uptakes throughout subsequent research (IRR = .877, p <.001; see **Figure 7.11a**). Notably, an interaction effect between *distal novelty* of innovations and the trend in the relative prevalence of the primary topic addressed in the paper in which they are introduced (i.e., increasing or decreasing prevalence in the preceding years; IRR = .915, p <.001) implies that the relationship between distal novelty and innovation uptake is, to an extent, moderated by the primary topic trend in papers introducing innovations. Further supported by estimation of simple slopes models (Dawson, 2014; Bauer & Curran, 2005) examining the relationship between *innovation uptakes* and *distal novelty* based on trend in primary topic trend which demonstrate simple slopes for distal novelty of innovations introduced in papers addressing topics with both increasing ($t_{[8899]}$ = -22.50, p <.001) and decreasing ($t_{[8899]}$ = -11.73, p <.001) trends differ significantly from zero, respective gradients indicate that the negative effect of *distal novelty* on *innovation uptakes* is exacerbated when introduced in papers addressing topics exhibiting increasing trends in prevalence (β = -.221) relative to those addressing topics demonstrating decreasing trends (β = -.132; see **Figure 7.11b**).

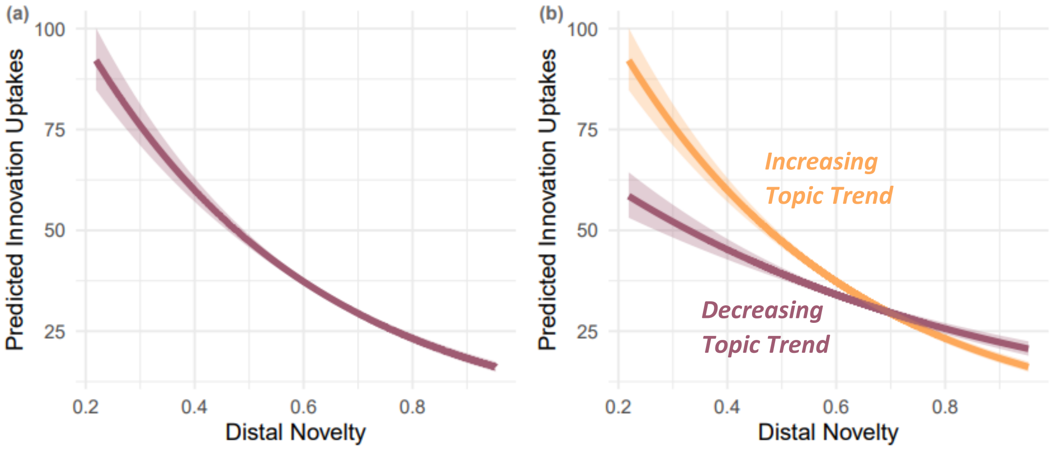


Figure 7.11. *Predicted marginal effect of (a) innovation distal novelty on innovation uptake (b) by primary topic trend (i.e., increasing or decreasing) in papers introducing innovations (i.e., interaction effect).*

Additionally, a number of control variables exhibited significant effects (see **Figure 7.12** and **Appendix KK**). Innovations introduced earlier in the field's development achieve greater uptake throughout subsequent publications, with each additional year since an innovation's introduction, on average, associated with a 19% increase in uptakes attained within the field (IRR = 1.191, *p* <.001). Furthermore, innovations introduced in papers published in nonspecialised venues generally attain greater uptake than those introduced in papers published in CCI's primary publication venues (IRR = 1.051, *p* <.01). Topic attributes of papers in which innovations are introduced are consequential for the extent to which innovations are adopted throughout subsequent literature, with innovations introduced in papers demonstrating greater *topic focus* typically achieving fewer subsequent uptakes (IRR = .968, *p* <.01) but innovations introduced in papers addressing a primary topic exhibiting increasing prevalence throughout the field in preceding years attaining greater uptakes relative to those introduced in papers addressing primary topics demonstrating decreasing trends in prevalence (IRR = 1.089, *p* <.001). Moreover, the extent to which papers address particular topics (i.e., latent *topic structure*) is found to be variously associated with significantly positive and negative effects on uptakes innovations introduced therein attain (see **Appendix LL**).

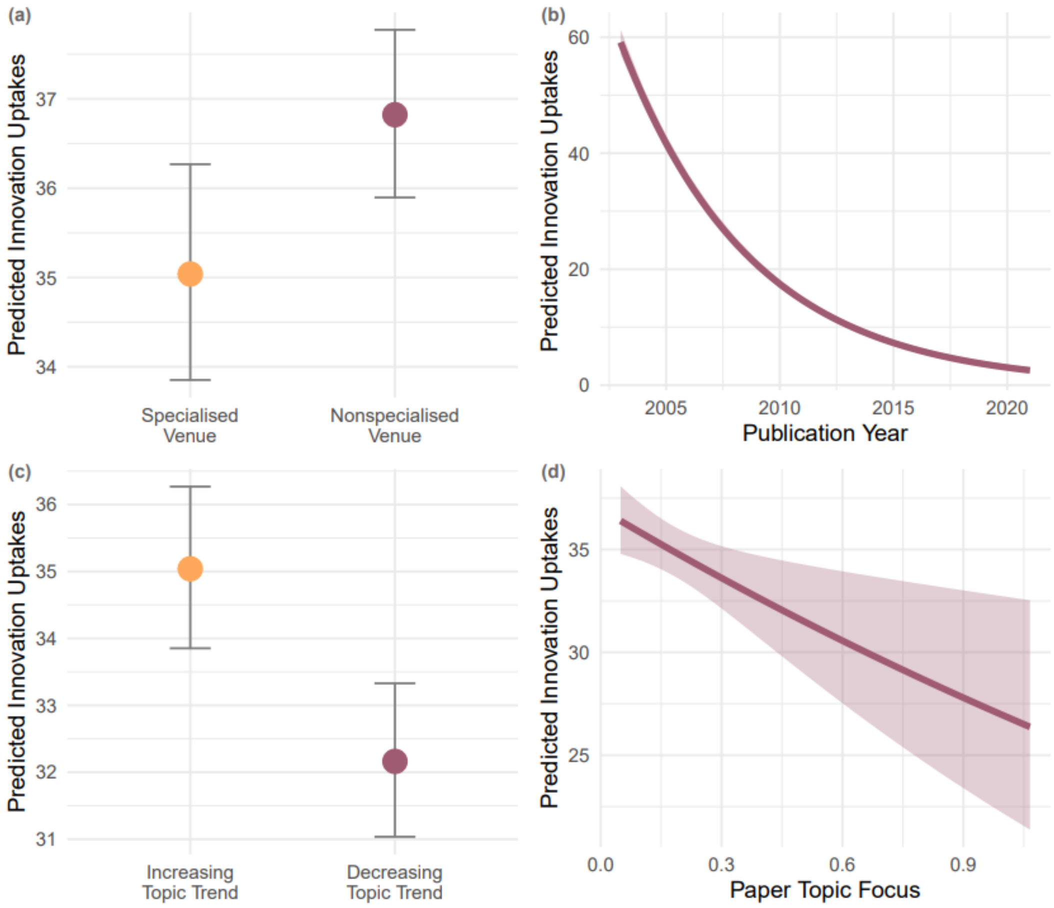


Figure 7.12. *Predicted marginal effect of paper (a) publication venue, (b) publication age (reverted to publication year), (c) primary topic trend, and (d) topic focus on innovation uptakes. 95 percent confidence intervals are indicated by error bars or shaded as appropriate.*

7.4. Relationship between Novelty and Impact

Results of regression analysis examining the relationship between the novelty of paper content, both in terms of the number (i.e., *scientific novelty*) and unusualness (i.e., *distal novelty*) of concept combinations, or innovations, introduced therein, and the *scientific impact* (i.e., citations) achieved thereby (Model 4) are presented in **Table 7.5**. In modelling this relationship, analysis investigates the assertions of **H3**, which proposes that *Child-Computer Interaction research papers exhibiting greater novelty within the field attain greater scientific impact*.

Model 4 was constructed – and is presented – in a stepwise manner through sequential addition of sets of relevant predictor variables and review of goodness of fit statistics (e.g., likelihood-ratio test, AIC). Model 4, modelling the relationship between predictors, including paper *scientific novelty* and *distal novelty*, and paper *scientific impact*, is specified as follows, with indicated sets of predictors added in turn:

$log(scientific\ impact_a) = \beta_0$	*(1) Intercept (Null Model)*
$+ \beta_1 age_a + \beta_2 venue_a$ $+ \beta_3 author\ count_a\ + \beta_4 productivity_a$ $+ \beta_5 prominence_a$	*(2) Publication and Author Attributes*
$+ \beta_6 topic\ trend_a + \beta_7 topic\ focus_a$	*(3) Topic Attributes*
$+ \beta_8\ \ldots\ \beta_{8+56} topic\ structure_a$	*(4) Topic Structure*
$+ \beta_{57} peripherality_a$	*(5) Paper Field Position*
$+ \beta_{58} scientific\ novelty_a$ $+ \beta_{59} distal\ novelty_a$	*(6) Innovation Attributes*
$+ \beta_{59} scientific\ nov_a * peripherality_a$ $+\beta_{60} distal\ novelty_a * topic\ trend_a$ $+\varepsilon_a$	*(7) Interaction Effects*

Scientific impact, or citation count, is modelled through negative binomial regression in order to account for overdispersion in the data (with respect to a Poisson distribution) – a likelihood ratio test comparing the negative binomial model to a Poisson model indicated that the dispersion parameter (φ) is significantly different from zero, with the negative binomial model providing a better fit to the data ($\chi^2_{[1,62]}$ = 38029, p <.001; see **Appendix MM** for plot comparing respective model prediction).

The interaction term between *distal novelty* and *topic trend* (i.e., *distal novelty*topic trend*) was removed from final models due to inferior model fit associated with its inclusion ($\chi^2_{[1,1369]}$ = .585, p =.444). In order to support model interpretability, a number of variables (*distal novelty*, *peripherality*, *topic focus*, and *topic structure* variables) were standardised (i.e., converted to *z*-scores) prior to analysis – however, it is noted that these variables were retransformed to their original metrics in depicting predicted marginal effects. Multicollinearity was examined based on variance inflation factors (VIF <3.5 for all variables, excepting those involved in interactions and quadratic terms), indicating no issues. Coefficient estimates are presented as incidence rate ratios (IRR; based on unstandardised estimates).

Due to the absence of *distal novelty* values for a considerable proportion of papers (see **Section 7.1.1**), the full model, which includes distal novelty as an independent variable, is fitted for the subset of papers for which *distal novelty* is calculable (n = 1,433). However, this subset, by its very nature, restricts inclusion to those papers with *scientific novelty* of greater than one (i.e., to calculate *distal novelty*, a paper must introduce at least one novel concept combination), and may thus offer biased estimates. Thus, for all results apart from those related to *distal novelty*, results of the full model excluding *distal novelty* – and thereby including all papers – are reported and considered in inferences.

Supporting the contentions of **H3**, results demonstrate a positive association between the number of novel concept combinations, or innovations, introduced in Child-Computer Interaction research papers (i.e., *scientific novelty*) and the *scientific impact* (i.e., citation count) attained thereby, such that for each additional innovation introduced CCI papers, on average, receive 5% more citations (IRR = 1.046, p <.001; see **Figure 7.13**).

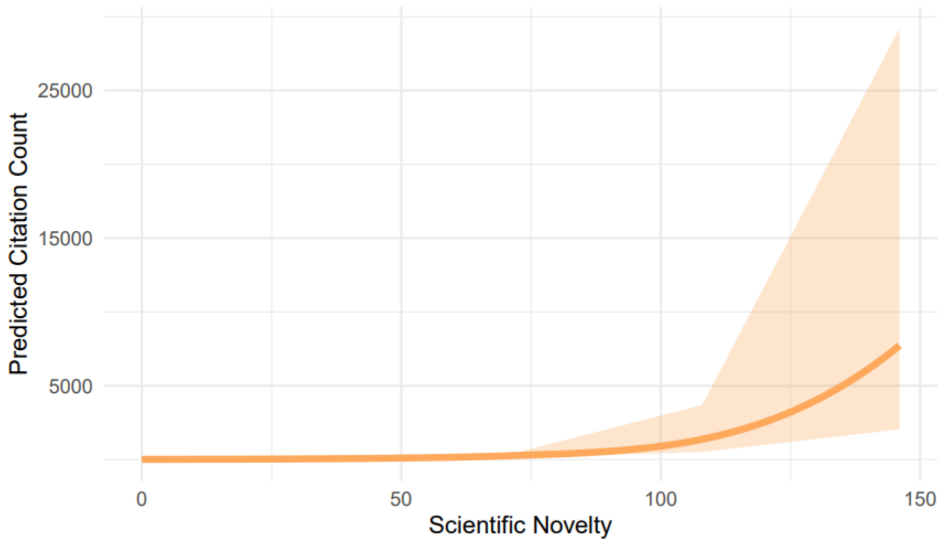


Figure 7.13. *Predicted marginal effect of Child-Computer Interaction research paper scientific novelty on scientific impact.*

A significant, negative relationship between unconventionality (i.e., *peripherality*) of papers within the field and *impact* is evident, such that papers presenting less conventional content (i.e., positioned further from the core of the field) typically attain fewer citations (IRR = .861, p <.001) – or, alternatively, those papers addressing content more conventional concepts within CCI tend to achieve more citations (see **Figure 7.14a**). However, a positive interaction (IRR = 1.020, p <.001) between paper unconventionality, or position within the field relative to the conceptual core (i.e., *peripherality*), and *scientific novelty* intimate that the negative effect of unconventionality on impact – or citation count – is more pronounced amongst those papers introducing fewer novel concept combinations. Simple slopes models for *peripherality* with average (mean; $t_{[4710]}$ = .620, p =.535), and high (2 SD above the mean; $t_{[4710]}$ = 3.749, p <.001) *scientific novelty* (see **Figure 7.14b**) differ significantly from zero, with respective gradients indicating that the negative effect of unconventionality on citation count is exacerbated when papers introduce an average number of novel concept combinations (β = -.113) but that unconventionality demonstrates an increasingly positive effect on citation count amongst papers introducing a high number of novel concept combinations (β = .146).

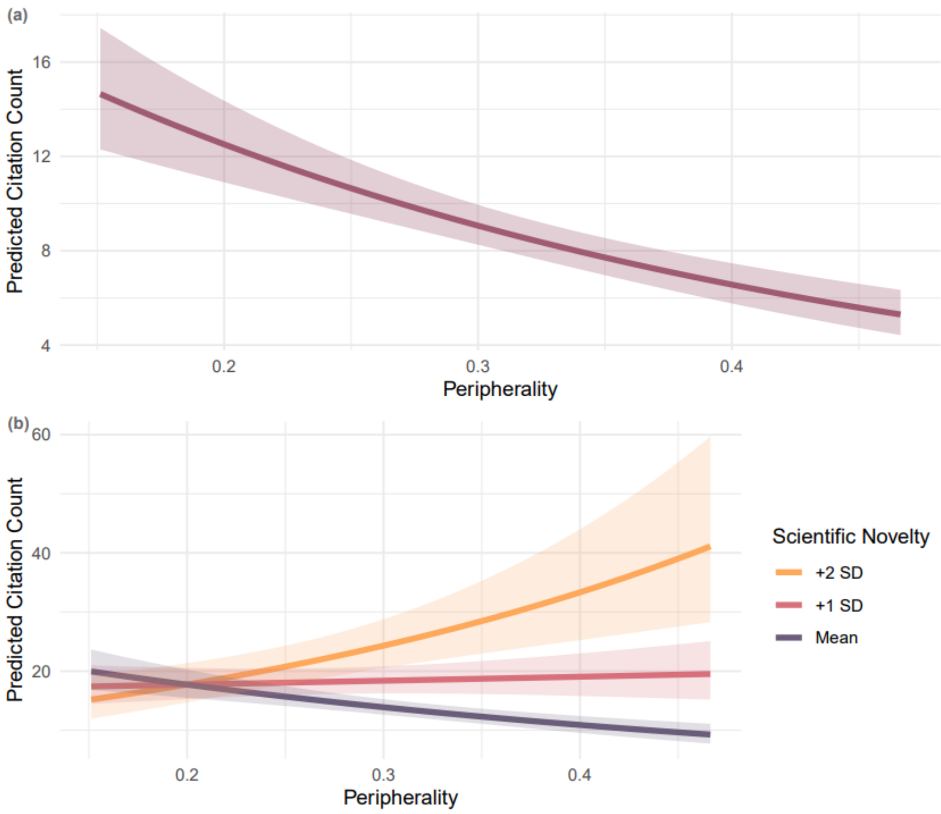


Figure 7.14. *Predicted marginal effect of (a) paper peripherality on scientific impact (i.e., citation count) (b) by scientific novelty.*

Table 7.5. *Results of negative binomial regression investigating the relationship between paper novelty and scientific impact (Model 4).*

Level of Analysis:	Paper			
Dependent Variable:	Scientific Impact (Citation Count)			
Model/Estimation:	Model 4 Negative Binomial			
	IRR (SE)	IRR (SE)	IRR (SE)	IRR (SE)
Intercept	.876 (.064)	.800** (.058)	.723*** (.052)	2.277*** (.494)
Publication Attributes				
Publication Age	1.689*** (.025)	1.721*** (.026)	1.840*** (.029)	1.364*** (.057)
Publication Age^2	.979*** (.001)	.979*** (.001)	.973*** (.001)	.988*** (.002)
Nonspecialised Publication Venue	1.474*** (.065)	1.241*** (.056)	1.221*** (.055)	1.412*** (.108)
Author Attributes				
Author Count	1.045*** (.010)	1.055*** (.010)	1.050*** (.010)	1.053** (.019)
Author Productivity	.999 (.004)	1.004 (.004)	1.003 (.004)	1.013 (.010)
Author Productivity^2	1.000* (.000)	1.000** (.000)	1.000** (.000)	1.000* (.000)
Author Prominence	1.000 (.000)	1.000* (.000)	1.001* (.000)	1.001 (.000)
Topic Attributes				
Topic Trend (Increasing)	1.008 (.039)	.959 (.037)	.944 (.036)	.909 (.060)
Topic Focus [a]	1.224*** (.024)	1.046 (.029)	1.058* (.029)	1.070 (.053)
Topic Structure [a b]		Yes ***	Yes ***	Yes ***
Paper Field Position				
Peripherality [a]			.861*** (.020)	.885** (.020)
Paper Novelty				
Scientific Novelty			1.046*** (.005)	1.022*** (.005)
Distal Novelty [a]				.960 (.032)
Interaction Effects				
Scientific Novelty x Peripherality [a]			1.020*** (.003)	1.014*** (.003)
Observations	4771	4771	4771	1433
Loglikelihood Ratio	-15572***	-15386***	-15325***	-5817***
Pseudo-R^2 [c]	.054	.066	.070	.647

[a] Variables standardised in order to support interpretability. Coefficient estimates represent the change in the outcome associated with a 1 standard deviation change in the predictor.

[b] Latent topic structure is investigated through 48 variables representing paper topic loadings associated with each topic identified through Correlated Topic Modelling (see **Section 5.2**). Significance here indicates the highest level of significance achieved amongst topic variables.

c Pseudo R2 (McFadden; R^2_{McF}) for negative binomial regression models.

* *p* <.05; ** *p* <.01; ****p*<.001.

Notwithstanding such support for **H3**, contrary to the hypothesised relationship between novelty and *scientific impact* results fail to demonstrate a distinct association between the unusualness of novel concept combinations, or innovations, introduced in Child-Computer Interaction research papers (i.e., *distal novelty*) and the *scientific impact* (i.e., citation count; IRR = .960, *ns*). As such, the number of citations CCI research papers receive do not appear to differ on the basis of the mean atypicality of those novel concept contributions introduced therein.

Results indicate a range of additional variables which demonstrate significant effects on predicted *scientific impact* (see **Figure 7.15**). Child-Computer Interaction research papers published in venues other than those which serve as the field's primary publication venues (i.e., *nonspecialised venues*) achieve significantly greater *impact* (IRR = 1.221, p <.001), receiving, on average, 21% more citations than those papers published in the field's primary (i.e., specialised) venues. Results also indicate, as may be anticipated, that CCI papers published earlier in the field's development demonstrate greater *scientific impact* (IRR = 1.840, p <.001), intimating that citations tend to accrue over time, although *publication age* exhibits a distinct quadratic relationship with citation count (IRR = .973, p <.001), with the number of citations papers have achieved peaking amongst those published in 2010 and subsequently declining over time (see **Figure 7.15c**). Both the number of authors contributing to papers (IRR = 1.050, p <.001) and the prominence, or visibility, of these authors within the field, based on citation count of papers previously published in the field's primary venues (IRR = 1.001, p <.05), are positively associated with the *scientific impact* papers achieve. Papers which focus to a greater extent on a narrow set of topics tend to achieve greater *scientific impact* (IRR = 1.058, p <.05), although the extent to which papers address various individual topics is associated with both positive and negative effects on citation count (see **Appendix NN**), with latent *topic structure* of papers explaining a relatively sizeable proportion of variance in scientific impact (.01 increase in Pseudo-R^2).

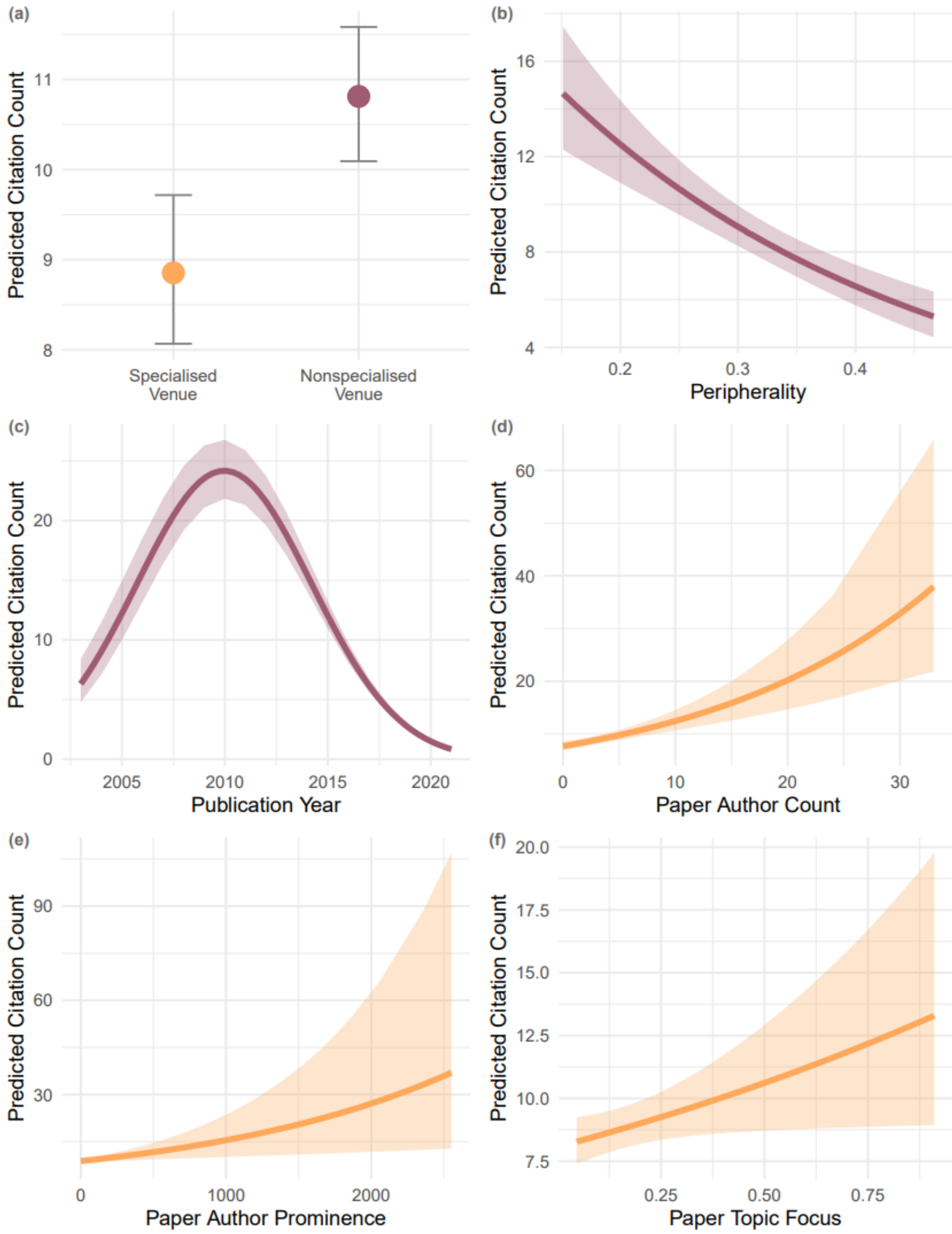


Figure 7.15. *Predicted marginal effect of paper (a) publication venue, (b) peripherality, (c) publication age (reverted to publication year), (d) author count, (e) author prominence, and (f) topic focus on citation count (i.e., scientific impact). 95 percent confidence intervals are indicated by error bars or shaded as appropriate.*

7.5. Summary

Generalisability of strategic publication strategies employed in negotiating challenges and tensions related to knowledge (re)construction within the field of Child-Computer Interaction, hypothesised based on Phase 2 qualitative analysis (see **Section 6.3**), were investigated through a series of regression models. Results offer insights concerning relationships between novelty and impact, or recognition, of innovative knowledge contributions and the papers in which they appear in CCI, and indicate various factors which may influence, or moderate these relationships, such as the conventionality of paper content within the field and attributes of paper latent topic structure. Partial support for hypotheses is evident, with CCI papers published in nonspecialised venues typically introducing greater numbers of novel concept combinations (**H1**), novel concept combinations embedded in conventional content attaining greater subsequent uptake throughout the field (**H2**), and papers introducing greater numbers of novel concept combinations achieving greater scientific impact (i.e., citations; **H3**). Critical discussion of findings and results in relation to research questions, supported through integration with results obtained through other phases of the present study, is presented in the following chapter.

Chapter Eight: Discussion

In this chapter, results of respective phases of the mixed methods research design implemented are integrated and contextualised within the relevant literature and conceptual framework in order to address research questions. Research questions are addressed, in turn, throughout the chapter through integration of relevant quantitative and qualitative findings. In so doing, this chapter elaborates the thematic structure of knowledge within the field of Child-Computer Interaction and the processes and practices through which this structure has been (re)produced and transformed throughout the field's development.

8.1. CCI Research as a Vibrant and Varied Landscape

Investigating major themes of study addressed in the field of Child-Computer Interaction during the period 2003 to 2021 (**RQ 1.1**) through Correlated Topic Modelling (CTM) of relevant published research papers, the current analysis identifies forty-eight distinct topics of study, representing the latent thematic dimensions of CCI research during the period of interest. Results of analysis demonstrate that the field of CCI research is comprised of contributions addressing a diverse array of research topics (see **Table 5.1**), informed by, and incorporating knowledge from, various disciplines and methodological traditions. The broad variety and volume of topics identified, as well as the relatively limited range in prominence of topics, such that no topics – perhaps with the exception of that related to *design methods and techniques* - appear to receive a disproportionate degree of attention, throughout research, indicate the existence of a vibrant, varied research landscape within the field of Child-Computer Interaction.

Whilst a number of topics – particularly those prominent throughout research in the field – identified within Child-Computer Interaction research resemble those recognised in previous studies mapping the thematic landscape of the fields of HCI (Y. Liu et al., 2014) and CCI (Giannakos, Papamitsiou, et al., 2020), including those related to *tangible user interfaces*, *mobile devices and* *applications*, *participatory design*, *design methods and techniques*, *digital libraries*, *making and makerspaces*, and *primary education*, a range of less prominent topics of study within CCI absent from prior overviews are identified, such as those concerning *visually impaired children*, *mental health*, *critical and ethical research and design*, *tutoring and scaffolding systems*, *emotion (recognition and expression)* and *cyberbullying and cybervictimization*. Identification of these less prominent, specialised topics within CCI research was facilitated by the finer level of granularity afforded by topic modelling of research paper abstracts relative to analyses of author-assigned keywords utilised in previous studies (e.g., Giannakos, Papamitsiou, et al., 2020; Y. Liu et al., 2014) – for example, topic models' conception of documents as comprising multiple latent semantic topics accommodated identification of minor and auxiliary topics addressed therein (see **Figure 5.12**).

Similar to Giannakos, Papamitsiou, et al.'s (2020) findings, general topics which are associated with knowledge broadly applicable throughout the field and may frequently be implicitly invoked, and reproduced, as ancillary (i.e., secondary, tertiary, etc.) topics in research – commonly those methodological, theoretical, and interdisciplinary topics (e.g., *design methods and techniques*, *embodied interaction*, *primary education*) – typically demonstrate greater prominence throughout CCI research than those topics concerned with specific user groups (e.g., *children on the autism spectrum*, *preschool children*, *visually impaired children*) and technologies and implementations (e.g., *virtual reality*, *reading and ebooks*, *child-robot interaction*; see **Figures 5.11** and **5.12**). Many of those most prominent topics, some of which have been recognised elsewhere as focal areas of study within the field (e.g., Giannakos, Papamitsiou, et al., 2020; Hourcade, 2015), have remained consistently so throughout the development of the field, serving both as an explicit subject of study and, as evidenced by relatively strong interactions (i.e., combinations) with a wide array of other topics in research (see **Figure 5.17**), to support broader research undertakings throughout the field. Similarly, those least prominent topics demonstrate consistency throughout the development of the field, appearing as relatively isolated areas of research which fail to exhibit strong interactions with other topics (see **Figure 5.17**) – such topics are thus likely to represent highly specialised (e.g., *augmented and mixed* *reality*) or emerging (e.g., *critical and ethical research and design*) research interests. Evident consistency in the prominence of certain topics throughout the field's development reflects conditions of 'institutional inertia' (Keller, 2011) therein postulated within the conceptual framework (see **Chapter Three**), such that configurations of knowledge in the field appear relatively resilient to abrupt, substantial transformation.

Specialised and nascent thematic areas, or subfields, identified, concerned with specific populations and technologies relevant to the field of Child-Computer Interaction, when addressed within CCI research papers frequently constitute the primary topic of study therein, seldom appearing as secondary or tertiary topics in research (see **Figure 5.12**). Apparent limited generalisability, or extensibility, of knowledge related to these topics – such that concepts associated with these topics are rarely applied in other areas of study in the field of CCI (i.e., seldom invoked as ancillary topics) – may be symptomatic of the propensity for artefact-centred research – which often generates highly contextualised, instance-oriented knowledge – within the field of CCI, as recognised by Barendregt et al. (2017) and identified by CCI researchers consulted (i.e., in workshops; see **Section 8.4.1**). Results may thus indicate a particular tendency towards artefact-centred research in emerging areas of study and those concerned with developing technologies. Nonetheless, a number of noteworthy exceptions are evident within the field, with topics such as those concerning *supports for mothers/caregivers*, *digital libraries*, *physical activity*, and *social media* more frequently appearing as secondary or tertiary than primary topics of study addressed within CCI research papers, intimating broader applicability of knowledge related thereto (i.e., intermediate-level knowledge; Barendregt et al., 2017; Höök & Löwgren, 2012) throughout the field.

Results thus illustrate the thematic structure of the field of Child-Computer Interaction which has arisen through the collective structuring and configuring effects of individual research practices and contributions related thereto, revealing a diverse assortment of topics of research actively investigated therein. Analysis indicates the prominence of broad methodological, theoretical, and interdisciplinary topics as a firmly established foundation, supporting emergence and development of more specialised thematic areas of study associated with production of instance-oriented, contextualised knowledge exhibiting limited generalisation throughout the broader field of CCI research.

8.2. CCI Research Landscape as an Evolving Terrain

Results of the current analysis, involving exploration of temporal trends in the relative prevalence of major themes of study throughout Child-Computer Interaction research during the period 2003 to 2021 (**RQ 1.2**), characterise the thematic structure of the field as dynamic and evolving, whereby the extent to which themes of study were subject to scholarly attention varied over time.

Throughout the past two decades the field of CCI research has witnessed steady growth, both in terms of the volume of research papers (see **Figure 5.1**; Giannakos, Papamitsiou, et al., 2020; Lehnert et al., 2021) and number of researchers (see **Figure 5.4**) contributing thereto. Although, as noted in previous studies (e.g., Hourcade, 2015; Kawas et al., 2020), the vast majority of authors contributing to CCI research papers indicate affiliations with institutions located in the United States, United Kingdom, and European nations (see **Figure 5.9**), the current analysis nonetheless identifies a much broader range of affiliations reported by authors than those evident in prior reviews – whilst Kawas et al. (2020), in a review of IDC papers, identify author institutional affiliations located in 28 countries, the current analysis finds author institutional affiliations located in 91 countries and territories, including a range of countries throughout Africa, South America, Asia, and Oceania (see **Figure 5.10**). Such a disparity may be attributable to the broader range of publication venues considered in the current analysis, implying a tendency, or preference, amongst those researchers affiliated with institutions located outside the United States and Europe to publish CCI research papers in venues associated with neighbouring and related fields rather than the primary venues of the field (i.e., IDC and IJCCI) – thus, primary venues of the field of CCI may be, or may be perceived as, relatively inaccessible or unappealing to researchers affiliated with institutions outside the United Stated and Europe. Indeed, identifying marginalisation and exclusion of researchers from non-Western nations in the field due, in part, to limited English proficiency and lack of familiarity with Western academic conventions, workshop participants suggest that researchers from non-Western nations consequently tend to publish research in alternative – typically national, rather than international – venues considered more accessible. As advocated by researchers in the field (e.g., Antle & Hourcade, 2022; Kawas et al., 2020), a burgeoning network of international collaboration is evident within the field of Child-Computer Interaction, with frequent and productive inter-institutional and international collaboration amongst researchers in contributing to the field (see **Figure 5.10**). Thus, a broadening, collaborative international community of researchers has developed around the field of Child-Computer Interaction throughout the past two decades, contributing to and progressing knowledge therein, although broadening diversity within this community has predominantly occurred beyond the primary venues of the field.

Whilst a number of topics of study addressed in the field of Child-Computer Interaction have remained relatively consistently prominent or limited within research throughout the past two decades, gradual shifts in research interests in the field over time are nonetheless evident, with various topics exhibiting consistent (i.e., monotonous) trends of increasing and decreasing prevalence throughout research in the field during the course of its development (see **Table 5.1**). Initially demonstrating prioritisation of methodological knowledge (e.g., *design methods and techniques*, *design evaluation*) and development upon knowledge from related and intersecting fields (e.g., *tangible user interfaces*, *embodied interaction*), distinct, specialised subfields (e.g., *child-robot interaction*, *parent-child interaction and communication*) have since emerged as areas of growing interest within Child-Computer Interaction (see **Figure 5.14a**).

Attention to methodological and interdisciplinary topics throughout CCI research, although remaining prominent, has generally diminished over time. Diminishing trends in prominence of such topics may be attributable to declining perceived necessity for such research as consequence of maturation in the field's structures and development of an established body of methodological and theoretical literature (Antle & Hourcade, 2022) which may, as evidenced by the frequency with which such topics appear as ancillary (i.e., secondary or tertiary) themes within papers (see **Figure 5.12**), serve as reference for, and support, a broad body of empirical study throughout the field. Nonetheless, however, workshop participants express persistent difficulty in identifying appropriate methods through review of extant methodological literature related to the field, necessitating consideration of methodological literature oriented towards neighbouring and related fields. As such, the extant corpus of methodological literature related to CCI may, regardless of volume, prove insufficient or incomplete for researchers' present purposes, or inaccessible due to the disciplinary diversity of both the literature and the researchers seeking to avail thereof. Diminishing prominence of contributions addressing methodological or interdisciplinary themes throughout the field despite inadequacies in extant literature expressed by researchers may suggest issues related to, and impinging upon, the capacity of current research practices related to the field to generate generalisable methodological and theoretical knowledge of which researchers may avail. Although, notably, workshop participants indicate renewed development and exploration of alternative, rigorous methodologies throughout the field following challenges imposed and exacerbated by the COVID-19 pandemic, which may address apparent shortcomings in current literature.

Trends in CCI research also exhibit a gradual shift from prioritisation of technology-driven to user needs-driven research (Antle & Hourcade, 2022; Yarosh et al., 2011), apparent in the emergence and increasing prevalence of topics related to specific user groups (e.g., *preschool children*, *children on the autism spectrum*). Such a shift in research interests within the field, intimating a decline in technological novelty as a primary rationale for research and an increase in attentiveness to children's needs, was initially noted by CCI researchers as a priority in Yarosh et al.'s (2011) survey and has likely accelerated in recent years following calls for progression in the field beyond an artefact-centred paradigm in order to generate more abstractable and generalisable – or intermediate-level

(Barendregt et al., 2017; Höök & Löwgren, 2012) – knowledge. Whilst workshop participants maintain, and analysis of the field's structure (see **Section 8.1**) suggest, that research in the field continues to be predominantly oriented towards development and evaluation of novel technologies, the evident burgeoning paradigmatic shift evident within published research towards consideration of the needs of diverse user groups is endorsed as the next frontier (i.e., future direction) within the field of CCI.

Notwithstanding this apparent decline in technological novelty as a primary rationale for research undertaken, Child-Computer Interaction research evidently remains responsive to exogenous technological developments, changes in the role of technology in children's lives, and associated public discourses. Results demonstrate discernible shifts in attention to (i.e., prevalence of) topics throughout research which may be, in part, attributable to contemporaneous technological developments – for instance, a notable increase in research related to mobile devices and applications (e.g., *mobile devices and applications*, *touchscreen gestures*) during the late 2000s paralleling development and widespread adoption of mobile technologies at that time (see **Figure 5.15b**), an increase in research related to social media and social networking following the establishment of social media platforms such as Facebook and Twitter (see **Figure 5.15a**), and an abrupt increase in research concerning topics concerning *e-learning environments*, *tutoring and scaffolding systems*, and *video game and screen media exposure* coinciding with the onset of the COVID-19 pandemic in 2020 (see **Table 5.1**). Moreover, agreeing with Lehnert et al. (2021) findings concerning product categories studied, results demonstrate that topics related to contemporary technological developments (e.g., artificial intelligence, augmented reality) – such as *child-robot interaction*, *augmented and mixed reality*, and *emotion (recognition and expression)* – have experienced considerable growth in prevalence throughout the field in recent years (see **Figure 5.14a**), indicative of a continued commitment within CCI research to investigate the role of, and phenomena related to, emerging technological advancements in children's lives. Workshop participants note that, whilst such advancements in technology have presented abundant and fruitful opportunities for further study, apparent prioritisation of emergent technologic advancements in CCI research has broadly been at the expense of further study regarding established, widely accessible technologies with empirically evidenced impact on children's lives, prompting concerns regarding the intended and realised impact of research in the field.

Notably, however, exploration of novel technological developments within CCI research generally appears slightly delayed relative to the introduction and broad adoption of these technologies amongst the public – for example, an observed, distinct increase in research throughout CCI concerned with *touchscreen gestures* emerged several years after widespread commercialisation and proliferation of touchscreen technologies (see **Figure 5.15a**). Indicative of an initial hesitancy or apprehension towards emerging technologies, perhaps attributable to ethical concerns regarding unidentified potential risks to children such technologies may pose, evident prioritisation of, and responsiveness to, novel technological developments within the CCI community may therefore be tempered and superseded by ethical imperatives related to minimisation of risks of harm to children.

As identified by Kawas et al. (2020), such technology-oriented topics address a variety of concerns dominant within public discourse associated with developments in technology and children's use thereof – for example, topics related to *cyberbullying and cybervictimization* and *addiction and problematic usage* arose alongside the growing presence of mobile devices and social media in children's lives, and concerns feature prominently in topics related to *social networking and peer relationships* (e.g., association with term "risk") and *video game and screen media exposure* (e.g., "aggression"). Thus, as proposed within the conceptual framework implemented in the present study (see **Chapter Three**), various external elements (e.g., public and media discourses), acting through (implicit or explicit) influences upon researchers and research practices, appear to actively contribute to, and influence, research priorities and consequent discourses throughout the field of Child-Computer Interaction.

Reflexivity and responsiveness to reviews and critiques of research within the field of Child-Computer Interaction are evident in the recent growing interest in, and attentiveness to, issues related to *critical and ethical research and design* (see Figure 5.16) therein. Whilst thus far demonstrating a notable lack of prevalence or progression throughout the field's development, recent advocacy and recommendations of community members (e.g., Iivari et al., 2021; Lehnert et al., 2021; Van Mechelen, Baykal, et al., 2020) concerning explicit, or systematic, consideration of ethics and criticality in CCI, as well as requirements related to mandatory reporting of ethical considerations imposed by the IDC conference and IJCCI journal (i.e., "Selection and participation [of children]"), primary venues of the field, appear to have prompted emerging interest in addressing these issues. Similarly, workshop participants cite conference (i.e., IDC) workshops (e.g., Antle et al., 2020; Constantin et al., 2022; Van Mechelen, Gilutz, et al., 2020) as fora in which perceived issues related to methodological proficiency and practices – including ethics – within the field have been addressed during recent years through concerted reflection, dialogue, and provision of relevant training. Reviews of, and reflections upon, the field evidently serve a self-regulatory function within the field of CCI to which community members appear responsive, guiding research priorities throughout the field to address perceived inadequacies or opportunities therein and thereby acting to catalyse reconfiguration of CCI knowledge.

Research interests within the field of Child-Computer Interaction have evidently shifted throughout the course of its development as a collaborative international community of researchers, through a growing corpus of research contributions addressing diverse thematic areas, builds upon multidisciplinary foundations and actively defines a distinct identity. Results demonstrate that, although CCI research continues to draw upon and develop methodological and interdisciplinary knowledge, and remains committed in investigation of technological developments, the field has increasingly prioritised research concerned with the needs of children and distinct user groups, prompting the emergence and continued growth of specialised subfields therein. Gradual evolution in the thematic structure of the field of Child-Computer Interaction throughout its development, results therefore suggest, reflects shifts in priorities, themselves subject – as proposed within the conceptual framework (see **Chapter Three**) – to both exogenous and endogenous influences, pursued through, and expressed within, research practices contributing to the field.

8.3. CCI Research as an Integrated Field

Despite the volume and diversity of topics of study addressed, interactions between, or combinations of, major themes of study within Child-Computer Interaction research during the period 2003 to 2021 (**RQ 1.3**), examined through pairwise correlation, imply a well-integrated field, in which topics of study are consistently combined in various configurations throughout research.

As identified in Giannakos, Papamitsiou, et al.'s (2020) earlier review, many of those prominent, methodological and interdisciplinary topics of study (e.g., *design methods and techniques*, *participatory design*, *tangible user interfaces*, *making and makerspaces*, *primary education*) demonstrate a high degree of interaction, or combination, with a broad range of topics throughout Child-Computer Interaction research (see **Figure 5.17**). Results indicate that, in addition to constituting distinct topics of study within the CCI field, these topics – here, knowledge and concepts associated therewith – serve to support research related to diverse areas of interest throughout the field, thereby serving as a "connecting glue" (Giannakos, Papamitsiou, et al., 2020) which coheres topics within the field.

Although results evince development of an integrated field of research related to Child-Computer Interaction, findings also indicate a decrease in the thematic diversity of CCI research throughout the past two decades (see **Figure 5.18**), such that, over time, CCI research papers have tended to focus on fewer topics simultaneously and thereby combine concepts related to different topics identified throughout the field to a lesser extent. Coinciding with emergence, and increasing prominence of, specialised thematic areas of study (e.g., *child-robot interaction, parent-child interaction and communication*) within the field, such a trend intimates a progression towards greater specialisation in research as the field develops and distinct thematic areas, or subfields, emerge therein. A number of these emergent, specialised subfields (e.g., *augmented and mixed reality*, *reading and eBooks*) appear as relatively isolated "research islands" (Daenekindt & Huisman, 2020) within the field, failing to exhibit robust interactions with other topics therein, indicative, as suggested by Y. Liu et al. (2014), of a failure of research addressing such topics to consistently incorporate, or build upon, established knowledge in the field or contribute knowledge which may be generalised to other areas of CCI research. Apparent lack of integration of established CCI knowledge in such areas of study may, in part, be symptomatic of the relative immaturity of such topics within the field and a consequent dearth of relevant knowledge established therein, with research related thereto instead drawing on corpora of knowledge associated with other fields. Moreover, as earlier posited, apparent limited generalisability of knowledge produced through research addressing these specialised topics of study may reflect the dominance of an artefact-centred research paradigm therein.

Notably, results indicate Child-Computer Interaction research papers published in the field's primary venues, IDC and IJCCI, exhibit, on average, higher thematic diversity – or, alternately, less specialisation – than those research papers published in venues associated with neighbouring and related fields (see **Figure 5.19**). In serving as publication venues explicitly catering to the CCI community, it may be that research papers published in the field's primary venues (i.e., IDC and IJCCI) are more firmly embedded in established knowledge within the field, explicitly premised and drawing upon recognised concepts and knowledge associated with a range of thematic areas therein – such an assertion aligns with assumptions implicit in the measure of paper conventionality developed and applied during Phase 3 analysis within the current study (see **Section 4.4.3.3**). Moreover, committed to supporting child-computer interaction and further research related thereto, such venues may seek to disseminate more broadly applicable (i.e., generalisable) knowledge, intended to inform a diverse range of areas of interest throughout the field. Although contributing to knowledge in the field, those Child-Computer Interaction research papers published in venues associated with neighbouring and related fields may seek to contribute, or appeal, to other, relevant specialised fields of study.

Whilst results portray the field of Child-Computer Interaction as well integrated, such that thematic areas therein interact and inform each other within research, several distinct, specialised subfields have emerged within the field during recent years which are yet to be fully incorporated, or integrated, within the field, demonstrating relatively weak interaction with other areas of study in the field (see **Figure 5.17**). Although results demonstrate that CCI research published in the primary venues of the field (i.e., IDC and IJCCI) are particularly well integrated, constituting a cohesive "core" of the field, research throughout the field – particularly research published in venues associated with neighbouring and related fields – has exhibited a trend towards increasing specialisation over time, implying increasing disintegration, or isolation, of thematic subfields apparent therein. Results thereby intimate that the field of CCI may be characterised by a core-periphery structure (Cattani et al., 2015; see **Appendix I**), comprising a core constituted by a cohesive, densely interconnected subgroup of actors and knowledge oriented towards, and embedded in, dominant discourses and a periphery consisting of actors and knowledge loosely connected to, and weakly embedded in, dominant discourses and culture within the field.

8.4. Factors Shaping the CCI Research Landscape

Whilst factors which have influenced the development of, and trends in, research priorities within the field of Child-Computer Interaction are conceived as inherently complex and multifarious (see **Chapter Three**), analysis of perspectives and experiences of CCI researchers participating in online workshops indicates several distinct factors, both endogenous and exogenous, perceived as having influenced research priorities throughout the field's development (**RQ 1.4**). Foremost amongst these factors are technological developments and discourses, funding priorities and opportunities, developments within related fields, researcher disciplinary backgrounds and training, and norms and structures which regulate practices related to the field, which appear intrinsically interrelated in influencing trends in CCI research. Notably, as contended within the conceptual framework specified (see **Chapter**

Three), results imply that such factors act upon individual researchers contributing to the field rather than the field, as a structure, in its entirety (Berger & Luckmann, 1966), affecting – or structuring – research problem and strategy selection, with the cumulative effects of these influences upon respective contributions posited as serving to perpetuate or modify agendas and priorities evident throughout the field of Child-Computer Interaction.

Perceiving technological novelty as a common expectation and major criterion of merit within the field, Child-Computer Interaction researchers participating in workshops indicate a tendency in the field, throughout its development, to prioritise investigation of emerging technologies and those technologies prominent within contemporary public discourse. Although results of analysis of trends in the prevalence of themes of study throughout CCI presented here (see **Section 8.2**), aligning with Yarosh et al.'s (2011) earlier findings, suggest a decline in technological novelty as a primary rationale for research in the field, researchers assert an emphasis thereon nonetheless persists, with researchers, as argued by Barendregt et al. (2017), seeking to capitalise upon opportunities and novel applications technological developments originating in industry may afford. Apparent prioritisation of emerging technologies and associated concerns throughout the field's development may, researchers propose, be attributable to the multidisciplinary constitution of the field and diverse disciplinary background of researchers contributing thereto, with expectations of exploitation of technological advancements considered characteristic of engineering and design fields from which CCI emerged, as well as a purported relative abundance of funding opportunities dedicated to investigation of technological advancements.

Nonetheless, as earlier posited (see **Section 8.2**), pursuit of technological novelty throughout the field may, to an extent, be moderated by ethical concerns and reservations regarding potential risks of harm emerging technological developments may pose. In particular, researchers participating in workshops intimate wariness towards emerging technologies (e.g., artificial intelligence, sensing technologies), potential negative effects or harms associated with which are yet to be fully investigated or understood. Hesitancy to pursue novelty in relation to a number of emerging technologies, evident in an observed negative relationship between a range of topics of study and the scientific novelty of papers addressing these topics, may therefore reflect commitment to, and prioritisation of, ethical imperatives espoused with the Child-Computer Interaction Community. For example, those papers addressing *data collection methods and tools*, which includes sensing (see **Table 5.1**) and wearable (see **Table HH.1**) technologies, the ethical implications of which have been the subject of review and discussion within recent literature (see K. Sharma & Giannakos, 2021; Van Mechelen, Baykal, et al., 2020), typically introduce fewer novel concept combinations (see **Table HH.1**).

Availability of funding opportunities, researchers participating in workshops assert, has influenced trends in priorities within Child-Computer Interaction throughout the field's development, such that research has demonstrated a tendency to concentrate on, and privilege, those areas of study within the field for which funding opportunities appear ample, with available calls for funding, as identified by Kawas et al. (2020), a common rationale in selection of research topics. In so directing priorities within the field, provision of funding opportunities has likely served as a mechanism through which agendas of respective funding bodies and organisations have been communicated to, enacted within, and advanced through, CCI research, with researchers attributing perceived trends in technologies and user groups studied to the availability of industry and government funding related to these areas. Agendas of funding bodies supporting CCI research, workshop participants contend, are, in large part, driven by industry interest related to cost-reduction and profitability of commercial products. In addition to dictating the degree of attention directed towards areas of study in CCI, availability of funding is also regarded as having regulated various practical aspects of research undertaken concerning such areas, determining, to varying extents, the resources available to research projects, and thereby posing implications for knowledge produced therethrough – for example, resource intensive research designs, such as longitudinal studies, are, workshop participants suggest, particularly sparse in areas of the field for which there has been a dearth of funding opportunities.

Whilst funding opportunities related to CCI are regarded as having, throughout the development of the field, predominantly supported short-term study and evaluation of emerging technologies, workshop participants note a recent, discernible shift in the distribution of funding availability throughout the field, whereby funding opportunities therein demonstrate support for a more varied range of research areas. Ascribed to changes in perceptions beyond the field (e.g., public discourses) concerning children's interaction with technology and participation in design processes, priorities of funding bodies and organisations have evolved to recognise, and value, a broader range of areas of study related to CCI, including research concerned with specific user groups and vulnerable and marginalised populations. Thus, agendas of funding bodies and organisations may be driven by and act to mediate, through provision of funding opportunities, the effects of external discourses, such as those apparent throughout media and government policy, on research within the field. Although research related to these areas evidently precedes the identified broadening availability of funding within CCI, the emergence of greater funding opportunities in these areas is likely to have contributed to the further development of these areas in recent years, as observable in the emergence and increasing prevalence of research topics related to specific user groups within the field identified in the current (see **Section 8.2**), and prior (e.g., Yarosh et al., 2011), analyses.

A multidisciplinary field, Child-Computer Interaction has been influenced by knowledge and developments within various fields of scientific inquiry, often implicitly, as proposed within the conceptual framework specified (see **Chapter Three**), through the varying disciplinary backgrounds and training of researchers contributing to the field throughout its development. In particular, developments in technology, methodologies, and theory originating, or prominent, in related fields have, workshop participants indicate, informed contributions to the field of CCI. In addition to informing research in the field, traditions associated with related fields, to which researchers contributing to CCI may be accustomed, are speculated to shape priorities within the field, with workshop participants arguing, as noted above, that emphasis on emerging technologies is a consequence of researchers' experience in engineering and design fields. Furthermore, in recent years, a distinct emphasis on theories underpinning and justifying investigations throughout the field has emerged (e.g., T. Bekker et al., 2014; Eriksson et al., 2022), prompting, researchers indicate, increased attentiveness to, and incorporation of, developments in theories arising in related fields. Consequently, research within CCI may be oriented towards those areas informed by robust, empirically validated theories developed in related fields – for example, researchers suggest that trends in the prevalence of CCI research concerning *tangible user interfaces* and *embodied interaction* may be attributed to developments in cognitive theories, such as embodied cognition (see Ale et al., 2022 for review). Thus, trends within the field of CCI appear shaped by cross-disciplinary movement of researchers and the practices and knowledge upon which they may draw.

Methodological training of researchers contributing to the field of Child-Computer Interaction is also regarded as having posed implications for trends in themes of study throughout the field's development. In particular, inconsistencies in methodological training and consequent deficiencies in methodological proficiency – most notably related to social science research methodologies – amongst researchers with diverse disciplinary backgrounds may, researchers suggest, have contributed to inadequate ethical sensitivity and misapprehension and misapplication of co-design methods throughout the field. Recent advocacy and concerted efforts within the field to address these concerns – for example, IDC workshops supporting development of ethical awareness and sensitivity (e.g., Antle et al., 2020; Constantin et al., 2022; Van Mechelen, Gilutz, et al., 2020) and co-design methodological proficiency (e.g., Muñoz Cardona et al., 2021; Pires et al., 2022) amongst researchers – may explain increasing attentiveness to such issues – for instance, an observed increase in the proportion of research addressing *critical and ethical research and design* (see **Table 5.1** and **Figure 5.16**) – within the field.

Notably, whereas Kawas et al. (2020) identify intentions to achieve specific desired outcomes for children as a primary motivation amongst Child-Computer Interaction researchers, guiding selection of topics of study, researchers participating in the current study, expressing scepticism regarding the sustained impact of CCI research on the lives of children, imply that pursuit of specific outcomes for children is unlikely, in practice, to dictate research problem selection in the field. Although researchers recognise that CCI research ought to benefit children beyond immediate participants, constituting an ethical and philosophical commitment within the field, such concerns are generally superseded by practical considerations, particularly those related to obtaining requisite funding and attaining publication. As a result, research related to CCI has, throughout the field's development, tended to prioritise investigation and evaluation of technological advancements, related to which funding opportunities are considered plentiful, at the expense of established technologies associated with empirically evidenced impact on children's lives (Giannakos, Horn, Read, et al., 2020). Thus, achievement of desired outcomes for, and genuine impact on, the lives of children through Child-Computer Interaction research may be encumbered by prioritisation of practical considerations in selection of research topics to pursue therein.

A range of factors, both endemic to the field and representing external agendas, have evidently exerted discernible influence upon trends in research priorities within Child-Computer Interaction throughout the field's development. As posited within the conceptual framework detailed (see **Chapter Three**), research contributions appear, in part, structured by these factors, with research problem and strategy selection – often tacitly – influenced thereby, and individual researchers consequently mediating and realising, to varying extents, the effects of such factors upon the broader structure of the field. Amongst those factors identified, availability of funding opportunities, itself driven by various discourses, has exerted particular influence in dictating trends in priorities within the field, inducing concentration of research on areas of study aligning with funder agendas as pragmatic considerations related to resources have generally taken precedence over pursuit of specific outcomes for, and impact on, the lives of children in research topic selection. Notably, whilst traditionally prioritising study and evaluation of emerging technologies, an apparent recent shift in availability of funding opportunities, whereby a broadening range of areas of study within the field receive support, may have enabled pursuit of a more varied array of desired outcomes for diverse populations of children in recent years, thereby explaining an identified shift from prioritisation of technology-driven to user needs-driven research within the field of Child-Computer Interaction (Antle & Hourcade, 2022; Yarosh et al., 2011; see **Section 8.2**).

8.4.1. Norms Structuring CCI Research

Norms – here, defined as (relatively) consistent standards and conventions associated with research practices and processes construed as valid – and structures – here, representing institutions arising from, and manifesting, norms, including established research traditions, configurations of knowledge, and peer review processes – associated with the field of Child-Computer Interaction are, as stipulated within the delineated conceptual framework (see **Chapter Three**), conceived both as structured by, and structuring, research practices related thereto. Analysis of CCI researchers' perspectives and experiences indicate norms and structures associated with the field of CCI, broadly interpreted as "rules" (Keller, 2011) which both implicitly condition research decisions and inform risk-reward calculations primarily concerned with likelihood of attaining publication and recognition within the field (Ayala-Bastidas et al., 2021; Kolesnikov et al., 2018), exercise substantial influence upon research practices related to the field (**RQ 1.5**). In particular, researchers express consistent concerns regarding the restrictive conditions norms and structures are perceived to impose upon research practices through which, and individuals by whom, knowledge within the field of CCI may be (re)constructed, with research contributions deviating from, or conflicting with, institutionalised norms generally foreclosed.

Norms identified within the field of Child-Computer Interaction related to expectations of technological novelty within research and prominence – evidenced both in the present analysis (see

Section 8.4) and prior reviews (e.g., Barendregt et al., 2017; Yarosh et al., 2011) – of design-oriented practices – typically involving design and evaluation of novel technologies, communicated through artefact-centred papers – are associated with construction of highly contextualised, situated knowledge related to specific novel solutions. Echoing concerns expressed throughout extant literature (e.g., Barendregt et al., 2017; Höök & Löwgren, 2012; Y. Liu et al., 2014; Whittaker et al., 2000), researchers consulted indicate that CCI research adhering to such norms generally fails to develop upon existing knowledge within the field or contribute generalisable knowledge which others may subsequently develop or progress, thereby impeding development of cumulative knowledge within, and consolidation of, the field. Moreover, research employing design-oriented practices, identified as primarily concerned with emerging technologies and therefore considered particularly susceptible to undue influence from naïve or biased external discourses related thereto, often proceeds in the absence of adequate theoretical rationale or empirical support and may consequently, researchers propose, inadvertently perpetuate problematic or harmful discourses concerning children's interaction with technologies within the field. Thus, in order to effectively construct and contribute to cumulative knowledge concerning children's interactions with technologies, both established and novel, workshop participants contend, as advocated by Giannakos et al. (2022) and Antle and Hourcade (2022), that Child-Computer Interaction research, whilst continuing to pursue and value design-oriented study and artefact-centric innovation, ought to progress and extrapolate knowledge beyond mere novel instances through development upon theory and cultivation of intermediate-level knowledge within the field.

In addition to apparent limited utility and, as demonstrated by Barendregt et al. (2017), impact of knowledge generated through design-oriented research practices within the field of Child-Computer Interaction, researchers assert that knowledge and artefacts produced therethrough achieve minimal recognition or impact beyond the field. Prioritisation, and primacy as a rationale for study, of technological novelty throughout the field – broadly, researchers contend, at the expense of research which, motivated and informed by user needs, examines established, widely accessible technologies exhibiting empirically evidenced impact on children's lives – is unlikely to yield outputs (i.e., artefacts or knowledge) accessible and of practical value to stakeholders beyond the field seeking to address the needs of broad populations of children (e.g., industry practitioners) due to the contextualised, situated nature of novel solutions, and knowledge related thereto, generated. Indeed, studies examining the evident research-practice gap related to HCI (Colusso et al., 2017) and CCI (Loustau & Chu, 2022), noting discrepancies between design themes prevalent within research and commercial systems, propose that theory-driven examples supporting specific design activities and actionable guidance and resources with prescriptive recommendations may prove particularly beneficial to, and thereby impact, (industry) practitioners. Despite this perceived dearth of meaningful, positive contribution to, and impact upon, the lives of children appearing in opposition to philosophical commitments and ethical imperatives espoused within, and traditionally underpinning, the CCI community (Antle & Hourcade, 2022), workshop participants generally express a sense of resigned tolerance thereof. Researchers thereby intimate a culture within the field of Child-Computer Interaction in which scepticism towards, or tacit disregard of, the extent to which research outputs may contribute meaningfully to, and thereby impact, children's lives is normalised and commonplace. Norms related to expectations of technological novelty which engender the novelty-dominated, technology-driven paradigm prevalent within the field may thereby contribute to tensions between the "intellectual appeal" associated with such research throughout the field and aspirations of "benefiting children's lives" (Antle & Hourcade, 2022, p.3) commonly advocated therein.

Notwithstanding apparent prominence of this design-oriented paradigm throughout the field of Child-Computer Interaction, however, consistent standards and conventions related to methods commonly applied in undertaking such research are, according to workshop participants, yet to be established within the field. As argued by Reeves (2015) and Gaver (2012), such a lack of formalisation of, and uniformity in methods, hindering rigorous assessment of contributions and cumulative development of knowledge, may contribute to anxieties and insecurities related to the perceived scientific status and legitimacy of the field amongst community members associated therewith.

Establishment and maintenance of adequate, agreed-upon standards and conventions related to methods within CCI is, however, regarded as implicitly challenging, due both to the disciplinary variety characterising methods throughout the field as researchers draw upon, and appropriate, methodological knowledge pertaining to other fields (see Antle & Hourcade, 2022), and challenges associated with reporting (co-)design processes in a representative and veracious, yet conventionally rigorous, manner. Commonly comprising non-linear, 'messy' processes, researchers contend that accurate portrayal of (co-)design methods in a manner conforming to traditional expectations and perceptions of scientific rigour within academic fora proves challenging, prompting researchers to often present sanitised, linear reports of complex (co-)design methods and processes. Antle and Hourcade (2022) argue that, due to such challenges, research conducted and published within the field commonly lacks "methodological rigour commensurate to the level of those methodologies' parent disciplines" (p.8), undermining the quality and value of outcomes and impact thereof. Workshop participants, however, imply that conventional standards of scientific rigour applied and publication media (i.e., journal articles and conference papers) employed may be ill-suited to the depiction of certain research practices and processes prominent within CCI, particularly those related to (co-)design. Notably, recent efforts within the field to accommodate alternative fora and media of presentation and communication, such as the introduction of a pictorial track at IDC 2022[14], may offer a potential solution to challenges associated with accurate portrayal of methods and processes in the field.

In addition to structuring research practices associated with the field of Child-Computer Interaction, norms evident within the field also dictate, to an extent, who, in performing such practices, may contribute to the field. Although regarded as an inclusive community, researchers indicate perceived marginalisation of non-Western voices within the field of Child-Computer Interaction due to the dominance of Western academic culture therein, manifested in norms and

[14] Interaction Design and Children 2022 call for pictorials (https://idc.acm.org/2022/call-pictorials/)

conventions adopted throughout the field. Whilst researchers contributing to the field demonstrate a broadening diversity of country of institutional affiliation throughout the field's development (see **Section 8.2**), discrepancies between findings of the current analysis and prior reviews (Kawas et al., 2020) nonetheless intimate that, relative to venues associated with neighbouring and related fields, researchers affiliated with institutions situated outside the United States and Europe remain underrepresented within primary venues of the field (i.e., IDC and IJCCI). Apparent marginalisation of researchers from non-Western nations within the field is broadly ascribed to reliance upon English as a lingua franca, with lack of proficiency therein impeding contribution to the field via publication and inhibiting meaningful participation in the CCI community, including membership of editorial boards and committees. Consequently, researchers from non-Western nations tend to publish CCI research in alternative – typically national, rather than international – venues, thereby producing, or compounding, gaps between knowledge accumulated in CCI across languages and cultures. Moreover, inadequate representation of non-Western voices in bodies (i.e., editorial boards, conference committees) and processes (i.e., peer review) which regulate the field may preclude revision and reformation of established norms and conventions contributing to, and perpetuating, such marginalisation.

Peer review and editorial processes, representing structures embodying norms, through which the field of Child-Computer Interaction is generally regulated, researchers indicate, are decidedly biased towards preservation of established research and knowledge traditions and perpetuation of dominant discourses within the field, with contributions regarded as conflicting with, or deviating from, accepted knowledge canon considered at greater risk of rejection from publication venues. Thus, despite the prominence and status of technological novelty throughout the field as a common criterion of merit, the field of CCI appears unreceptive towards research introducing novel, nonnormative contributions to knowledge therein. Notably, preference towards contributions reproducing or reaffirming established knowledge has similarly been identified, and empirically evidenced, throughout a range of fields (e.g., Foster et al., 2015; Uzzi et al., 2013). In part, apparent aversion to nonnormative knowledge contributions within publication venues associated with the field of CCI, researchers suggest, may be ascribed to antipathy amongst reviewing audiences towards limitations often inherent in, and qualifying, innovative research practices which generate such knowledge. Wariness of limitations, negative results, and failure stories may reflect insecurities and vulnerabilities within the CCI community regarding, and represent efforts to progress and preserve, the disciplinary 'shape' (Reeves, 2015) and scientific status of the field. Conscious of this disinclination, researchers regard pursuit of research problems considered novel and nonnormative as inherently 'risky' – here, based on judgements of reduced likelihood of publication and recognition of papers derived therethrough. Along with pressures of emerging imperatives such as ''publish or perish'' (Fanelli, 2010; Neill, 2008; Rawat & Meena, 2014), perceived negative social consequences and risk of rejection associated with adoption of unconventional positions and contribution of novel, nonnormative knowledge may implicitly encourage CCI researchers to pursue low-risk research strategies – typically involving adherence to established norms and dominant discourse. In discouraging and excluding research contributing novel, nonnormative, and innovative knowledge, which often serves to catalyse advancement in knowledge (Blackwell, 2015), present regulatory processes may, researchers posit, impede continued progression of knowledge within the field of CCI.

Notably, as the field of Child-Computer Interaction has developed and matured, consolidating and institutionalising norms within structures associated with, and regulating, the field, norms and structures therein may increasingly foster these constrictive conditions impinging on knowledge (re)construction, wherein adherence to, and reproduction of, dominant discourses and established tradition is incentivised and deviation therefrom penalised. Results of quantitative analysis (see **Figure 7.9**), corresponding to Foster et al.'s (2015) findings, indicate substantial decline in the volume of innovative contributions within the field of CCI throughout the course of its development, thereby implying increasing concentration within CCI research on incremental contributions which conform to norms and conventions associated with dominant discourse, relative to innovative contributions which diverge therefrom, over time – it ought to be qualified, however, that these results may, in part be a consequence of the operationalisation and measurement of innovation applied in the current analysis (see **Section 4.4.3.1**), whereby only a limited number of innovations yet to attain uptakes within the field – which tend to be those more recently introduced innovations – were included as such innovations were more likely to be penalised as spurious by the PMI cut-off specified, thereby favouring contributions published earlier in the field's development which experienced greater opportunity to receive such uptake. Thus, as the field matures towards scientific disciplinarity and norms and structures associated therewith ossify, adherence to dominant discourse and established tradition appears increasingly stimulated and rewarded – suggested by results which indicate greater recognition and impact (i.e., citations) attained amongst those papers in which content relates more closely to central, conventional concepts commonly addressed throughout the field (i.e., positioned centrally within the field; see **Figure 7.15b**) – whilst departure or digression therefrom appears increasingly impeded and foreclosed, likely hampering intellectual innovation and advancement within the field.

Posited as both structured by, and structuring, research practices, norms – as well as structures and processes in which they are manifest – apparent throughout the field of Child-Computer Interaction are evidently interpreted amongst community members as rules to be negotiated which implicitly regulate and orient research practices therein, instructing who may contribute to the field, through what means, and what contributions may be accepted as legitimate and of value therein. In so doing, norms, as proposed within the conceptual framework implemented (see **Chapter Three**), realise power effects produced by discourses within the field and pervading the community of researchers contributing thereto (Foucault, 1972, 1982; Keller, 2011). Norms and structures which have developed within the field, results indicate, thereby broadly serve to perpetuate dominant discourses within the field, precluding nonnormative or unconventional contributions perceived as incongruous with established tradition. Norms and structures hence facilitate proposed conditions of institutional inertia (Keller, 2011), whereby discourses and configurations of knowledge throughout the field demonstrate resilience to abrupt, substantial shifts and remain relatively consistent, or stable, over time. In impeding nonnormative contributions and preserving established conditions and conventions, norms apparent within the field, commonly perceived as persistent challenges and tensions to be negotiated and surmounted, may inhibit the continued development and progression of cumulative knowledge within the field of Child-Computer Interaction.

8.5. Negotiation of Norms in CCI Research

Posing notable impediments to certain contributions, pursuit of publication and impact within the field of Child-Computer Interaction may necessitate negotiation and navigation of challenges and tensions arising as consequences of norms and structures apparent therein. In order to do so, researchers contributing to the field ostensibly deploy various strategic publication practices posited as providing means through which encumbrances attributable to deviation from norms may be minimised or circumvented (**RQ 1.6**), the practical feasibility and efficacy of which are substantiated in results of analysis of semantic features and attributes of published research papers constituting the field.

In order to avoid the restrictive conditions norms and standards associated with the field are perceived to impose upon contributions, workshop participants propose pursuit of publication of research in venues beyond those primarily serving the Child-Computer Interaction community (i.e., venues associated with neighbouring and related fields) which, consonant with contentions of a core-periphery conception of the field (Cattani et al., 2015, 2022), are presumed unburdened by normative pressures to conform to, and less likely to penalise deviation from, the field's dominant discourses and established tradition (see **Section 6.3** and **Appendix I**). In doing so, recognition and legitimacy, researchers propose, may be attained, supporting subsequent adoption and integration of novel contributions to knowledge within the conventional core of the CCI field. Premised on eventual integration of novel knowledge contributions into the core of the field following initial publication in the field's periphery, such a strategy is, based on this intended trajectory (see, for example, the progression of the '*haptic*' – '*feedback*' concept combination within the field, **Figure 7.5**), here termed an *outside-in* strategy.

Assertions upon which this outside-in strategy is premised are supported by results of quantitative analysis, with venues associated with neighbouring and related fields demonstrating a penchant to publish Child-Computer Interaction papers introducing a greater volume of novel concept combinations (i.e., scientific novelty) – which, in (re)combining previously unrelated or disparate concepts within the field, are conceived as departing from, and thereby transformative of, established knowledge – than the field's primary venues (i.e., IDC and IJCCI; see **Figure 7.8b**). Indicative of the potential efficacy of such a strategy in facilitating subsequent integration and permeation of innovative contributions throughout the field, novel concept combinations introduced within papers published in venues associated with neighbouring and related fields tend to attain greater subsequent uptake throughout CCI research than those introduced in papers published in the field's primary venues (see **Figure 7.12**). Unusualness or atypicality – in the context of the CCI field – of novel concept combinations introduced within papers published in respective venues, however, do not differ (see **Figure 7.8a**), suggesting that venues associated with neighbouring fields, albeit receptive to innovations related to CCI, may nonetheless regard unusual or atypical contributions as limited in relevance or utility to audiences within, and intersecting with, the CCI community – a presumption supported by the evident negative relationship between atypicality of novel concept combinations (i.e., distal novelty) and subsequent uptake throughout the field (see **Figure 7.11a**). Thus, the proposed outside-in strategy may prove a broadly advantageous approach for publication of innovative, transformative contributions within the field of Child-Computer Interaction, although is nevertheless unlikely to overcome impediments associated with publication of unusual or atypical novel contributions.

Alternatively, in order to overcome apparent aversion towards novel contributions which diverge from dominant discourse and established tradition within the field of Child-Computer

Interaction, researchers propose conscious embedding of novel, nonnormative contributions within conventional CCI knowledge, thereby demonstrating compatibility of contributions therewith, or basis therein. In so doing, such contributions may, consistent with assertions associated with the concept of optimal marginality (McLaughlin, 1998, 2000, 2001) and optimal network structuration strategy (Cattani et al., 2015), exploit the relevance and familiarity positioning relative to, and embedding within, conventional and established knowledge may endow in insinuating novel contributions into contemporary discourse within the core of the field (see **Section 6.3** and **Appendix I**). Premised on integration and suffusion of novel knowledge contributions throughout the broader field following initial introduction grounded or embedded in conventional knowledge established within the field's core, such a strategy is, based on this envisaged trajectory (see, for example, the progression of the '*program*' – '*comput think*' concept combination within the field, **Figure 7.5**), here termed an inside-out strategy.

Demonstrative of the potential efficacy of this inside-out strategy in supporting integration and pervasion of innovative contributions throughout the field, results of quantitative analysis indicate that novel concept combinations introduced within papers in which content relates more closely – in terms of semantic similarity – to central, underlying concepts and concerns conventionally addressed throughout the field of Child-Computer Interaction tend to accrue greater subsequent uptake throughout CCI research papers (see **Figure 7.10**). Thus, congruent with the postulations of this strategy, relevance and utility of novel concept combinations may be more readily apparent to audiences when embedded within conventional concepts and content associated with the field of CCI, thereby facilitating subsequent adoption and thorough integration throughout CCI research, whereas audiences may regard novel concept combinations presented devoid of sufficiently familiar or relevant context which conventional concepts may convey as lacking value or applicability to research in the field. As such, the proposed inside-out strategy may offer a fruitful means through which innovative, transformative contributions may be introduced and integrated within the field of Child-Computer Interaction.

Notably, results indicate that the applicability and efficacy of proposed strategies in supporting publication, and integration, of innovative contributions within the field of Child-Computer Interaction may be, to a substantial extent, dependent upon various attributes of the topics of study addressed therein. Feasibility and application of respective strategies – apparent in the number, and atypicality, of novel concept contributions introduced – demonstrably differs based on a number of topic attributes associated with papers, including the trend in prevalence throughout the field of the primary topic addressed at the time of publication, the breadth of topics on which papers focus, and the extent to which papers pertain to respective topics of study identified throughout the field (i.e., topic structure). Amongst these attributes, results imply, similar to those reported by Antons et al. (2019), that the latter may be most consequential in dictating the number, and atypicality, of novel concept combinations introduced, with particular areas of study within the field appearing more amenable to the introduction of innovative contributions, including those areas related to specific user groups (e.g., *children on the autism spectrum*) which have emerged and increased in prevalence throughout the field's development, and others more averse, including those areas related to methodologies (e.g., *design methods and techniques*) which have declined in prevalence over time (see **Appendices FF** and **HH**).

Illustrative of normative pressures to conform with, and penalisation of deviation from, dominant discourses related to distinct areas of study within the field, papers focusing on specific, or a limited number of, topics (i.e., specialised) typically introduce fewer, less atypical innovative contributions, with papers which span, draw upon, or combine a broader variety of areas of study within the field introducing more atypical novel concept combinations (see **Table 7.3**). Demonstrative of challenges associated with introduction and interposition of nonnormative or unconventional concept contributions into established, specialised discourses, those novel concept combinations successfully introduced into the field of Child-Computer Interaction within papers exhibiting greater topic focus, or specialisation, generally attain less subsequent uptake throughout the field (see **Figure 7.12d**). Suggestive of the potential applicability and utility of an inside-out strategy when pursuing publication of innovative contributions pertaining to a specific, specialised subfield or subcommunity within the field of CCI, results thereby intimate that embedding novel concept contributions within germane discourses may be necessary to support perceptions of pertinence, and consequential acceptance, amongst relevant audiences.

Trends in prevalence – here, dichotomised as either increasing or decreasing – of the primary topic addressed within a paper throughout the field of Child-Computer Interaction at the time of publication also pose implications for the introduction, and subsequent uptake within the field, of novel concept combinations. Specifically, papers addressing topics exhibiting increasing prevalence throughout the field tend to introduce a greater volume of novel concept combinations than those addressing topics decreasing in prevalence (see **Table 7.3**), with those novel concept combinations introduced therein typically achieving greater uptake within the field (see **Figure 7.12c**). Thus, pronounced attentiveness to trending areas of study within the field may, as cumulative consequence of concerted study, produce an abundance of innovative contributions, which may, through adoption and advancement in ensuing research, reciprocally promote further study. Contrariwise, a relative lack of innovative contributions in papers concerning primary topics declining in prevalence may be indicative of intellectual stagnation within these areas of study, with the relative paucity of innovative contributions failing to stimulate research related thereto. Notably, results indicate that the earlier indicated negative relationship between atypicality and subsequent uptake of novel concept combinations is, in part, moderated by trends in prevalence of the primary topic of study addressed in papers in which such combinations are introduced, such that the negative effect of atypicality on uptake appears exacerbated when introduced in papers addressing topics increasing in prevalence (see **Figure 7.11b**). Thus, although innovative contributions to trending areas of study appear broadly valued, greater departure from established knowledge may nonetheless be regarded as frivolous, offering limited opportunity for advancement in succeeding study, or perceived as threatening, undermining other developments more compatible with conventional knowledge, whereas unanticipated innovative contributions to areas of waning interest may, in presenting novel avenues for exploration, reinvigorate study related thereto.

Notwithstanding evident impediments to publication and integration of innovative contributions which deviate from dominant discourse and established tradition within the field Child-Computer Interaction, however, results indicate that, when published, such contributions may nonetheless be richly rewarded, achieving disproportionate impact within the field. As observed in other scientific fields (e.g., Foster et al., 2015; Painter et al., 2021; Uzzi et al., 2013), papers introducing a greater number of novel concept combinations to the field of CCI tend to accumulate citations, indicative of recognition and impact attained, at a higher rate than those papers introducing fewer, if any, novel concept combinations (see **Figure 7.13**). Identified effects of the number of novel concepts introduced on impact – here, citations – achieved by CCI research papers, however, appears moderated by the extent to which content addressed therein relates to core, conventional concepts associated with the field (see **Figure 7.14b**). Amongst those papers addressing more conventional content (i.e., more semantically similar to central concepts within the field), introduction of a greater number of novel concept combinations commonly negligibly – if not adversely – influences impact attained, suggesting that an inside-out publication strategy, which seeks to embed innovative contributions within such conventional, established knowledge, may achieve greatest impact when applied to papers presenting a limited number of innovations. Conversely, introduction of a greater number of novel concept combinations amongst those papers addressing less conventional content (i.e., more semantically distant from central concepts within the field) appears advantageous, posited as attributable to an increased likelihood that at least one, or a number, of those novel concept combinations introduced may be recognised by, and inform, ensuing research. Therefore, an outside-in publication strategy, intended to circumvent constraints imposed by norms and structures associated with the field's core through publication along the field's periphery, may support attainment of impact when utilised in publishing papers presenting several innovations. Notably, whereas Uzzi et al. (2013) found that those papers drawing on highly conventional knowledge featuring an intrusion of novel concept combinations (i.e., *low peripherality*, *low scientific novelty*) achieved greatest impact, results of the current analysis indicate that those papers exhibiting relatively limited incorporation of conventional knowledge featuring a profusion of novel concept combinations (i.e., *high peripherality*, *high scientific novelty*) may achieve comparable, if not greater, impact.

In addition to negotiation of challenges and tensions associated with norms and structures associated with the field of Child-Computer Interaction through application of strategic publication practices, researchers recommend involvement in, and service to, the community in order to actively address and amend perceived issues therein. In particular, workshop participants suggest that researchers may instigate and support progress and change sought through active involvement in regulatory processes, such as peer review, through which norms and standards governing the field are typically perpetuated and reinforced, and contribution to advocacy and education within the field, with workshops serving as notable fora through which such efforts may be promoted. In so doing, community members may collectively reform norms and structures within the field so as to better align with, and accommodate, shifting discourses related thereto.

Whilst norms and structures evident within the field of Child-Computer Interaction, in biasing regulatory processes governing the field towards perpetuation of dominant discourses, pose substantial impediments to publication and integration of innovative contributions therein, strategic practices articulated by researchers may facilitate negotiation of consequent challenges and tensions. Termed outside-in and inside-out strategies respectively, results demonstrate that, although various attributes associated with papers dictate integration and impact thereof within the field, publication strategies proposed and applied by researchers, applicable in differing instances, provide efficacious approaches to publication of novel, nonnormative contributions to the field of Child-Computer Interaction, and may support subsequent integration of novel contributions and impact of papers therein.

8.6. Research Practices (Re)Structuring the CCI Research Landscape

Integrated results of respective phases of qualitative and quantitative analysis support and affirm assertions of the conceptual framework, derived from the of the sociology of knowledge approach to discourse (SKAD; Keller, 2001, 2011, 2018), proposed (see **Chapter Three**), which delineates a reciprocally structured and structuring dialectic relationship between research practices and the field of Child-Computer Interaction to which they contribute (**RQ 1**). Research practices, themselves structured by subjective interpretations and sedimentations of discourses circulating both within and beyond the field, have, results evince, shaped the development of discourses within the field of Child-Computer Interaction throughout the period 2003 to 2021.

Postulated structuring effects of research practices upon discourses within the field of Child-Computer Interaction are evident in the apparent tacit influence of various external factors – mediated by, and realised through, researchers' contributions to the field – upon the configuration of knowledge and systems of meaning (i.e., norms) observed therein. In particular, prioritisation of emerging technologies throughout CCI research, attributed to disciplinary backgrounds of researchers and concentration of funding opportunities related thereto (see **Section 8.4**), has ostensibly contributed to prevalence of a technology-driven, novelty-dominated paradigm, and formation of associated norms related to expectations of technological novelty, pervading the field (see **Section 8.4.1**). Technology-driven themes consequently demonstrate prominence throughout the field's development (see **Section 8.1**), with persistence of such a paradigm evident in the recent emergence of distinct, specialised subfields concerning advanced technologies (e.g., *child-robot interaction*, *augmented and mixed reality*) as areas of interest within the field of CCI (see **Section 8.2**). Design-oriented research practices, and artefact-centred papers produced therethrough, commonly associated with such areas of study, however, are regarded as typically generating contextualised, instance-oriented knowledge related to novel solutions which, limited in generalisability and utility, is generally regarded as impeding development and progression of cumulative knowledge and attainment of impact within, and beyond, the field of Child-Computer Interaction (see **Section 8.4.1**). As consequence of apparent limited extensibility or applicability of knowledge produced through such research practices, knowledge generated concerning technology-driven themes appears seldom utilised (i.e., invoked as ancillary topics) in other areas of study in the field and study throughout the field exhibits a progression towards specialisation, whereby technology-driven themes – particularly those nascent areas of study related to advanced technologies – exhibit increasing isolation within, and disintegration from, the field of CCI (see **Section 8.3**).

Changes in external factors and agendas influencing the field – paired with an aspirational identity defined by contribution to, and shaping of, a positive future for children espoused within the Child-Computer Interaction community (Antle & Hourcade, 2022) – have, however, been associated with apparent shifts in priorities evident throughout the field over time. A discernible shift from prioritisation of technology-driven to user needs-driven themes of study (e.g., *preschool children*, *children on the autism spectrum*) within the field of CCI throughout recent years (see **Section 8.2**) is attributed to perceived progression in agendas of funding bodies and organisation, whereby a broadening range of areas of study related to CCI are recognised, valued, and supported through provision of funding opportunities (see **Section 8.4**). Therefore, as research practices contributing to, and discourses comprising, the field have evolved, subject to conditions imposed by a range of influencing factors, throughout the field's development, the field has continued to form a distinct identity characterised by values espoused throughout the associated community.

Notably, however, evolution and progression in discourses within the field of Child-Computer Interaction, results indicate, has been gradual and protracted, with intransigence therein ascribed, in part, to conditions of institutional inertia (Keller, 2011) fostered by the structuring effect of norms, and regulatory institutions (e.g., peer review) in which they are manifest, which arise through discourses. Interpreted as normative rules defining and governing standards and conventions associated with research practices and thereby realising power effects produced by discourses within the field, norms, in implicitly encouraging research practices which adhere to dominant discourses and discouraging those which deviate therefrom, inherently promote perpetuation and preservation of established structure and tradition within the field (see **Section 8.4.1**). As the disciplinary shape of the field of CCI has matured, results intimate that norms, institutionalised and ossifying through structures regulating the field, have increasingly stimulated research practices which, compliant with norms, perpetuate dominant discourses and foreclosed practices which, deviating from norms, modify and transform discourses within the field. In particular, norms related to expectations of technological novelty, conceptions of methodological rigour, and Western-oriented academic conventions throughout the field are regarded as contributing to tensions which have impeded progression of knowledge within the field of CCI.

Whilst the conceptual framework earlier detailed (see **Chapter Three**) articulates the evident reciprocal relationship between research practices and the field of Child-Computer Interaction, findings of the present analysis extend and nuance the conceived framework, elaborating perceived social and epistemic structures defining the field and practices through which tensions therein are negotiated as researchers seek to progress the field. Amendments and extensions to the conceptual framework accounting for these findings are elaborated and visually illustrated (see **Figure 8.1**) below.

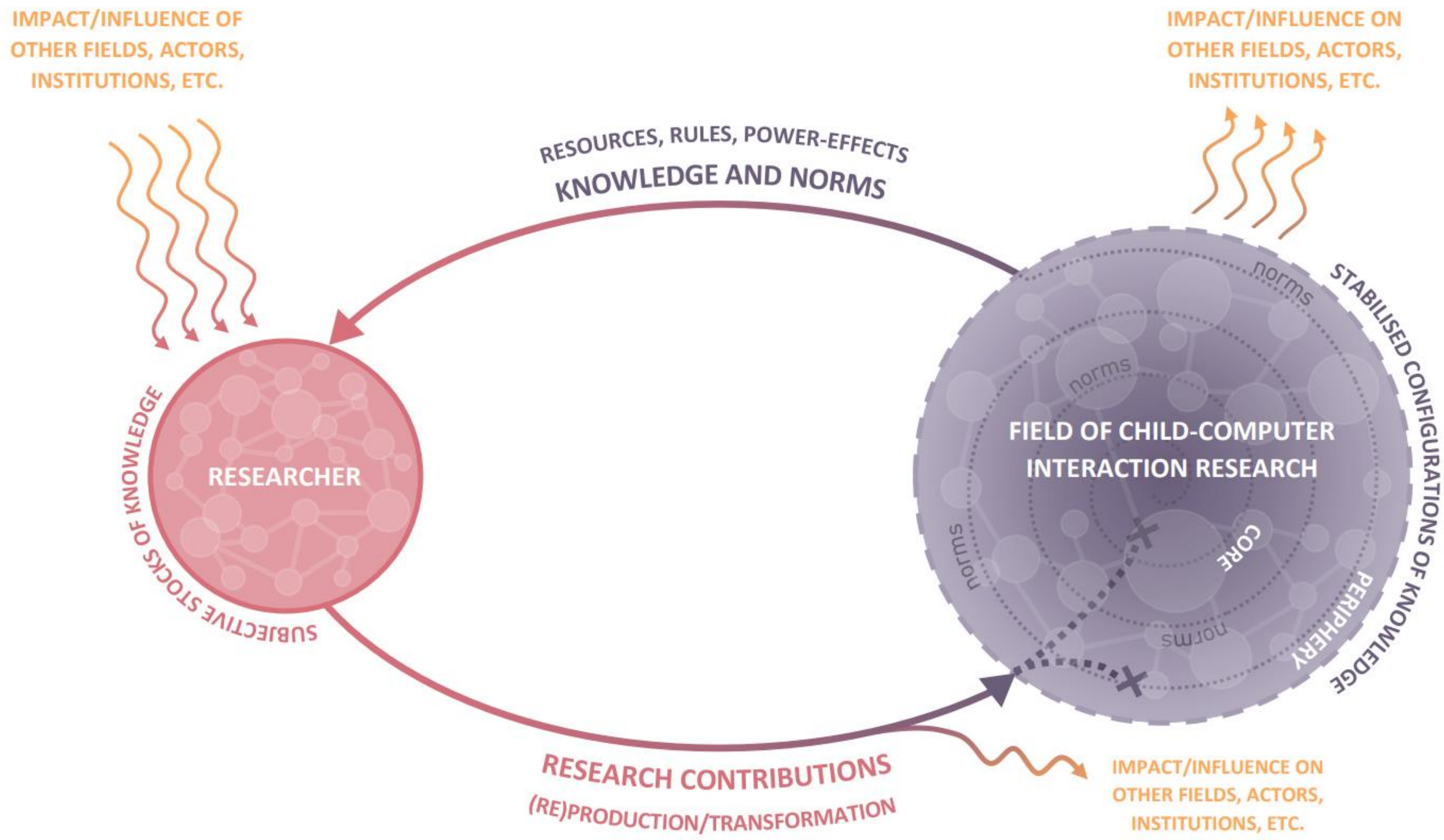


Figure 8.1. *Revised Conceptual Framework*

Whereas power effects produced by discourses, realised through commitment to norms and associated composition of regulatory structures, throughout the field of Child-Computer Interaction may, within the earlier adumbration of the conceptual framework, be inferred as broadly uniform, findings intimate that such effects vary throughout the field based on social and epistemic position relative to the core community and conventional concepts and concerns therein. Indicating that challenges and tensions associated with norms increasingly constrain and condition research practices as contributions are positioned centrally within the social and epistemic systems defining the field, findings characterise the field of CCI as a *core-periphery* structure. Depicted in **Figure 8.1** as a gradient in hue of the field, this core-periphery structure comprises a core characterised by adherence to convention and tradition associated with dominant discourses therein and a periphery typified by amenability to deviation from norms associated with dominant discourses. Therein, those contributions addressing central concepts in a conventional manner or published within specialised venues serving the community (i.e., positioned within the core), conditioned by compliance with norms requisite for acceptance and recognition therein, generally perpetuate dominant discourses, whilst those contributions introducing novel concepts or published within venues associated with neighbouring and related fields, relatively unconstrained by pressures to conform to norms, may deviate from, and modify, dominant discourses (see **Section 8.5**). Diminishing influence of norms, and structures which arise therefrom, associated with the field of CCI in structuring contributions as position therein proceeds from the core to the periphery is interpreted in **Figure 8.1** through a dotted spiral radiating from the field's core.

Conscious of this core-periphery structure characterising the field of Child-Computer Interaction, findings indicate that researchers commonly anticipate consequences (i.e., tensions and challenges) of positioning of contributions within the field for the likelihood of attaining publication and recognition (i.e., risk-reward calculations) therein. Informed by these considerations, researchers may, findings suggest, deploy strategic research and publications practices which, through deliberate positioning of contributions within the core-periphery structure apparent, facilitate efficacious negotiation and navigation of tensions and challenges associated with perceived norms within the field (see **Section 8.5**). In so doing, contributions may attain recognition and integration within the field of CCI despite deviation from established norms and dominant discourses, and thereby enact modifications or transformations of discourses within the field. Trajectories of two such strategic practices, involving intentional positioning of contributions along the field's periphery (outside-in strategy) and embedding of contributions within the field's core (inside-out strategy) respectively (see **Section 8.5**), are portrayed in **Figure 8.1** as dotted pathways penetrating the field to differing extents.

Thus, as articulated within the conceptual framework detailed and evidenced in findings of the current analysis, research practices have evidently shaped knowledge constituting the field of Child-Computer Interaction, continuously (re)structuring knowledge through (re)production and modification of discourses therein, throughout the field's maturation. In doing so, research practices have been devised and deployed in order to accommodate navigation and negotiation of tensions and challenges arising within the field which may impede (re)structuring. Through ongoing research practices, researchers contributing to the field continue to (re)structure and progress the disciplinary shape and identity of the field of Child-Computer Interaction to better embody values advocated and espoused throughout the associated community.

8.7. Summary

Integrating results of respective phases of analysis, findings of the current study offer a broad range of insights concerning the structures and processes of knowledge (re)reconstruction related to the field of Child-Computer Interaction, thereby addressing research questions. Findings illustrate the diverse assortment of (forty-eight) distinct areas of study comprising the field of Child-Computer Interaction and the evolution in research priorities therein throughout the field's development, with a nascent paradigmatic shift from traditional prioritisation of novel and emerging technologies towards consideration of needs of diverse user groups evident within CCI research. Several factors which have discernibly influenced apparent trends in priorities throughout the field's development are identified, commonly exercising such influence through tacit structuring of researchers' problem and strategy selection, with availability of funding in particular directing attention, and thereby realising various external actors' agendas, within the field of CCI. Norms, and structures in which they are manifest (e.g., peer review), which, implicitly informing decisions related to research problem and strategy selection, regulate processes of knowledge (re)production within the field of CCI are established. Strategic publication practices developed and deployed by researchers in order to negotiate challenges and tensions arising due to distinct biases towards reproduction and incremental advancement of dominant discourses associated with norms within the field of CCI are inferred, the feasibility and efficacy of which in supporting publication and integration of innovative contributions in the field are empirically evidenced.

Aligning with assertions of the earlier specified conceptual framework, findings elaborate the reciprocally structured and structuring dialectic relationship between knowledge constituting the field of Child-Computer Interaction and the research practices through which researchers continually (re)produce this knowledge. Informing revision of the proposed conceptual framework, however, findings evince a core-periphery characterisation of the social and epistemic systems which define the field in which researchers position contributions through negotiation of tensions associated with norms within the field.

Substantive conclusions arising from these findings, including notable contributions, limitations, and recommendations for future study associated therewith, are detailed in the following chapter.

Chapter Nine: Conclusion

Child-Computer Interaction, as both a research field and community, has been characterized by sustained, steady growth over the past two decades, broadening and developing beyond structures, methods, and interests inherited from fields and disciplines from which it initially emerged. As the field has proceeded to do so, anxieties have arisen within the community regarding the disciplinary shape and scientific status of the field (Reeves, 2015), prompting calls (e.g., Antle & Hourcade, 2022; Kawas et al., 2020) for critical reflection upon, and dialogue concerning, the development, current state, and future direction of the field. Implementing an iterative sequential mixed methods design (Tashakkori et al., 2020) framed within a conceptual framework based on the sociology of knowledge approach to discourse (Keller, 2011), the current study, mapping discourses comprising the field and examining community members' dialectic relationship therewith, engages in such critical reflection and dialogue. Facilitating investigation of discourses, construed as manifest within published research papers, and researchers' discursive practices, conceived as observable in actu, within respective phases of analysis, the mixed methods design employed, through integration of findings regarding individual components, accommodated exploration of the reciprocally structured and structuring relationship therebetween postulated within the conceptual framework.

Findings evince the diversity characterising the Child-Computer Interaction research landscape, indicating 48 major thematic areas comprising the field, and demonstrate the expansion and evolution of priorities therein throughout the field's development, intimating a progression towards increasing specialisation as distinct subfields have emerged and nascent shift from a technology- to user needs-driven agenda. Notwithstanding apparent burgeoning shifts, researchers indicate that various endogenous and exogenous factors, through tacit structuring of research practices, have conspired to preserve the established tradition and perpetuate dominant discourses within the field. In particular, regulative norms related to expectation of technological novelty and standards of methodological rigour, availability of funding opportunities prioritising emerging technologies, and disciplinary backgrounds of community members have, findings imply, contributed to sustained prevalence of a technology-driven, novelty-dominated paradigm throughout the field. Conditioned by such factors, researchers have exhibited a tendency to engage in design-oriented practices and produce artefact-centred papers which, commonly generating contextualised knowledge related to novel solutions and thereby offering limited generalisability or applicability, generally fail to substantively progress cumulative knowledge within the field of Child-Computer Interaction. Suggestive of a consequent lack of coherence, limited extensibility or applicability of knowledge produced through these practices to areas of the field beyond those immediately implicated has, findings suggest, contributed to increasing isolation, and gradual disintegration, of Child-Computer Interaction's constituent subfields. Conflicting with aspirations of meaningful, positive contribution to children's lives espoused within the community, findings further indicate that these prominent practices, yielding insights and artefacts of limited practical utility and achieving minimal impact beyond the field, may have exacerbated a perceived research-practice gap related to child-computer interaction.

Whilst routinely impeding alternative research practices which may deviate from, and thereby modify, discourses associated with the technology-driven agenda dominant throughout the field of Child-Computer Interaction, researchers suggest discernible recent shifts in agendas pursued throughout the field are attributable to endogenous and exogenous factors' increasing stimulation and support of aberrant practices. In particular, reflexivity and advocacy within the community, recognition of the value of child-computer interaction in public discourse, and broadening availability of funding opportunities have contributed to renewed commitment to methodological and theoretical study and the emergence of a user needs-driven paradigm throughout the field. Additionally, through application of strategies designed to negotiate challenges and tensions impeding aberrant practices, researchers – considered agentic actors creatively interpreting, rather than passive recipients or addressees ventriloquising, various discourses – may, resisting and subverting dominant discourses, have contributed to evident shifts within the field of Child-Computer Interaction.

The field of Child-Computer Interaction, evolving throughout the two decades since formalisation, has evidently proceeded to form an increasingly distinct disciplinary shape and identity. Progression therein, however, has been notably protracted and, researchers contributing thereto indicate, fraught with persistent tensions hindering continued development. These tensions appear largely attributable to anxieties and insecurities which have arisen amongst the community regarding the incipient disciplinary shape and scientific status of the field as Child-Computer Interaction has advanced beyond foundations derived from the various fields from which it initially emerged. Due to consequent concerns regarding coherence and (intellectual) adequacy relative to established fields and trepidation towards the field's direction as it treads upon novel terrain, community members have ostensibly sought security through adoption of familiar norms and standards practised within related, established traditions considered scientific. Whilst resulting in a status quo broadly favourable to those maintaining it, these conditions, seemingly engendering wariness towards, and penalising, departure from these accepted norms and standards due to perceived threat to the field's emergent scientific status, have, somewhat ironically, impeded development of a coherent, cumulative corpus of knowledge therein and attainment of meaningful contribution to children's lives. Although these norms and conventions have, researchers' perspectives suggest, ossified and been institutionalised within the structure of the field, contributing to an entrenched tension between knowledge (re)produced and the aspirational identity espoused within the field, an ongoing gradual shift within the field of Child-Computer Interaction has nonetheless emerged. Broadening consciousness of, and commitment to address, these tensions, prompted by increasing critical reflection and discussion undertaken within the Child-Computer Interaction community, and perseverance in pursuing values and aspirations in research practices through strategic negotiation of perceived impediments have supported progression in the field towards a disciplinary shape reflective of the community's original agenda. Through concerted, conscious efforts enacted through research practices and advocacy, therefore, community members appear capable of affecting substantive, structural change within the field of Child-Computer Interaction.

Child-Computer Interaction thus appears to be proceeding through an intermediary phase or transitionary period, comparable to "adolescence" (Antle & Hourcade, 2022), as the community resolves apparent tensions between commitments to a scientific disciplinary shape informed by antecedent fields (e.g., Human-Computer Interaction) and an identity and values distinct from these same antecedent fields. Consequently, the field currently occupies a state partway between serving as a subfield within fields from which it initially arose, subject to and constrained by many of the regulative norms and conventions associated with these traditions, and a distinctive, individual field characterised by a definite identity and well-established structures and methodologies. The field of Child-Computer Interaction is, findings of the current study therefore indicate, in the process of 'becoming' as it progresses through community members' continued negotiation of tensions therein.

In order to further this process of 'becoming' as the field of Child-Computer Interaction matures, a number of recommendations prompted by findings of the current study are offered.

In pursuing development of cumulative, coherent knowledge related to child-computer interaction, there is an apparent need for progression beyond present preoccupation with novel technologies and associated design-oriented, artefact-centric practices predominant throughout the field. Whilst technology-driven, design-oriented, and artefact-centred study remain, as contended by Giannakos et al. (2022) and Antle and Hourcade (2022), of considerable value to the field, application of these approaches in practice – typically describing a particular instance of a novel technological solution for children – has thus far generally failed to substantively contribute to cumulative knowledge therein. Therefore, the present study advocates conscious commitment to production of knowledge which may be extrapolated and applied beyond novel instances from which it originates through purposeful development upon theory and cultivation of intermediate-level knowledge (e.g., strong concepts; see Barendregt et al., 2017) throughout the field. Prioritisation of, and development of knowledge concerning, needs of specific user groups may, findings suggest, provide a particularly productive approach through which this may be achieved.

Similarly, in pursuing realisation of aspirations related to meaningful, positive contribution to the lives of children, there is an evident requirement to address a perceived research-practice gap through generation of knowledge of practical applicability and utility to stakeholders beyond the field of Child-Computer Interaction, such as industry practitioners, parents, and educators. Themes of study pertinent to such stakeholders may be identified through further investigation of discrepancies between research priorities and commercial systems (e.g., Loustau & Chu, 2022) and consultation of, or collaboration with, stakeholders (e.g., industry partners). Additionally, actionable insights derived through study may be abstracted and communicated through provision of theory-driven examples, guidance, resources, and recommendations. In so doing, studies may contribute to burgeoning shifts in external discourses concerning the value of research related to child-computer interaction, thereby garnering continued support (e.g., funding) for a broadening range of areas of study throughout the field.

Regarded as having reached a critical juncture in its maturation, continued reflection upon the development and current state of Child-Computer Interaction, as both a field and community, and collective deliberation concerning the future direction thereof is considered timely (Antle & Hourcade, 2022). Given the apparent influence of recent, broadening reflexivity and advocacy within the community, evidently serving as a principal mechanism through which reform of practice may be instigated and promoted, critical reflection and dialogue may serve as an efficacious means through which tensions characterising the field's development may be negotiated and resolved. As indicated by researchers consulted, specialised conference (e.g., IDC) workshops may provide particularly suitable, productive fora to host such dialogue.

In summary, whilst the field of Child-Computer Interaction has progressed and developed throughout the past two decades, the distinct identity and disciplinary shape of the field continues to be fashioned in a process of "becoming" through the collective practices of the associated community. Analogous to a ship endeavouring on an intrepid expedition, the field's progression thus far has been characterised by a tension between apprehension to stray from the security familiar shores provide and the promise of territories anew which may yet be discovered in so doing. As André Gide observed, however, "[o]ne does not discover new lands without consenting to lose sight of the shore" (1973). Pursuing novel knowledge and meaningful impact, there appears a necessity for departure from the familiarity of inherited traditions and embrace of uncertainty and innovation as the field of Child-Computer Interaction charts its own course into the future.

9.1. Contributions

Findings of the present study offer a number of notable theoretical, methodological, empirical, and practical contributions to the field of Child-Computer Interaction, as well as several other fields (e.g., natural language processing, sociology of knowledge), which are here outlined.

9.1.1. Mapping of the Landscape of Child-Computer Interaction Research

The current study, through Correlated Topic Modelling (CTM; Blei & Lafferty, 2007) of an extensive corpus of published research papers, contributes an empirically grounded mapping, or overview, of the thematic structure of the field of Child-Computer Interaction and its development over time.

Whilst a number of recent studies (e.g., Giannakos, Papamitsiou, et al., 2020; Kawas et al., 2020), have undertaken efforts to examine, and offer overviews of, the structure of, and progress in, the Child-Computer Interaction research landscape, such analyses generally exhibit limited scope – considering only research published in the field's primary publication venues (i.e., IDC and IJCCI) – as consequence of inherent demands and challenges associated with methods employed therein (e.g., close reading, manual coding). Considering contributions to the field of Child-Computer Interaction published in a range of relevant venues, including those serving neighbouring and related fields (e.g., Human-Computer Interaction; see **Appendix B**), the present study offers a broader mapping of contributions to the field. Methods employed in generating prior overviews, such as co-word analysis of limited numbers of keywords (e.g., Giannakos, Papamitsiou, et al., 2020), may also fail to adequately apprehend and portray the heterogeneity of thematic content addressed throughout the field of Child-Computer Interaction. Applying topic modelling, which affords a finer level of granularity in analysis of text content, the present study provides a nuanced depiction of the field's latent thematic structure. Additionally, whereas previous overviews (e.g., Giannakos, Papamitsiou, et al., 2020; Kawas et al., 2020), examining discrete periods, provide largely static mappings of the Child-Computer Interaction landscape, the present study, detailing annual trends, offers a dynamic representation of evolution in the field's thematic structure.

The mapping of the field of Child-Computer Interaction presented in the current study may serve to inform reflection upon, and critical dialogue concerning, the development and current state of the field. Moreover, given a noted lack of adequate supports addressing the needs and challenges of Child-Computer Interaction community members (Markopoulos et al., 2008; Read & Markopoulos, 2013), this mapping offers a practical resource and common language which researchers (and other stakeholders) – including newcomers to the field – may avail of in familiarisation with discourses and research in the field and identification of gaps, trends, and opportunities therein.

9.1.2. SKAD-Based Conceptual framework

The current study, developing and propounding a conceptual framework which extends Keller's (2011) sociology of knowledge approach to discourse (SKAD), presents, and provides empirical evidence related to, a theoretical model through which the relationship between individual researchers, research practices, and scientific fields may be conceived and investigated.

Although prior research in the field of Child-Computer Interaction (e.g., Kawas et al., 2020; Yarosh et al., 2011) has jointly examined researcher values and values expressed throughout published research in the field, considering the relationship therebetween, such research fails to identify or advance an explicit theoretical account of this relationship and the processes through which it is mediated. The sociology of knowledge approach to discourse, which has largely been limited to investigation of public and media discourses in German-speaking contexts (see Keller, 2013), is introduced and conceptualised in the present study as a framework through which the production and circulation of knowledge within scientific fields may be comprehended and practically investigated through concurrent consideration of relevant micro-, meso-, and macro-level conditions and processes. The current study thereby contributes, and provides empirical evidence supporting, a theoretical conception of processes of knowledge (re)production and transformation within scientific fields.

Facilitating comprehension, and further investigation, of processes of knowledge (re)structuring within the field of Child-Computer Interaction, as well as other scientific fields, the framework articulated within the current study may support identification of challenges, tensions, and practices prominent therein.

9.1.3. Novel Methodological Approaches

The current study pioneers a number of novel methodological approaches in quantitative text analysis, extending existing approaches both in relation to topic modelling and analysis of innovation and novelty in published research.

Whereas previous studies have commonly employed ex post evaluation of models based on human evaluation of topic interpretability (e.g., Gurcan, Cagiltay, et al., 2021) or topic diagnostic metrics (e.g., King's College London & Digital Science, 2015) in determining a suitable level of granularity and deriving an appropriate number of topics for which to model a corpus through topic modelling, the present study implements a novel triangulation method, consisting of a sequential process of unsupervised clustering, evaluation of metrics for latent topic estimation, evaluation of candidate models based on diagnostic metrics, and manual review of candidate model interpretability and coherence. The approach employed offers a systematic, scalable, and robust means through which an appropriate number of latent topics within a corpus may be identified applicable to a broad range of topic modelling methods (e.g., LDA, CTM, STM).

The current study also extends quantitative approaches to identification and measurement of innovation novelty within research (e.g., Hofstra et al., 2020; Uzzi et al., 2013), incorporating consideration of the (un)conventionality (i.e., semantic peripherality, or centrality) of paper content within a field. Here, a novel approach is devised and implemented in quantifying the (semantic) distance between the content of research papers and the central concepts (i.e., semantic core) of the field, consisting of construction of a semantic space representing concepts within the field through word embedding (word2vec; Mikolov, Chen, et al., 2013) and measurement of dissimilarity (Word Mover's Distance; Kusner et al., 2015) between papers therein. The approach utilised offers a means through which further insight regarding the relationship between the semantic content of research papers and novel contributions presented therein, as well as the consequences of this relationship for subsequent adoption and uptake of innovations throughout the field and research impact (i.e., citations), may be obtained.

Replication of novel methodological approaches developed and applied in the current study are supported through provision of detailed description, including justification of decisions, and documenting of R packages utilised in completing analyses (see **Appendix N**).

9.1.4. Strategic Publication Practices

The current study elaborates, and evidences the feasibility and efficacy of, strategic publications practices through which researchers may negotiate and navigate challenges and tensions within the field of Child-Computer Interaction.

Examining researchers' practices in negotiating norms, and challenges and tensions arising therefrom, in contributing to the field of Child-Computer Interaction, the current study identifies and delineates a set of strategic practices applied in pursuing publication and integration of innovative contributions therein. An *outside-in* strategy involves pursuit of publication in venues beyond those primarily serving the CCI community (i.e., IDC and IJCCI) in order to avoid restrictive conditions norms associated with the field may impose, whilst an *inside-out* strategy involves embedding of novel contributions in conventional knowledge within the field in order to demonstrate compatibility with, or basis in, the field's dominant knowledge canon. Findings of quantitative analysis exploring the practical feasibility and efficacy of respective strategies within the field demonstrate the utility thereof. In particular, findings indicate that an inside-out publication strategy may prove most beneficial when applied to papers introducing a limited number of novel concepts, whereas an outside-in publication strategy may prove most advantageous when utilised in publishing papers introducing several novel concepts.

Strategic practices detailed in the present study, proposing approaches through which tensions and challenges impeding innovative contributions may be successfully negotiated, may be availed of by researchers in pursuing publication of papers introducing novel concepts within the field of Child-Computer Interaction. Practices identified may also be applicable in, and offer utility throughout, other scientific fields, although the broader relevance and efficacy thereof requires further study (see **Section 9.3**).

9.1.5. Processes and Factors Shaping (Re)Structuring of Knowledge

Through a mixed methods approach framed within a conceptual framework based on the sociology of knowledge approach to discourse (Keller, 2011), the current study explicates processes through which researchers may (re)structure knowledge within the field of Child-Computer Interaction, and identifies various factors influencing such processes. In so doing, findings of the current study support critical reflection and dialogue within the community regarding the implications of such processes and factors for the current state, and future direction, of the field.

Critical reflection upon processes through which knowledge within the field of Child-Computer Interaction is actively (re)produced, although emerging, remains limited (Iivari et al., 2021). In detailing such processes, the current study facilitates scrutiny of, and reflection upon, the 'status quo', established practices contributing thereto, and agendas which discourses therein serve. In particular, findings may support reflexivity and inform critical dialogue amongst stakeholders regarding various aspects of processes through which knowledge is (re)structured within the field of CCI, including the role of regulative norms and conventions governing the field, standards of methodological rigour, methodological training and proficiency of community members, agendas of funding bodies, technological developments, and intended impact.

Prominent issues influencing processes through which knowledge is (re)structured within, and thereby shaping, the field of Child-Computer Interaction identified in the present study may serve to instigate and inform constructive dialogue within the community regarding future directions in the field.

9.2. Limitations

A number of notable limitations pertaining to the data retrieved and methods through which these data were analysed qualify findings and conclusions presented herein.

9.2.1. Data

Any attempt, such as that presented in the current study, to define and scrutinise a field inevitably entails the political act of bounding the landscape. The current analysis, through the search query implemented in data retrieval, sought to obtain an expansive, representative collection of contributions to the field of Child-Computer Interaction published in a broad range of relevant venues. However, the search query devised and implemented, in pursuing comprehensiveness, may, in some respects, have been too broad, obtaining non-CCI related publications and requiring considerable manual curation, whilst simultaneously overly restrictive, omitting contributions to the field published beyond publication venues – primarily related to the fields of CCI and HCI – considered. Thus, the overview of the CCI research landscape presented, while extensive, ought not to be presumed comprehensive.

Furthermore, in largely restricting publication venues considered to those traditionally publishing Child-Computer Interaction and Human-Computer Interaction research, the search query implemented in the current study is likely to have neglected relevant research published in venues primarily serving neighbouring and related fields (e.g., education, psychology). In so doing, data retrieval may have favoured papers associated with particular research traditions and communities (e.g., interaction design), thereby biasing the obtained corpus of CCI research papers and associated depictions of the CCI research landscape. Thus, the overview of CCI research landscape presented, while illustrative, ought not to be presumed entirely representative.

In addition to limitations and biases implicit in the search query devised and implemented in retrieving data, a number of noteworthy biases associated with the source from which data were procured, Elsevier's Scopus database, also qualify findings of the current study. Although exhibiting broad international and interdisciplinary coverage, Scopus nonetheless demonstrates structural biases against research produced in non-Western nations, non-English language research, and research related to the arts, humanities, and social sciences (see Mongeon & Paul-Hus, 2016 and Tennant, 2020). Systematic inequities apparent therein may, consequently, be inherent in data obtained and analysed within the current study, producing portrayals of the field in which non-Western voices may be disproportionately underrepresented and marginalised. Moreover, ambiguities and inconsistencies in author and institution naming conventions throughout Scopus data (see Sutarsyah & Yoganingrum, 2019), producing attribution errors, may have contributed to inaccuracies in results concerning contributors to, and collaborations within, research related to CCI – although, such inconsistencies were, where identified, corrected through manual standardisation.

Purposive sampling applied in recruitment of workshop participants, in drawing upon results of quantitative analysis of the retrieved corpus, inherently subjected qualitative data obtained to above noted limitations and biases implicit within the corpus. Biases related to marginalisation of non-Western voices and voices of those primarily associated with other research communities within the retrieved text corpus may, in reducing likelihood of identification of such individuals as possessing sufficient applicable experience within the field, have contributed to disproportionate underrepresentation of these voices in workshops and qualitative data derived therethrough.

Biases related to representativeness of the sample may have been compounded by the limited number of participants involved, with the current study failing – based on recommendations of extant methodological literature (e.g., Johnson & Christensen, 2017; Kitzinger, 1995; Langford et al., 2002) – to recruit a sufficient number of participants due to issues related to rates of response and attrition amongst those invited to participate in the present study. Pursuing data saturation (Guest et al., 2006), although analysis of collected data exhibited code saturation (i.e., point at which no additional issues are identified), meaning saturation (i.e., point at which no further nuances or insights related to issues are identified) may not have been achieved (Hennink et al., 2017). As consequence of limited volume and variety of perspectives obtained, therefore, the extent to which findings derived therethrough may be regarded as internally valid, generalisable, and demonstrative of the full spectrum and variation of phenomena investigated may be questionable.

Furthermore, data collected from this sample may be subject to biases associated with participants' self-selection, whereby individuals' propensity to participate in the current study may have been correlated with the substantive phenomena of interest (Olsen, 2008). In particular, the current study's concern with systemic and structural aspects of the field of Child-Computer Interaction may have appealed to those researchers invested, and actively involved, in the associated community and its infrastructure (i.e., editorial boards, committees, working groups). Perspectives of such individuals may, due to biases associated with vested interests and position within the field, have been more or less critical than would otherwise be the case.

9.2.2. Methods

Topic models, whilst providing powerful techniques with which to elicit latent patterns and structure in otherwise unstructured text corpora, present noteworthy novel problems of interpretation and validation with which their use and interpretation ought to be qualified (Blei & Lafferty, 2009; DiMaggio et al., 2013). Inference through topic modelling is "fundamentally imprecise" (Blei & Lafferty, 2009, p. 17), with estimation requiring a priori specification of a number of topics and model optimisation in a semantic space with multiple solutions. Moreover, substantive interpretations of topics inferred represent inherently subjective judgements, with no natural means or objective measure by which the quality or accuracy of outputs may be measured (Kraemer et al., 2018). Although the current study implemented robust methods in model selection and interpretation, the model presented and interpretation of outputs detailed are ultimately subject to human judgement, and thus ought to be conceived as chiefly an exploratory tool, offering utility rather than accuracy (DiMaggio et al., 2013).

Similarly, word2vec hyperparameters, although specified based on recommendations within extant literature (e.g., Mikolov, Chen, et al., 2013; Pennington et al., 2014; Yang & Deravi, 2022) and evaluation of semantic structure and interpretability of embeddings produced therethrough (Park et al., 2017; Senel et al., 2018), nonetheless reflect subjective judgements with notable implications for model efficacy and output accuracy. Therefore, word embeddings obtained through the word2vec model specified and measures derived therefrom, whilst ostensibly preserving meaningful semantic relationships, ought not be regarded as objective or definitive.

In addition to limitations related to parameterisation of machine learning models implemented, caveats concerning novel metrics conceived and operationalised through use of outputs thereof ought to be noted. In particular, the measure of paper peripherality, or centrality, within the field of Child-Computer Intervention devised, intended to quantify the (un)conventionality of paper content in the context of the field, is premised on a number of a priori assumptions. In presuming that papers published in the primary venues associated with the field address underlying concerns of Child-Computer Interaction research in a more consistent, explicit manner than those published elsewhere, the derived measure may inherently reflect biases related to themes of study prioritised or privileged within these venues. Furthermore, a number of decisions in contrivance of a 'dummy' document representing the semantic core of the field, including specification of the number of concepts included and concepts excluded, represent subjective judgements which may introduce biases based on the researcher's preconceptions regarding the field's structure. Moreover, the approach implemented presumes time-invariance of the semantic space comprising the field of Child-Computer Interaction, such that measurement is predicated on the unrealistic assumption that contexts in which concepts appear throughout the field and concepts constituting core concerns therein remain relatively consistent over time. Assumptions implicit in derivation of measures may thus impinge upon the validity of results of analysis and limit extensibility of such an approach (i.e., assumptions may not be applicable or remain true for other fields of study).

Inconsistencies in methods of qualitative data collection employed, necessitated by scheduling conflicts and last-minute attrition, may have contributed to a difference in interpretation, and relative imbalance in representation, of respective participant voices and perspectives in analysis. Inherent differences in data obtained through various methods employed (i.e., focus groups, dyadic interviews, and semi-structured interviews) may have unintentionally contributed to dominance or marginalisation of certain voices in data and subsequent analysis thereof. Whereas interactions amongst participants constitute a core element of data generation in focus groups and dyadic interviews, interactions captured within through individual, semi-structured interviews were limited to those between participants and the researcher. Although the researcher engaged in role as an active discussant during individual and dyadic interviews, interactions therein nonetheless inherently differed in relational and power dynamics from those observed amongst participants in group sessions. Individual interview participants may have been afforded greater opportunity to express perspectives without challenge, support, or request for clarification or elaboration which additional participants may otherwise provide than group session participants subject to such interactions. Additionally, whilst not explicitly observed in the current study, implicit dominance of certain voices and consequent marginalisation or conditioning of others due to relational and power dynamics between participants, thereby limiting views expressed therein, may nonetheless have occurred within group sessions (Sim & Waterfield, 2019; Smithson, 2000) and ought not be discounted. Consequently, findings arising through analysis of qualitative data collected may be disproportionately reflective of, and biased by, subjective experiences and perceptions of those researchers participating in individual interviews or exercising dominance within group discussions.

9.3. Recommendations for Future Research

Based on findings, as well as associated limitations, of the current study, a range of auspicious avenues for future study are suggested.

Extension of the qualitative phase of analysis undertaken within the current study through recruitment of a larger, more diverse sample of relevant stakeholders may, in addition to supporting validity and generalisability of findings, yield further insights concerning processes and practices through which knowledge within the field of Child-Computer Interaction has evolved. Investigation of experiences of industry practitioners, representatives of prominent funding bodies and organisations, and members of communities traditionally marginalised within the field and throughout academia, the voices of whom are conspicuously absent throughout extant literature, may prove particularly fruitful in supplementing the current study. Providing a broader variety of perspectives, and facilitating comparative analysis therebetween, such study may advance understanding of values and agendas pursued by respective stakeholders, mechanisms through which these are enacted, and consequent influence upon development of knowledge within the field of Child-Computer Interaction. In so doing, such study may support further reflection upon the current state of the field, identification of challenges and limitations therein, and formulation of practical recommendations and solutions through which issues apparent in the field may be addressed.

Perceived inconsistences and shortcomings in impact intended, and realised, throughout the field of Child-Computer Interaction identified amongst participants within the present study may be further examined through future study. In particular, investigation of attitudes towards, and experiences of, impact amongst CCI community members may garner insights concerning the current capacity and capability to undertake meaningful knowledge translation (KT) – here, approaches and activities which convey results of scientific research to relevant stakeholders in a practicable manner – throughout the community, thereby facilitating identification of needs associated with further development of such capacity therein. Additionally, investigation of perspectives of relevant stakeholders (e.g., industry practitioners, government and non-government agencies) may yield insights concerning effective KT practices and approaches of which CCI community members may avail. In so doing, such study may accommodate collation of exemplars of successful KT associated with the field and support development of guidelines and frameworks informing subsequent practice throughout the community.

Future work may provide a more extensive overview of the field of Child-Computer Interaction through refinement of the data retrieval process in order to obtain a more comprehensive, representative corpus of relevant published papers. Revised data retrieval processes may include simultaneous querying of several additional databases (e.g., Web of Science, Google Scholar), consideration of additional venues serving various neighbouring and related fields (e.g., *Education and Information Technologies*, *British Journal of Educational Psychology*) and grey literature, and emending of the search query in order to optimise precision. Appropriate publication venues for inclusion may be identified, and the search query may be amended, through consultation with experts in the field. Overviews of the field of CCI generated through analysis of corpora retrieved through revised processes may reveal additional detail and nuance of the structure of the field.

Following findings of the present study, further investigation of strategic publication practices through which researchers negotiate and navigate challenges and tensions perceived within the field of Child-Computer Interaction, and their efficacy in doing so, is warranted. Whilst the present study identified and explored the feasibility and efficacy of two such strategies, researchers contributing to the field may deploy an array of additional strategic practices serving diverse purposes and applicable in various contexts. Additional strategic practices may be recognised or inferred through qualitative analysis of a broader range of researchers' experiences in contributing to the field, particularly those traditionally marginalised within, or excluded from, the field. Alternatively, potential strategic practices, including those which may be applied unconsciously, may be deduced through quantitative analysis extending approaches developed and implemented within the current study. In particular, identification and evaluation of patterns in propagation of innovative contributions throughout the semantic space of the field – as illustrated in **Figure 7.5** – through clustering (e.g., agglomerative hierarchical) of temporal trends is proposed as a promising approach through which such study may be pursued. In addition to providing actionable strategies and insights of which researchers may avail, such study may further awareness and comprehension of challenges and tensions which researchers – possibly subconsciously – perceive, and are required to negotiate, within the field.

Replication of analyses undertaken within the current study throughout a range of fields beyond that of Child-Computer Interaction, in addition to facilitating investigation of extensibility and generalisability of assertions associated with the conceptual framework developed herein and findings related thereto, may advance understanding of general processes through which knowledge is (re)structured within scientific fields. Moreover, as demonstrated within the current study, such an approach may support critical reflection upon the development, current state, and future directions of a field, offering particular value in supporting identification of lacunae, limitations, and challenges therein, and processes and practices through which researchers may actively negotiate or resolve consequent tensions.

References

Abrams, K. M., Wang, Z., Song, Y. J., & Galindo-Gonzalez, S. (2015). Data Richness Trade-Offs Between Face-to-Face, Online Audiovisual, and Online Text-Only Focus Groups. *Social Science Computer Review*, *33*(1), 80–96. https://doi.org/10.1177/0894439313519733

Adeoye-Olatunde, O. A., & Olenik, N. L. (2021). Research and scholarly methods: Semi-structured interviews. *JACCP: JOURNAL OF THE AMERICAN COLLEGE OF CLINICAL PHARMACY*, *4*(10), 1358–1367. https://doi.org/10.1002/jac5.1441

Airoldi, E. M., & Bischof, J. M. (2016). Improving and Evaluating Topic Models and Other Models of Text. *Journal of the American Statistical Association*, *111*(516), 1381–1403. https://doi.org/10.1080/01621459.2015.1051182

Aitchison, J. (1982). The Statistical Analysis of Compositional Data. *Journal of the Royal Statistical Society. Series B (Methodological)*, *44*(2), 139–177.

Aitchison, J., & Shen, S. M. (1980). Logistic-Normal Distributions: Some Properties and Uses. *Biometrika*, *67*(2), 261–272. https://doi.org/10.2307/2335470

Ale, M., Sturdee, M., & Rubegni, E. (2022). A systematic survey on embodied cognition: 11 years of research in child–computer interaction. *International Journal of Child-Computer Interaction*, *33*, 100478. https://doi.org/10.1016/j.ijcci.2022.100478

Aletras, N., & Stevenson, M. (2014). Measuring the Similarity between Automatically Generated Topics. *Proceedings of the 14th Conference of the European Chapter of the Association for Computational Linguistics, Volume 2: Short Papers*, 22–27. https://doi.org/10.3115/v1/E14-4005

Älgå, A., Eriksson, O., & Nordberg, M. (2020). Analysis of Scientific Publications During the Early Phase of the COVID-19 Pandemic: Topic Modeling Study. *Journal of Medical Internet Research*, *22*(11). https://doi.org/10.2196/21559

Alivernini, F. (2012). Mixed Methods Research on Learning. In N. M. Seel (Ed.), *Encyclopedia of the Sciences of Learning* (pp. 2280–2284). Springer US. https://doi.org/10.1007/978-1-4419-1428-6_846

Antle, A. N., & Frauenberger, C. (2020). Child–Computer Interaction in times of a pandemic. *International Journal of Child-Computer Interaction*, *26*, 100201. https://doi.org/10.1016/j.ijcci.2020.100201

Antle, A. N., Frauenberger, C., Landoni, M., Fails, J. A., Jirotka, M., Webb, H., & Tutiyaphuengprasert, N. (2020). Emergent, situated and prospective ethics for child-computer interaction research. *Proceedings of the 2020 ACM Interaction Design and Children Conference: Extended Abstracts*, 54–61. https://doi.org/10.1145/3397617.3398058

Antle, A. N., & Hourcade, J. P. (2022). Research in Child–Computer Interaction: Provocations and envisioning future directions. *International Journal of Child-Computer Interaction*, 100374. https://doi.org/10.1016/j.ijcci.2021.100374

Antons, D., Joshi, A. M., & Salge, T. O. (2019). Content, Contribution, and Knowledge Consumption: Uncovering Hidden Topic Structure and Rhetorical Signals in Scientific Texts. *Journal of Management*, *45*(7), 3035–3076. https://doi.org/10.1177/0149206318774619

Archibald, M. M., Ambagtsheer, R. C., Casey, M. G., & Lawless, M. (2019). Using Zoom Videoconferencing for Qualitative Data Collection: Perceptions and Experiences of Researchers and Participants. *International Journal of Qualitative Methods*, *18*, 1609406919874596. https://doi.org/10.1177/1609406919874596

Aronson, J. (1995). A Pragmatic View of Thematic Analysis. *The Qualitative Report*, *2*(1), 1–3. https://doi.org/10.46743/2160-3715/1995.2069

Arora, S., Ge, R., Halpern, Y., Mimno, D., Moitra, A., Sontag, D., Wu, Y., & Zhu, M. (2013). A Practical Algorithm for Topic Modeling with Provable Guarantees. *Proceedings of the 30th International Conference on Machine Learning*, 280–288. https://proceedings.mlr.press/v28/arora13.html

Arun, R., Suresh, V., Veni Madhavan, C. E., & Narasimha Murthy, M. N. (2010). On Finding the Natural Number of Topics with Latent Dirichlet Allocation: Some Observations. In M. J. Zaki, J. X. Yu, B. Ravindran, & V. Pudi (Eds.), *Advances in Knowledge Discovery and Data Mining* (pp. 391–402). Springer. https://doi.org/10.1007/978-3-642-13657-3_43

Asmussen, C. B., & Møller, C. (2019). Smart literature review: A practical topic modelling approach to exploratory literature review. *Journal of Big Data*, *6*(1), 93. https://doi.org/10.1186/s40537-019-0255-7

Atasu, K., Parnell, T., Dünner, C., Sifalakis, M., Pozidis, H., Vasileiadis, V., Vlachos, M., Berrospi, C., & Labbi, A. (2017). *Linear-Complexity Relaxed Word Mover's Distance with GPU Acceleration* (arXiv:1711.07227). arXiv. https://doi.org/10.48550/arXiv.1711.07227

Attride-Stirling, J. (2001). Thematic networks: An analytic tool for qualitative research. *Qualitative Research*, *1*(3), 385–405. https://doi.org/10.1177/146879410100100307

Ayala-Bastidas, G., Ceballos, H. G., Garza, S. E., & Cantu-Ortiz, F. J. (2021). Identifying Researchers' Publication Strategies by Clustering Publication and Impact Data. *Publishing Research Quarterly*, *37*(3), 347–363. https://doi.org/10.1007/s12109-021-09832-7

Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative Science Studies*, *1*(1), 377–386. https://doi.org/10.1162/qss_a_00019

Bailey, H. & OBS Project Contributors. (2022). *Open Broadcaster Software Studio* (27.1.3) [C++]. https://obsproject.com/

Bajaj, C. (1988). The algebraic degree of geometric optimization problems. *Discrete & Computational Geometry*, *3*(2), 177–191. https://doi.org/10.1007/BF02187906

Bakala, E., Gerosa, A., Hourcade, J. P., & Tejera, G. (2021). Preschool children, robots, and computational thinking: A systematic review. *International Journal of Child-Computer Interaction*, *29*, 100337. https://doi.org/10.1016/j.ijcci.2021.100337

Baralis, E., Cerquitelli, T., Chiusano, S., Grimaudo, L., & Xiao, X. (2013). Analysis of Twitter Data Using a Multiple-level Clustering Strategy. In A. Cuzzocrea & S. Maabout (Eds.), *Model and Data Engineering* (pp. 13–24). Springer. https://doi.org/10.1007/978-3-642-41366-7_2

Barendregt, W., Bekker, T., Börjesson, P., Eriksson, E., Vasalou, A., & Torgersson, O. (2018). Intermediate-level knowledge in child-computer interaction. *Proceedings of the 17th ACM Conference on Interaction Design and Children*, 699–704. https://doi.org/10.1145/3202185.3205865

Barendregt, W., Torgersson, O., Eriksson, E., & Börjesson, P. (2017). Intermediate-Level Knowledge in Child-Computer Interaction: A Call for Action. *Proceedings of the 2017 Conference on Interaction Design and Children*, 7–16. https://doi.org/10.1145/3078072.3079719

Baykal, G. E., Alaca, I. V., Yantaç, A. E., & Göksun, T. (2018). A review on complementary natures of tangible user interfaces (TUIs) and early spatial learning. *International Journal of Child-Computer Interaction*, *16*, 104–113. https://doi.org/10.1016/j.ijcci.2018.01.003

Beck, J., & Stolterman, E. (2016). Examining Practical, Everyday Theory Use in Design Research. *She Ji: The Journal of Design, Economics, and Innovation*, *2*(2), 125–140. https://doi.org/10.1016/j.sheji.2016.01.010

Bekker, M., & Markopoulos, P. (2003). Interaction design and children: (IDC 2002). *ACM SIGCHI Bulletin - a Supplement to Interactions*, *2003*, 6. https://doi.org/10.1145/601798.601806

Bekker, T., Barendregt, W., Markopoulos, P., & Read, J. (2014). Teaching Interaction Design and Children: Understanding the Relevance of Theory for Design. *Interaction Design and Architecture(s) Journal*, *21*, 9–24.

Benton, L., & Johnson, H. (2015). Widening participation in technology design: A review of the involvement of children with special educational needs and disabilities. *International Journal of Child-Computer Interaction*, *3–4*, 23–40. https://doi.org/10.1016/j.ijcci.2015.07.001

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. Anchor Books.

Berger, P. L., & Luckmann, T. (1980). *Die gesellschaftliche Konstruktion der Wirklichkeit*. Fischer paperback.

Berger, P. L., & Luckmann, T. (1991). *The social construction of reality: A treatise in the sociology of knowledge*. Penguin Books.

Bischof, J. M., & Airoldi, E. M. (2012). Summarizing topical content with word frequency and exclusivity. *Proceedings of the 29th International Coference on International Conference on Machine Learning*, 9–16.

Blackwell, A. F. (2015). HCI as an Inter-Discipline. *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*, 503–516. https://doi.org/10.1145/2702613.2732505

Blei, D. M., & Lafferty, J. D. (2007). A correlated topic model of Science. *The Annals of Applied Statistics*, *1*(1), 17–35. https://doi.org/10.1214/07-AOAS114

Blei, D. M., & Lafferty, J. D. (2009). Topic Models. In A. N. Srivastava & M. Sahami (Eds.), *Text Mining: Classification, Clustering and Applications* (pp. 71–94). Chapman and Hall/CRC. https://doi.org/10.1201/9781420059458-12

Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent dirichlet allocation. *The Journal of Machine Learning Research*, *3*, 993–1022.

Bloch, C., Graversen, E. K., & Pedersen, H. S. (2014). Competitive Research Grants and Their Impact on Career Performance. *Minerva*, *52*(1), 77–96.

Borgatti, S. P., & Everett, M. G. (2000). Models of core/periphery structures. *Social Networks*, *21*(4), 375–395. https://doi.org/10.1016/S0378-8733(99)00019-2

Börjesson, P., Barendregt, W., Eriksson, E., & Torgersson, O. (2015). Designing technology for and with developmentally diverse children: A systematic literature review. *Proceedings of the 14th International Conference on Interaction Design and Children*, 79–88. https://doi.org/10.1145/2771839.2771848

Bornmann, L., & Daniel, H. (2008). What do citation counts measure? A review of studies on citing behavior. *Journal of Documentation*, *64*(1), 45–80. https://doi.org/10.1108/00220410810844150

Boucenna, S., Narzisi, A., Tilmont, E., Muratori, F., Pioggia, G., Cohen, D., & Chetouani, M. (2014). Interactive Technologies for Autistic Children: A Review. *Cognitive Computation*, *6*(4), 722–740. https://doi.org/10.1007/s12559-014-9276-x

Boudreau, K. J., Guinan, E. C., Lakhani, K. R., & Riedl, C. (2016). Looking Across and Looking Beyond the Knowledge Frontier: Intellectual Distance, Novelty, and Resource Allocation in Science. *Management Science*, *62*(10), 2765–2783.

Bourdieu, P. (1975). The specificity of the scientific field and the social conditions of the progress of reason. *Social Science Information*, *14*(6), 19–47. https://doi.org/10.1177/053901847501400602

Bourdieu, P. (1984). *Distinction: A Social Critique of the Judgement of Taste* (R. Nice, Trans.). Harvard University Press. http://ebookcentral.proquest.com/lib/oxford/detail.action?docID=1433990

Bourdieu, P. (1990). *The Logic of Practice* (R. Nice, Trans.). Stanford University Press.

Bourdieu, P. (2004). *Science of Science and Reflexivity* (R. Nice, Trans.). University of Chicago Press. https://press.uchicago.edu/ucp/books/book/chicago/S/bo3630402.html

Boyatzis, R. E. (1998). *Transforming Qualitative Information: Thematic Analysis and Code Development*. SAGE Publications, Inc.

Boyd-Graber, J., Mimno, D., & Newman, D. (2014). Care and Feeding of Topic Models: Problems, Diagnostics, and Improvements. In E. M. Airoldi, D. Blei, E. A. Erosheva, & S. E. Fienberg (Eds.), *Handbook of Mixed Membership Models and Their Applications* (pp. 3–41). CRC Press.

Brannen, J. (2005). Mixing Methods: The Entry of Qualitative and Quantitative Approaches into the Research Process. *International Journal of Social Research Methodology*, *8*(3), 173–184. https://doi.org/10.1080/13645570500154642

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2014). What can “thematic analysis” offer health and wellbeing researchers? *International Journal of Qualitative Studies on Health and Well-Being*, *9*, 10.3402/qhw.v9.26152. https://doi.org/10.3402/qhw.v9.26152

Bridges, J., Gray, W., Box, G., & Machin, S. (2008). Discovery Interviews: A mechanism for user involvement. *International Journal of Older People Nursing*, *3*(3), 206–210. https://doi.org/10.1111/j.1748-3743.2008.00128.x

Brooke, A., Anderson, M., Perrin, A., & Turner, E. (2020). *Parenting Children in the Age of Screens*. Pew Research Center. https://www.pewresearch.org/internet/2020/07/28/parenting-children-in-the-age-of-screens/

Brozen, Y. (1951). Invention, Innovation, and Imitation. *The American Economic Review*, *41*(2), 239–257.

Bruce, P., Bruce, A., & Gedeck, P. (2020). *Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python* (2nd Edition). O’Reilly Media.

Bryman, A. (2006). Integrating quantitative and qualitative research: How is it done? *Qualitative Research*, *6*(1), 97–113. https://doi.org/10.1177/1468794106058877

Bryman, A. (2012). *Social Research Methods*. Oxford University Press.

Buck, A. M., & Ralston, D. F. (2021). I didn't sign up for your research study: The ethics of using "public" data. *Computers and Composition*, *61*, 102655. https://doi.org/10.1016/j.compcom.2021.102655

Burton, L. J., & Bruening, J. E. (2003). Technology and Method Intersect in the Online Focus Group. *Quest*, *55*(4), 315–327. https://doi.org/10.1080/00336297.2003.10491807

Campello, R. J. G. B., Moulavi, D., Zimek, A., & Sander, J. (2015). Hierarchical Density Estimates for Data Clustering, Visualization, and Outlier Detection. *ACM Transactions on Knowledge Discovery from Data*, *10*(1), 5:1-5:51. https://doi.org/10.1145/2733381

Cao, J., Xia, T., Li, J., Zhang, Y., & Tang, S. (2009). A density-based method for adaptive LDA model selection. *Neurocomputing*, *72*(7), 1775–1781. https://doi.org/10.1016/j.neucom.2008.06.011

Card, S. K., Moran, T. P., & Newell, A. (1983). *The Psychology of Human-Computer Interaction*. Lawrence Erlbaum Associates. https://doi.org/10.1201/9780203736166

Carey, M. A., & Asbury, J.-E. (2016). *Focus Group Research*. Routledge. https://doi.org/10.4324/9781315428376

Cattani, G., Deichmann, D., & Ferriani, S. (2022). Novelty: Searching for, Seeing, and Sustaining it. In G. Cattani, D. Deichmann, & S. Ferriani (Eds.), *The Generation, Recognition and Legitimation of Novelty* (Vol. 77, pp. 3–23). Emerald Publishing Limited. https://doi.org/10.1108/S0733-558X20220000077002

Cattani, G., & Ferriani, S. (2008). A Core/Periphery Perspective on Individual Creative Performance: Social Networks and Cinematic Achievements in the Hollywood Film Industry. *Organization Science*, *19*(6), 824–844. https://doi.org/10.1287/orsc.1070.0350

Cattani, G., Ferriani, S., & Colucci, M. (2015). Creativity in Social Networks: A Core-Periphery Perspective. In C. Jones, M. Lorenzen, & J. Sapsed (Eds.), *The Oxford Handbook of Creative Industries* (pp. 75–95). Oxford University Press. http://dx.doi.org/10.1093/oxfordhb/9780199603510.013.008

Cattani, G., Ferriani, S., & Lanza, A. (2017). Deconstructing the Outsider Puzzle: The Legitimation Journey of Novelty. *Organization Science*, *28*(6), 965–992. https://doi.org/10.1287/orsc.2017.1161

CESSDA Training Team. (2020). *CESSDA Data Management Expert Guide*. CESSDA ERIC. https://doi.org/10.5281/zenodo.3820473

Chandrasekaran, R., & Tamir, A. (1989). Open questions concerning Weiszfeld's algorithm for the Fermat-Weber location problem. *Mathematical Programming*, *44*(1), 293–295. https://doi.org/10.1007/BF01587094

Chang, J., Boyd-Graber, J., Gerrish, S., Wang, C., & Blei, D. M. (2009). Reading tea leaves: How humans interpret topic models. *Proceedings of the 22nd International Conference on Neural Information Processing Systems*, 288–296.

Charlesworth, A., & Tonkin, E. L. (2016). If You Find Yourself in a Hole, Stop Digging: Legal and Ethical Issues of Text/Data Mining in Research. In E. L. Tonkin & G. J. L. Tourte (Eds.), *Working with Text: Tools, Techniques and Approaches for Text Mining* (pp. 61–88). Chandos Publishing. https://doi.org/10.1016/B978-1-84334-749-1.00003-2

Chen, X., Zou, D., Cheng, G., & Xie, H. (2020). Detecting latent topics and trends in educational technologies over four decades using structural topic modeling: A retrospective of all volumes of Computers & Education. *Computers & Education*, *151*, 103855. https://doi.org/10.1016/j.compedu.2020.103855

Christ, T. W. (2007). A Recursive Approach to Mixed Methods Research in a Longitudinal Study of Postsecondary Education Disability Support Services. *Journal of Mixed Methods Research*, *1*(3), 226–241. https://doi.org/10.1177/1558689807301101

Clarke, V., & Braun, V. (2017). Thematic analysis. *The Journal of Positive Psychology*, *12*(3), 297–298. https://doi.org/10.1080/17439760.2016.1262613

Collins, K. M. T., Onwuegbuzie, A. J., & Sutton, I. L. (2006). A model incorporating the rationale and purpose for conducting mixed methods research in special education and beyond. *Learning Disabilities: A Contemporary Journal*, *4*, 67–100.

Collins, R. (1998). *The Sociology of Philosophies: A Global Theory of Intellectual Change*. Harvard University Press.

Colusso, L., Bennett, C. L., Hsieh, G., & Munson, S. A. (2017). Translational Resources: Reducing the Gap Between Academic Research and HCI Practice. *Proceedings of the 2017 Conference on Designing Interactive Systems*, 957–968. https://doi.org/10.1145/3064663.3064667

Constantin, A., Andries, V., Korte, J., Alexandru, C. A., Good, J., Sim, G., Read, J., Fails, J. A., & Eriksson, E. (2022). Ethical Considerations of Distributed Participatory Design with Children. *Interaction Design and Children*, 700–702. https://doi.org/10.1145/3501712.3536386

Cooper, A. K., & Coetzee, S. (2020). On the Ethics of Using Publicly-Available Data. In M. Hattingh, M. Matthee, H. Smuts, I. Pappas, Y. K. Dwivedi, & M. Mäntymäki (Eds.), *Responsible Design, Implementation and Use of Information and Communication Technology* (Vol. 12067, pp. 159–171). Springer International Publishing. https://doi.org/10.1007/978-3-030-45002-1_14

Copestake, J., Davies, G., & Remnant, F. (2019). Generating credible evidence of social impact using the Qualitative Impact Protocol (QuIP): The challenge of positionality in data coding and analysis. In B. Clift, J. Gore, S. Bekker, I. Costas Batlle, K. Chudzikowski, & J. Hatchard (Eds.), *Myths, Methods, and Messiness: Insights for Qualitative Research: Analysis Proceedings of 5th Annual Qualitative Research Symposium* (pp. 17–29). University of Bath. https://purehost.bath.ac.uk/ws/portalfiles/portal/212863959/2019_MythsMethods_Messiness.pdf

Corbin, J., & Strauss, A. (2014). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* (4th ed.). SAGE Publications, Inc.

Crabtree, B. F., & Miller, W. L. (Eds.). (1999). *Doing Qualitative Research* (2nd ed.). SAGE Publications, Inc.

Crane, D. (1976). Reward Systems in Art, Science, and Religion. *American Behavioral Scientist*, *19*(6), 719–734. https://doi.org/10.1177/000276427601900604

Creswell, J. W. (2005). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (2nd ed.). Merill Prentice Hall.

Creswell, J. W. (2009). Editorial: Mapping the Field of Mixed Methods Research. *Journal of Mixed Methods Research*, *3*(2), 95–108. https://doi.org/10.1177/1558689808330883

Creswell, J. W. (2013). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). SAGE Publications, Inc.

Creswell, J. W. (2015). *A Concise Introduction to Mixed Methods Research*. SAGE Publications, Inc.

Creswell, J. W., & Plano Clark, V. L. (2007). Choosing a Mixed Methods Design. In *Designing and conducting mixed methods research* (pp. 58–88). SAGE Publications.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and Conducting Mixed Methods Research* (2nd ed.). SAGE Publications, Inc.

Creswell, J. W., Plano Clark, V. L., Gutmann, M. L., & Hanson, W. E. (2003). Advanced Mixed Methods Research Designs. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of Mixed Methods in Social & Behavioral Research* (pp. 209–240). SAGE.

Creswell, J. W., & Tashakkori, A. (2007). Editorial: Differing Perspectives on Mixed Methods Research. *Journal of Mixed Methods Research*, *1*(4), 303–308. https://doi.org/10.1177/1558689807306132

Cronenberg, S. (2020). Paradigm Parley: A Framework for the Dialectic Stance. *Journal of Mixed Methods Research*, *14*(1), 26–46. https://doi.org/10.1177/1558689818777925

Cypress, B. S. (2017). Rigor or Reliability and Validity in Qualitative Research: Perspectives, Strategies, Reconceptualization, and Recommendations. *Dimensions of Critical Care Nursing*, *36*(4), 253–263. https://doi.org/10.1097/DCC.0000000000000253

Daenekindt, S., & Huisman, J. (2020). Mapping the scattered field of research on higher education. A correlated topic model of 17,000 articles, 1991–2018. *Higher Education*, *80*(3), 571–587. https://doi.org/10.1007/s10734-020-00500-x

Dahlin, K. B., & Behrens, D. M. (2005). When is an invention really radical?: Defining and measuring technological radicalness. *Research Policy*, *34*(5), 717–737. https://doi.org/10.1016/j.respol.2005.03.009

Daly, J., Kellehear, A., & Gliksman, M. (1997). *The Public Health Researcher: A Methodological Guide*. Oxford University Press.

Daniels, N., Gillen, P., Casson, K., & Wilson, I. (2019). STEER: Factors to Consider When Designing Online Focus Groups Using Audiovisual Technology in Health Research. *International Journal of Qualitative Methods*, *18*, 1609406919885786. https://doi.org/10.1177/1609406919885786

David, S. L., Hitchcock, J. H., Ragan, B., Brooks, G., & Starkey, C. (2018). Mixing Interviews and Rasch Modeling: Demonstrating a Procedure Used to Develop an Instrument That Measures Trust. *Journal of Mixed Methods Research*, *12*(1), 75–94. https://doi.org/10.1177/1558689815624586

Davies, D., & Dodd, J. (2002). Qualitative Research and the Question of Rigor. *Qualitative Health Research*, *12*(2), 279–289. https://doi.org/10.1177/104973230201200211

Dawadi, S., Shrestha, S., & Giri, R. A. (2021). Mixed-Methods Research: A Discussion on its Types, Challenges, and Criticisms. *Journal of Practical Studies in Education*, *2*(2), Article 2. https://doi.org/10.46809/jpse.v2i2.20

Dawe, J., Sutherland, C., Barco, A., & Broadbent, E. (2019). Can social robots help children in healthcare contexts? A scoping review. *BMJ Paediatrics Open*, *3*(1), e000371. https://doi.org/10.1136/bmjpo-2018-000371

Day, N. E. (2011). The Silent Majority: Manuscript Rejection and Its Impact on Scholars. *Academy of Management Learning & Education*, *10*(4), 704–718.

Deakin, H., & Wakefield, K. (2014). Skype interviewing: Reflections of two PhD researchers. *Qualitative Research*, *14*(5), 603–616. https://doi.org/10.1177/1468794113488126

Deerwester, S., Dumais, S. T., Furnas, G. W., Landauer, T. K., & Harshman, R. (1990). Indexing by latent semantic analysis. *Journal of the American Society for Information Science*, *41*(6), 391–407. https://doi.org/10.1002/(SICI)1097-4571(199009)41:6<391::AID-ASI1>3.0.CO;2-9

Dellinger, A. B., & Leech, N. L. (2007). Toward a Unified Validation Framework in Mixed Methods Research. *Journal of Mixed Methods Research*, *1*(4), 309–332. https://doi.org/10.1177/1558689807306147

Denny, M. J., & Spirling, A. (2018). Text Preprocessing For Unsupervised Learning: Why It Matters, When It Misleads, And What To Do About It. *Political Analysis*, *26*(2), 168–189. https://doi.org/10.1017/pan.2017.44

Denscombe, M. (2008). Communities of Practice: A Research Paradigm for the Mixed Methods Approach. *Journal of Mixed Methods Research*, *2*(3), 270–283. https://doi.org/10.1177/1558689808316807

DeSantis, L., & Ugarriza, D. N. (2000). The Concept of Theme as Used in Qualitative Nursing Research. *Western Journal of Nursing Research*, *22*(3), 351–372. https://doi.org/10.1177/019394590002200308

Deveaud, R., SanJuan, E., & Bellot, P. (2014). Accurate and effective latent concept modeling for ad hoc information retrieval. *Document Numerique*, *17*(1), 61–84.

DiMaggio, P., Nag, M., & Blei, D. (2013). Exploiting affinities between topic modeling and the sociological perspective on culture: Application to newspaper coverage of U.S. government arts funding. *Poetics*, *41*(6), 570–606. https://doi.org/10.1016/j.poetic.2013.08.004

Döringer, S. (2021). 'The problem-centred expert interview'. Combining qualitative interviewing approaches for investigating implicit expert knowledge. *International Journal of Social Research Methodology*, *24*(3), 265–278. https://doi.org/10.1080/13645579.2020.1766777

Druin, A. (1996). CHIkids: A common ground for kids and adults. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 506–507. https://doi.org/10.1145/238386.248153

Druin, A. (1999). Cooperative inquiry: Developing new technologies for children with children. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 592–599. https://doi.org/10.1145/302979.303166

Druin, A., & Solomon, C. (1996). *Designing multimedia environments for children: Computers, creativity, and kids*. John Wiley & Sons, Inc.

Eagle, C. C. (2021). Teams.<www.microsoft.com/en-us/microsoft-teams/free>. *The French Review*, *94*(4), 262. https://doi.org/10.1353/tfr.2021.0164

Eberle, T. S. (1993). Social Psychology and the Sociology of Knowledge. *International Journal of Social Psychology*, *8*(1), 5–13. https://doi.org/10.1080/02134748.1993.10821666

Edwards, R., & Holland, J. (2013). *What is Qualitative Interviewing?* Bloomsbury.

Elsevier. (2019). *Text and data mining policy*. Elsevier. https://www.elsevier.com/about/policies/text-and-data-mining

Elsevier. (2020). *Content Policy and Selection*. Elsevier. https://www.elsevier.com/solutions/scopus/how-scopus-works/content/content-policy-and-selection

Engelhardt, A. (2015). The sociology of knowledge approach of discourse analysis in innovation research: Evaluation of innovations in contemporary fine art. *Historical Social Research*, *40*(3), 130–160. https://doi.org/10.12759/hsr.40.2015.3.130-160

Eriksson, E., Baykal, G. E., & Torgersson, O. (2022). The Role of Learning Theory in Child-Computer Interaction—A Semi-Systematic Literature Review. *Interaction Design and Children*, 50–68. https://doi.org/10.1145/3501712.3529728

ESRC. (2010). *Framework for Research Ethics*. Economic and Social Research Council. https://www.gla.ac.uk/media/Media_326706_smxx.pdf

General Data Protection Regulation, 2016/679 OJ L 119 1 (2016). http://data.europa.eu/eli/reg/2016/679/2016-05-04/eng

Falter, M., Arenas, A. A., Maples, G. W., Smith, C. T., Lamb, L. J., Anderson, M. G., Uzzell, E. M., Jacobs, L. E., Cason, X. L., Griffis, T. A. N., Polzin, M., & Wafa, N. Z. (2022). Making Room for Zoom in Focus Group Methods: Opportunities and Challenges for Novice Researchers (During and Beyond COVID-19). *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *23*(1), Article 1. https://doi.org/10.17169/fqs-23.1.3768

Fanelli, D. (2010). Do pressures to publish increase scientists' bias? An empirical support from US States Data. *PloS One*, *5*(4), e10271. https://doi.org/10.1371/journal.pone.0010271

Faruqui, M., Tsvetkov, Y., Rastogi, P., & Dyer, C. (2016). Problems With Evaluation of Word Embeddings Using Word Similarity Tasks. *Proceedings of the 1st Workshop on Evaluating Vector-Space Representations for NLP*, 30–35. https://doi.org/10.18653/v1/W16-2506

Feilzer, M. Y. (2010). Doing Mixed Methods Research Pragmatically: Implications for the Rediscovery of Pragmatism as a Research Paradigm. *Journal of Mixed Methods Research*, *4*(1), 6–16. https://doi.org/10.1177/1558689809349691

Felt, U., Igelsböck, J., Schikowitz, A., & Völker, T. (2016). Transdisciplinary Sustainability Research in Practice: Between Imaginaries of Collective Experimentation and Entrenched Academic Value Orders. *Science, Technology, & Human Values*, *41*(4), 732–761. https://doi.org/10.1177/0162243915626989

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods*, *5*(1), 80–92. https://doi.org/10.1177/160940690600500107

Ferguson, J.-P., & Hasan, S. (2013). Specialization and Career Dynamics: Evidence from the Indian Administrative Service. *Administrative Science Quarterly*, *58*(2), 233–256. https://doi.org/10.1177/0001839213486759

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving Integration in Mixed Methods Designs—Principles and Practices. *Health Services Research*, *48*(6 Pt 2), 2134–2156. https://doi.org/10.1111/1475-6773.12117

Fleiss, J. L., Levin, B., & Paik, M. C. (2003). *Frontmatter* (3rd ed.). John Wiley & Sons, Ltd. https://doi.org/10.1002/0471445428.fmatter

Fleming, L. (2001). Recombinant Uncertainty in Technological Search. *Management Science*, *47*(1), 117–132.

Flick, U. (2018). Doing Qualitative Data Collection – Charting the Routes. In U. Flick (Ed.), *The SAGE handbook of qualitative data collection* (pp. 3–16). SAGE Publications, Inc. https://dx.doi.org/10.4135/9781526416070.n1

Flynn, R. M., Kleinknecht, E., Ricker, A. A., & Blumberg, F. C. (2021). A narrative review of methods used to examine digital gaming impacts on learning and cognition during middle childhood. *International Journal of Child-Computer Interaction*, *30*, 100325. https://doi.org/10.1016/j.ijcci.2021.100325

Forrestal, S. G., D'Angelo, A. V., & Vogel, L. K. (2015). Considerations for and Lessons Learned from Online, Synchronous Focus Groups. *Survey Practice*, *8*(3), 2844. https://doi.org/10.29115/SP-2015-0015

Foster, J. G., Rzhetsky, A., & Evans, J. A. (2015). Tradition and Innovation in Scientists' Research Strategies. *American Sociological Review*, *80*(5), 875–908. https://doi.org/10.1177/0003122415601618

Foucault, M. (1972). *The Archaeology of Knowledge* (A. Sheridan, Trans.). Pantheon Books.

Foucault, M. (1977). History of Systems of Thought. In D. F. Bouchard (Ed.), & D. F. Bouchard & S. Simon (Trans.), *Language, Counter-Memory, Practice: Selected Essays and nterviews* (pp. 199–204). Cornell University Press.

Foucault, M. (1980). *Power/Knowledge: Selected Interviews and Other Writings 1972-1977* (C. Gordon, Ed.). Pantheon Books.

Foucault, M. (Ed.). (1982). *I, Pierre Rivière, having slaughtered my mother, my sister, my brother…: A Case of Parricide in the 19th century*. University of Nebraska Press.

Foucault, M. (1984). Polemics, politics and problematizations: An Interview with Michel Foucault. In P. Rabinow (Ed.), *The Foucault Reader* (pp. 381–390). Pantheon Books. https://monoskop.org/images/f/f6/Rabinow_Paul_ed_The_Foucault_Reader_1984.pdf

Fox, F. (2017). Meeting in Virtual Spaces: Conducting Online Focus Groups. In D. Gray, V. Clarke, & V. Braun (Eds.), *Collecting Qualitative Data: A Practical Guide to Textual, Media and Virtual Techniques* (pp. 256–274). Cambridge University Press. https://doi.org/10.1017/9781107295094.014

Franzke, A. S., Bechmann, A., Zimmer, M., Ess, C., & the Association of Internet Researchers. (2020). *Internet Research: Ethical Guidelines 3.0*. Association of Internet Researchers. https://aoir.org/reports/ethics3.pdf

Frauenberger, C. (2016). Critical Realist HCI. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 341–351. https://doi.org/10.1145/2851581.2892569

Friedman, K. (2003). Theory construction in design research: Criteria: approaches, and methods. *Design Studies*, *24*(6), 507–522. https://doi.org/10.1016/S0142-694X(03)00039-5

Fuchs, C. (2003). Some Implications of Pierre Bourdieu's Works for a Theory of Social SelfOrganization. *European Journal of Social Theory*, *6*(4), 387–408. https://doi.org/10.1177/13684310030064002

Gale, N. K., Heath, G., Cameron, E., Rashid, S., & Redwood, S. (2013). Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *BMC Medical Research Methodology*, *13*(1), 117. https://doi.org/10.1186/1471-2288-13-117

Galke, L., Saleh, A., & Scherp, A. (2017). Word Embeddings for Practical Information Retrieval. In M. Eibl & M. Gaedke (Eds.), *INFORMATIK 2017* (pp. 2155–2167). Gesellschaft für Informatik. https://doi.org/10.18420/in2017_215

Garfinkel, H. (1967). *Studies in ethnomethodology*. Prentice-Hall.

Gaver, W. (2012). What should we expect from research through design? *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 937–946. https://doi.org/10.1145/2207676.2208538

Giannakos, M., Horn, M. S., Read, J. C., & Markopoulos, P. (2020). Movement forward: The continued growth of Child–Computer Interaction research. *International Journal of Child-Computer Interaction*, *26*, 100204. https://doi.org/10.1016/j.ijcci.2020.100204

Giannakos, M., Horn, M. S., & Rubegni, E. (2020). Advancements on Child–Computer Interaction research: Contributions from IDC 2018. *International Journal of Child-Computer Interaction*, *23–24*, 100170. https://doi.org/10.1016/j.ijcci.2020.100170

Giannakos, M., Markopoulos, P., Hourcade, J. P., & Antle, A. N. (2022). 'Lots done, more to do': The current state of interaction design and children research and future directions. *International Journal of Child-Computer Interaction*, *33*, 100469. https://doi.org/10.1016/j.ijcci.2022.100469

Giannakos, M., Papamitsiou, Z., Markopoulos, P., Read, J., & Hourcade, J. P. (2020). Mapping child–computer interaction research through co-word analysis. *International Journal of Child-Computer Interaction*, *23–24*, 100165. https://doi.org/10.1016/j.ijcci.2020.100165

Giddens, A. (1984). *The Constitution of Society: Outline of the Theory of Structuration*. Polity Press.

Gide, A. (1973). *The Counterfeiters* (D. Bussy, Trans.). Vintage Books/A Division of Random House, Inc.

Gieryn, T. F., & Hirsh, R. F. (1983). Marginality and Innovation in Science. *Social Studies of Science*, *13*(1), 87–106.

Gill, A. J., Hinrichs-Krapels, S., Blanke, T., Grant, J., Hedges, M., & Tanner, S. (2017). Insight workflow: Systematically combining human and computational methods to explore textual data. *Journal of the Association for Information Science and Technology*, *68*(7), 1671–1686. https://doi.org/10.1002/asi.23767

Gómez, J., & Vázquez, P.-P. (2022). An Empirical Evaluation of Document Embeddings and Similarity Metrics for Scientific Articles. *Applied Sciences*, *12*(11), Article 11. https://doi.org/10.3390/app12115664

Graff, J. C. (2014). Mixed Methods Research. In H. R. Hall & L. A. Roussel (Eds.), *Evidence-Based Practice: An Integrative Approach to Research, Administration, and Practice* (pp. 45–64). Jones and Bartlett Publishers.

Gray, D. E. (2018). *Doing Research in the Real World* (4th ed.). SAGE Publications, Inc.

Gray, L., Wong-Wylie, G., Rempel, G., & Cook, K. (2020). Expanding Qualitative Research Interviewing Strategies: Zoom Video Communications. *The Qualitative Report*, *25*(5), 1292–1301. https://doi.org/10.46743/2160-3715/2020.4212

Greene, D., O'Callaghan, D., & Cunningham, P. (2014). How Many Topics? Stability Analysis for Topic Models. In T. Calders, F. Esposito, E. Hüllermeier, & R. Meo (Eds.), *Machine Learning and Knowledge Discovery in Databases* (pp. 498–513). Springer. https://doi.org/10.1007/978-3-662-44848-9_32

Greene, J. C. (2006). Toward a Methodology of Mixed Methods Social Inquiry. *Research in the Schools*, *13*(1), 93–99.

Greene, J. C., & Caracelli, V. J. (1997). Defining and describing the paradigm issue in mixed-method evaluation. *New Directions for Evaluation*, *1997*(74), 5–17. https://doi.org/10.1002/ev.1068

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a Conceptual Framework for Mixed-Method Evaluation Designs. *Educational Evaluation and Policy Analysis*, *11*(3), 255–274. https://doi.org/10.3102/01623737011003255

Greenspan, S. B., Gordon, K. L., Whitcomb, S. A., & Lauterbach, A. A. (2021). Use of Video Conferencing to Facilitate Focus Groups for Qualitative Data Collection. *American Journal of Qualitative Research*, *5*(1), 85–93. https://doi.org/10.29333/ajqr/10813

Griffiths, T. L., & Steyvers, M. (2004). Finding scientific topics. *Proceedings of the National Academy of Sciences*, *101*(suppl 1), 5228–5235. https://doi.org/10.1073/pnas.0307752101

Griffiths, T. L., Steyvers, M., & Tenenbaum, J. B. (2007). Topics in semantic representation. *Psychological Review*, *114*(2), 211–244. https://doi.org/10.1037/0033-295X.114.2.211

Grimmer, J. (2010). A Bayesian Hierarchical Topic Model for Political Texts: Measuring Expressed Agendas in Senate Press Releases. *Political Analysis*, *18*(1), 1–35. https://doi.org/10.1093/pan/mpp034

Grimmer, J., & Stewart, B. M. (2013). Text as Data: The Promise and Pitfalls of Automatic Content Analysis Methods for Political Texts. *Political Analysis*, *21*(3), 267–297. https://doi.org/10.1093/pan/mps028

Groundwater-Smith, S., Dockett, S., & Bottrell, D. (2015). *Participatory Research with Children and Young People*. SAGE Publications Ltd. https://dx.doi.org/10.4135/9781473910751

Grün, B., & Hornik, K. (2011). topicmodels: An R Package for Fitting Topic Models. *Journal of Statistical Software*, *40*, 1–30. https://doi.org/10.18637/jss.v040.i13

Guba, E. G., & Lincoln, Y. S. (1982). Epistemological and Methodological Bases of Naturalistic Inquiry. *Educational Communication and Technology*, *30*(4), 233–252.

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth Generation Evaluation*. SAGE Publications, Inc.

Guest, G. (2013). Describing Mixed Methods Research: An Alternative to Typologies. *Journal of Mixed Methods Research*, *7*(2), 141–151. https://doi.org/10.1177/1558689812461179

Guest, G., Bunce, A., & Johnson, L. (2006). How Many Interviews Are Enough?: An Experiment with Data Saturation and Variability. *Field Methods*, *18*(1), 59–82. https://doi.org/10.1177/1525822X05279903

Guetzkow, J., Lamont, M., & Mallard, G. (2004). What is Originality in the Humanities and the Social Sciences? *American Sociological Review*, *69*(2), 190–212. https://doi.org/10.1177/000312240406900203

Gurcan, F., Cagiltay, N. E., & Cagiltay, K. (2021). Mapping Human–Computer Interaction Research Themes and Trends from Its Existence to Today: A Topic Modeling-Based Review of past 60

Years. *International Journal of Human–Computer Interaction*, *37*(3), 267–280. https://doi.org/10.1080/10447318.2020.1819668

Gurcan, F., Ozyurt, O., & Cagitay, N. E. (2021). Investigation of Emerging Trends in the E-Learning Field Using Latent Dirichlet Allocation. *The International Review of Research in Open and Distributed Learning*, *22*(2), 1–18. https://doi.org/10.19173/irrodl.v22i2.5358

Hahsler, M., Piekenbrock, M., & Doran, D. (2019). dbscan: Fast Density-Based Clustering with R. *Journal of Statistical Software*, *91*, 1–30. https://doi.org/10.18637/jss.v091.i01

Hainey, T., Connolly, T. M., Boyle, E. A., Wilson, A., & Razak, A. (2016). A systematic literature review of games-based learning empirical evidence in primary education. *Computers & Education*, *102*, 202–223. https://doi.org/10.1016/j.compedu.2016.09.001

Halcomb, E. J., & Andrew, S. (2009). Practical considerations for higher degree research students undertaking mixed methods projects. *International Journal of Multiple Research Approaches*, *3*(2), 153–162. https://doi.org/10.5172/mra.3.2.153

Halcomb, E. J., Gholizadeh, L., DiGiacomo, M., Phillips, J., & Davidson, P. M. (2007). Literature review: Considerations in undertaking focus group research with culturally and linguistically diverse groups. *Journal of Clinical Nursing*, *16*(6), 1000–1011. https://doi.org/10.1111/j.1365-2702.2006.01760.x

Halcomb, E. J., & Hickman, L. (2015). Mixed methods research. *Nursing Standard*, *29*(32), 41–47. https://doi.org/10.7748/ns.29.32.41.e8858

Halliday, M., Mill, D., Johnson, J., & Lee, K. (2021). Let's talk virtual! Online focus group facilitation for the modern researcher. *Research in Social and Administrative Pharmacy*, *17*(12), 2145–2150. https://doi.org/10.1016/j.sapharm.2021.02.003

Hamed, K. H. (2007). Improved finite-sample Hurst exponent estimates using rescaled range analysis. *Water Resources Research*, *43*(4). https://doi.org/10.1029/2006WR005111

Hammersley, M. (1996). *The relationship between qualitative and quantitative research: Paradigm loyalty versus methodological eclecticism* (J. T. E. Richardson, Ed.; pp. 159–174). BPS Blackwell. http://eu.wiley.com/WileyCDA/WileyTitle/productCd-185433204X,descCd-tableOfContents.html

Harding, T., & Whitehead, D. (2013). Analysing data in qualitative research. In Z. Schneider & D. Whitehead (Eds.), *Nursing & Midwifery Research: Methods and Appraisal for Evidence-Based Practice* (4th Edition, pp. 141–160). Elsevier Mosby.

Hausser, J., & Strimmer, K. (2021). *entropy: Estimation of Entropy, Mutual Information and Related Quantities* (R package version 1.3.0). Comprehensive R Archive Network (CRAN). https://CRAN.R-project.org/package=entropy

Hecking, T., & Leydesdorff, L. (2018). Topic Modelling of Empirical Text Corpora: Validity, Reliability, and Reproducibility in Comparison to Semantic Maps. *ArXiv:1806.01045 [Cs]*. http://arxiv.org/abs/1806.01045

Heiberger, R. H., Munoz-Najar Galvez, S., & McFarland, D. A. (2021). Facets of Specialization and Its Relation to Career Success: An Analysis of U.S. Sociology, 1980 to 2015. *American Sociological Review*, *86*(6), 1164–1192. https://doi.org/10.1177/00031224211056267

Hennink, M. M., Kaiser, B. N., & Marconi, V. C. (2017). Code Saturation Versus Meaning Saturation: How Many Interviews Are Enough? *Qualitative Health Research*, *27*(4), 591–608. https://doi.org/10.1177/1049732316665344

Hirsch, R. M., & Slack, J. R. (1984). A Nonparametric Trend Test for Seasonal Data With Serial Dependence. *Water Resources Research*, *20*(6), 727–732. https://doi.org/10.1029/WR020i006p00727

Hirschman, A. O. (1964). The Paternity of an Index. *The American Economic Review*, *54*(5), 761–762.

Hisdal, H., Stahl, K., Tallaksen, L. M., & Demuth, S. (2001). Have streamflow droughts in Europe become more severe or frequent? *International Journal of Climatology*, *21*(3), 317–333. https://doi.org/10.1002/joc.619

Hitzler, R., Reichertz, J., & Schröer, N. (1999). Das Arbeitsfeld einer hermeneutischen Wissenssoziologie. In R. Hitzler, J. Reichertz, & N. Schröer (Eds.), *Hermeneutische Wissenssoziologie: Standpunkte zur Theorie der Interpretation* (pp. 9–13). UVK Univ.-Verl. Konstanz.

Hoffman, D. L., Novak, T. P., & Stein, R. (2012). The Digital Consumer. In R. Llamas & R. Belk (Eds.), *The Routledge Companion to Digital Consumption* (pp. 28–38). Routledge.

Hofmann, T. (1999). Probabilistic latent semantic indexing. *Proceedings of the 22nd Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, 50–57. https://doi.org/10.1145/312624.312649

Hofstra, B., Kulkarni, V. V., Munoz-Najar Galvez, S., He, B., Jurafsky, D., & McFarland, D. A. (2020). The Diversity–Innovation Paradox in Science. *Proceedings of the National Academy of Sciences*, *117*(17), 9284–9291. https://doi.org/10.1073/pnas.1915378117

Holloway, I., & Todres, L. (2003). The Status of Method: Flexibility, Consistency and Coherence. *Qualitative Research*, *3*(3), 345–357. https://doi.org/10.1177/1468794103033004

Holloway, I., & Wheeler, S. (2013). *Qualitative Research in Nursing and Healthcare*. John Wiley & Sons, Ltd.

Hong, Q. N., Pluye, P., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., Gagon, M.-P., Griffiths, F., Nicolau, B., O'Cathain, A., Rousseau, M.-C., & Vedel, I. (2018). *Mixed Methods*

Appraisal Tool (MMAT), version 2018 (Canadian Intellectual Property Office Patent No. 1148552). https://www.nccmt.ca/knowledge-repositories/search/232%20(accessed%20May%202017)

Hoofnagle, C. J., van der Sloot, B., & Borgesius, F. Z. (2019). The European Union general data protection regulation: What it is and what it means. *Information & Communications Technology Law*, *28*(1), 65–98. https://doi.org/10.1080/13600834.2019.1573501

Höök, K., Bardzell, J., Bowen, S., Dalsgaard, P., Reeves, S., & Waern, A. (2015). Framing IxD knowledge. *Interactions*, *22*(6), 32–36. https://doi.org/10.1145/2824892

Höök, K., Dalsgaard, P., Reeves, S., Bardzell, J., Löwgren, J., Stolterman, E., & Rogers, Y. (2015). Knowledge Production in Interaction Design. *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*, 2429–2432. https://doi.org/10.1145/2702613.2702653

Höök, K., & Löwgren, J. (2012). Strong concepts: Intermediate-level knowledge in interaction design research. *ACM Transactions on Computer-Human Interaction*, *19*(3), 23:1-23:18. https://doi.org/10.1145/2362364.2362371

Horrobin, D. F. (1990). The Philosophical Basis of Peer Review and the Suppression of Innovation. *JAMA*, *263*(10), 1438–1441. https://doi.org/10.1001/jama.1990.03440100162024

Hourcade, J. P. (2015). *Child-Computer Interaction* (First Edition). CreateSpace Independent Publishing Platform. http://homepage.divms.uiowa.edu/~hourcade/book/child-computer-interaction-first-edition.pdf

Howe, K. R. (1988). Against the Quantitative-Qualitative Incompatibility Thesis or Dogmas Die Hard. *Educational Researcher*, *17*(8), 10–16. https://doi.org/10.3102/0013189X017008010

Howe, K. R., & Moses, M. S. (1999). Chapter 2: Ethics in Educational Research. *Review of Research in Education*, *24*(1), 21–59. https://doi.org/10.3102/0091732X024001021

Hsin, C.-T., Li, M.-C., & Tsai, C.-C. (2014). The Influence of Young Children's Use of Technology on Their Learning: A Review. *Journal of Educational Technology & Society*, *17*(4), 85–99.

Iacopini, I., Milojević, S., & Latora, V. (2018). Network Dynamics of Innovation Processes. *Physical Review Letters*, *120*(4), 048301. https://doi.org/10.1103/PhysRevLett.120.048301

Iivari, N., Sharma, S., Ventä-Olkkonen, L., Molin-Juustila, T., Kuutti, K., Holappa, J., & Kinnunen, E. (2021). Critical agenda driving child–computer interaction research—Taking a stock of the past and envisioning the future. *International Journal of Child-Computer Interaction*, 100408. https://doi.org/10.1016/j.ijcci.2021.100408

Ilag, B. N. (2020). *Understanding Microsoft Teams Administration: Confugure, Customize, and Manage the Teams Experience*. Apress. https://doi.org/10.1007/978-1-4842-5875-0

Ivankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using Mixed-Methods Sequential Explanatory Design: From Theory to Practice. *Field Methods*, *18*(1), 3–20. https://doi.org/10.1177/1525822X05282260

Jäger, S. (2001). Discourse and knowledge: Theoretical and methodological aspects of a critical discourse and dispositive analysis. In R. Wodak & M. Meyer (Eds.), *Methods of critical discourse analysis* (pp. 32–62). SAGE Publications, Inc. https://dx.doi.org/10.4135/9780857028020

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An Introduction to Statistical Learning: With Applications in R*. Springer. https://doi.org/10.1007/978-1-4614-7138-7

Janghorban, R., Latifnejad Roudsari, R., & Taghipour, A. (2014). Skype interviewing: The new generation of online synchronous interview in qualitative research. *International Journal of Qualitative Studies on Health and Well-Being*, *9*, 24152. https://doi.org/10.3402/qhw.v9.24152

Jensen, J. J., & Skov, M. B. (2005). A review of research methods in children's technology design. *Proceedings of the 2005 Conference on Interaction Design and Children*, 80–87. https://doi.org/10.1145/1109540.1109551

Jeppesen, L. B., & Lakhani, K. R. (2010). Marginality and Problem-Solving Effectiveness in Broadcast Search. *Organization Science*, *21*(5), 1016–1033. https://doi.org/10.1287/orsc.1090.0491

Joffe, H. (2011). Thematic Analysis. In D. Harper & A. R. Thompson (Eds.), *Qualitative Research Methods in Mental Health and Psychotherapy* (pp. 209–223). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119973249.ch15

Johnson, R. B., & Christensen, L. B. (2017). *Educational Research: Quantitative, Qualitative, and Mixed Approaches* (6th ed.). SAGE Publications, Inc.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, *33*(7), 14–26. https://doi.org/10.3102/0013189X033007014

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research*, *1*(2), 112–133. https://doi.org/10.1177/1558689806298224

Jowett, A., Peel, E., & Shaw, R. (2011). Online Interviewing in Psychology: Reflections on the Process. *Qualitative Research in Psychology*, *8*(4), 354–369. https://doi.org/10.1080/14780887.2010.500352

Kafai, Y. B. (1998). Video game design by girls and boys: Variability and consistency of gender differences. In J. Cassell & H. Jenkins, *From Barbie to Mortal Kombat* (pp. 90–114). MIT Press.

Kantardzic, M. (2019). *Data Mining: Concepts, Models, Methods, and Algorithms* (3rd ed.). Wiley-IEEE Press. https://www.wiley.com/en-sg/Data+Mining%3A+Concepts%2C+Models%2C+Methods%2C+and+Algorithms%2C+3rd+Edition-p-9781119516040

Kawas, S., Yuan, Y., DeWitt, A., Jin, Q., Kirchner, S., Bilger, A., Grantham, E., Kientz, J. A., Tartaro, A., & Yarosh, S. (2020). Another decade of IDC research: Examining and reflecting on values and ethics. *Proceedings of the Interaction Design and Children Conference*, 205–215. https://doi.org/10.1145/3392063.3394436

Keller, R. (2001). Wissenssoziologische Diskursanalyse. In R. Keller, A. Hirseland, W. Schneider, & W. Viehöver (Eds.), *Handbuch Sozialwissenschaftliche Diskursanalyse: Band I: Theorien und Methoden* (3rd ed., pp. 113–143). VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-322-99906-1_5

Keller, R. (2005). Analysing Discourse. An Approach From the Sociology of Knowledge. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *6*(3), Article 3. https://doi.org/10.17169/fqs-6.3.19

Keller, R. (2006). Analysing Discourse. An Approach From the Sociology of Knowledge. *Historical Social Research*, *31*(2 (116)), 223–242. https://doi.org/10.12759/hsr.31.2006.2.223-242

Keller, R. (2011). The Sociology of Knowledge Approach to Discourse (SKAD). *Human Studies*, *34*(1), 43. https://doi.org/10.1007/s10746-011-9175-z

Keller, R. (2012). Entering Discourses: A New Agenda for Qualitative Research and Sociology of Knowledge. *Qualitative Sociology Review*, *8*(2), Article 2. https://doi.org/10.18778/1733-8077.8.2.04

Keller, R. (2013). *Doing discourse research: An introduction for social scientists* (B. Jenner, Trans.). SAGE Publications Ltd. https://dx.doi.org/10.4135/9781473957640

Keller, R. (2018). The sociology of knowledge approach to discourse: An introduction. In R. Keller, A.-K. Hornidge, & W. J. Schünemann (Eds.), *The Sociology of Knowledge Approach to Discourse* (Vol. 250, pp. 16–47). Routledge. https://www.taylorfrancis.com/books/oa-edit/10.4324/9781315170008/sociology-knowledge-approach-discourse-reiner-keller-anna-katharina-hornidge-wolf-sch%C3%BCnemann

Kendall, M. G. (1975). *Rank Correlation Methods* (4th Edition). Charles Griffin.

Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical Teacher*, *42*(8), 846–854. https://doi.org/10.1080/0142159X.2020.1755030

King, L. (2007). Charting a Discursive Field: Environmentalists for U.S. Population Stabilization*. *Sociological Inquiry*, *77*(3), 301–325. https://doi.org/10.1111/j.1475-682X.2007.00195.x

King, N. (2004). Using Templates in the Thematic Analysis of Text. In C. Cassell & G. Symon (Eds.), *Essential Guide to Qualitative Methods in Organizational Research* (pp. 256–270). SAGE Publications Ltd. https://doi.org/10.4135/9781446280119

King's College London & Digital Science. (2015). *The nature, scale and beneficiaries of research impact: An initial analysis of the Research Excellence Framework (REF) 2014 impact case studies*. Higher Education Funding Council for England. https://www.kcl.ac.uk/policy-institute/assets/ref-impact.pdf

Kite, J., & Phongsavan, P. (2017). Insights for conducting real-time focus groups online using a web conferencing service. *F1000Research*, *6*, 122. https://doi.org/10.12688/f1000research.10427.1

Kitzinger, J. (1995). Qualitative Research: Introducing focus groups. *BMJ*, *311*(7000), 299–302. https://doi.org/10.1136/bmj.311.7000.299

Kitzinger, J., & Barbour, R. S. (1999). Introduction: The Challenge and Promise of Focus Groups. In R. S. Barbour & J. Kitzinger (Eds.), *Developing Focus Group Research* (pp. 1–20). SAGE Publications Ltd. https://dx.%3Cwbr%3Edoi.%3Cwbr%3Eorg/10.4135/9781849208857.n1

Kolesnikov, S., Fukumoto, E., & Bozeman, B. (2018). Researchers' risk-smoothing publication strategies: Is productivity the enemy of impact? *Scientometrics*, *116*(3), 1995–2017. https://doi.org/10.1007/s11192-018-2793-8

Koltcov, S., Ignatenko, V., Boukhers, Z., & Staab, S. (2020). Analyzing the Influence of Hyper-parameters and Regularizers of Topic Modeling in Terms of Renyi Entropy. *Entropy*, *22*(4), Article 4. https://doi.org/10.3390/e22040394

Korte, J. (2020). Patterns and Themes in Designing with Children. *Foundations and Trends® in Human–Computer Interaction*, *13*(2), 70–164. https://doi.org/10.1561/1100000079

Kraemer, G., Reichstein, M., & Mahecha, M. D. (2018). dimRed and coRanking—Unifying Dimensionality Reduction in R. *The R Journal*, *10*(1), 342–358.

Krefting, L. (1991). Rigor in qualitative research: The assessment of trustworthiness. *The American Journal of Occupational Therapy: Official Publication of the American Occupational Therapy Association*, *45*(3), 214–222. https://doi.org/10.5014/ajot.45.3.214

Krippendorff, K. (2018). *Content Analysis: An Introduction to its Methodology* (4th ed.). SAGE Publications Ltd. https://us.sagepub.com/en-us/nam/content-analysis/book258450

Kroll-Smith, S., & Gunter, V. (2005). Governing Sleepiness: Somnolent Bodies, Discourse, and Liquid Modernity. *Sociological Inquiry*, *75*(3), 346–371. https://doi.org/10.1111/j.1475-682X.2005.00126.x

Krueger, R. A., & Casey, M. A. (2000). *Focus Groups: A Practical Guide for Applied Research* (3rd ed.). SAGE Publications, Inc.

Kuhn, H. W. (1973). A note on Fermat's problem. *Mathematical Programming*, *4*(1), 98–107. https://doi.org/10.1007/BF01584648

Kuhn, T. S. (1962). *The structure of scientific revolutions*. University of Chicago Press. http://archive.org/details/structureofscie00kuhn

Kuhn, T. S. (1970). *The Structure of Scientific Revolutions* (2nd ed., Vol. 2). University of Chicago Press.

Kuhn, T. S. (1978). The Essential Tension: Tradition and Innovation in Scientific Research. In *The Essential Tension: Selected Studies in Scientific Tradition and Change* (pp. 225–239). University of Chicago Press. http://ebookcentral.proquest.com/lib/oxford/detail.action?docID=2130131

Kusner, M. J., Sun, Y., Kolkin, N. I., & Weinberger, K. Q. (2015). From word embeddings to document distances. *Proceedings of the 32nd International Conference on International Conference on Machine Learning - Volume 37*, 957–966.

Kyriazopoulos, I., Koutromanos, G., Voudouri, A., & Galani, A. (2021). Educational Robotics in Primary Education: A Systematic Literature Review. In S. Papadakis & M. Kalogiannakis (Eds.), *Handbook of Research on Using Educational Robotics to Facilitate Student Learning* (pp. 377–401). IGI Global. https://doi.org/10.4018/978-1-7998-6717-3.ch015

Lancichinetti, A., Sirer, M. I., Wang, J. X., Acuna, D., Körding, K., & Amaral, L. A. N. (2015). High-Reproducibility and High-Accuracy Method for Automated Topic Classification. *Physical Review X*, *5*(1), 011007. https://doi.org/10.1103/PhysRevX.5.011007

Langford, B. E., Schoenfeld, G., & Izzo, G. (2002). Nominal grouping sessions vs focus groups. *Qualitative Market Research: An International Journal*, *5*(1), 58–70. https://doi.org/10.1108/13522750210414517

Larsen, B., & Aone, C. (1999). Fast and effective text mining using linear-time document clustering. *Proceedings of the Fifth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, 16–22. https://doi.org/10.1145/312129.312186

Law, E. L.-C., & Heintz, M. (2021). Augmented reality applications for K-12 education: A systematic review from the usability and user experience perspective. *International Journal of Child-Computer Interaction*, *30*, 100321. https://doi.org/10.1016/j.ijcci.2021.100321

Leahey, E. (2007). Not by Productivity Alone: How Visibility and Specialization Contribute to Academic Earnings. *American Sociological Review*, *72*(4), 533–561. https://doi.org/10.1177/000312240707200403

Leahey, E., Beckman, C. M., & Stanko, T. L. (2017). Prominent but Less Productive: The Impact of Interdisciplinarity on Scientists' Research*. *Administrative Science Quarterly*, *62*(1), 105–139. https://doi.org/10.1177/0001839216665364

Leahey, E., & Moody, J. (2014). Sociological Innovation through Subfield Integration. *Social Currents*, *1*(3), 228–256. https://doi.org/10.1177/2329496514540131

Leech, N. L., Dellinger, A. B., Brannagan, K. B., & Tanaka, H. (2010). Evaluating Mixed Research Studies: A Mixed Methods Approach. *Journal of Mixed Methods Research*, *4*(1), 17–31. https://doi.org/10.1177/1558689809345262

Leech, N. L., & Onwuegbuzie, A. J. (2009). A typology of mixed methods research designs. *Quality & Quantity*, *43*(2), 265–275. https://doi.org/10.1007/s11135-007-9105-3

Lehnert, F. K., Niess, J., Lallemand, C., Markopoulos, P., Fischbach, A., & Koenig, V. (2021). Child-Computer Interaction: From a systematic review towards an integrated understanding of interaction design methods for children. *International Journal of Child-Computer Interaction*, 100398. https://doi.org/10.1016/j.ijcci.2021.100398

Leinster, T. (2021). *Entropy and Diversity: The Axiomatic Approach*. Cambridge University Press. https://arxiv.org/pdf/2012.02113.pdf

Levinthal, D. A., & March, J. G. (1993). The Myopia of Learning. *Strategic Management Journal*, *14*, 95–112.

Levitt, H. M., Bamberg, M., Creswell, J. W., Frost, D. M., Josselson, R., & Suárez-Orozco, C. (2018). Journal article reporting standards for qualitative primary, qualitative meta-analytic, and mixed methods research in psychology: The APA Publications and Communications Board task force report. *American Psychologist*, *73*(1), 26. https://doi.org/10.1037/amp0000151

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. SAGE Publications Ltd.

Linnander, E., LaMonaca, K., Brault, M. A., Vyavahare, M., & Curry, L. A. (2019). A mixed methods evaluation of a multi-country, cross-sectoral knowledge transfer partnership to improve health systems across Africa. *International Journal of Multiple Research Approaches*, *11*(1), 136–148. https://doi.org/10.29034/ijmra.v10n1a9

Liu, S., & Chen, C. (2013). The differences between latent topics in abstracts and citation contexts of citing papers. *Journal of the American Society for Information Science and Technology*, *64*(3), 627–639. https://doi.org/10.1002/asi.22771

Liu, Y., Goncalves, J., Ferreira, D., Xiao, B., Hosio, S., & Kostakos, V. (2014). CHI 1994-2013: Mapping two decades of intellectual progress through co-word analysis. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 3553–3562. https://doi.org/10.1145/2556288.2556969

Lo Iacono, V., Symonds, P., & Brown, D. H. K. (2016). Skype as a Tool for Qualitative Research Interviews. *Sociological Research Online*, *21*(2), 103–117. https://doi.org/10.5153/sro.3952

Lobe, B. (2017). Best Practices for Synchronous Online Focus Groups. In R. S. Barbour & D. L. Morgan (Eds.), *A New Era in Focus Group Research: Challenges, Innovation and Practice* (pp. 227–250). Palgrave Macmillan UK. https://doi.org/10.1057/978-1-137-58614-8_11

Lobe, B., & Morgan, D. L. (2021). Assessing the effectiveness of video-based interviewing: A systematic comparison of video-conferencing based dyadic interviews and focus groups. *International Journal of Social Research Methodology*, *24*(3), 301–312. https://doi.org/10.1080/13645579.2020.1785763

Loustau, T., & Chu, S. L. (2022). Characterizing the research-practice gap in children’s interactive storytelling systems. *International Journal of Child-Computer Interaction*, *34*, 100544. https://doi.org/10.1016/j.ijcci.2022.100544

Luckmann, B. (1970). The small life-worlds of modern man. *Social Research*, *37*(4), 580–596.

Lund, T. (2012). Combining Qualitative and Quantitative Approaches: Some Arguments for Mixed Methods Research. *Scandinavian Journal of Educational Research*, *56*(2), 155–165. https://doi.org/10.1080/00313831.2011.568674

Lunt, P., & Livingstone, S. (1996). Rethinking the Focus Group in Media and Communications Research. *Journal of Communication*, *46*(2), 79–98. https://doi.org/10.1111/j.1460-2466.1996.tb01475.x

Luo, H., Liu, Z., Luan, H., & Sun, M. (2015). Online Learning of Interpretable Word Embeddings. *Proceedings of the 2015 Conference on Empirical Methods in Natural Language Processing*, 1687–1692. https://doi.org/10.18653/v1/D15-1196

Luukkonen, T., & Thomas, D. A. (2016). The ‘Negotiated Space’ of University Researchers’ Pursuit of a Research Agenda. *Minerva*, *54*(1), 99–127.

Lynch, M. (2012). Revisiting the Cultural Dope. *Human Studies*, *35*(2), 223–233. https://doi.org/10.1007/s10746-012-9227-z

Lynn, F. B. (2014). Diffusing through Disciplines: Insiders, Outsiders, and Socially Influenced Citation Behavior. *Social Forces*, *93*(1), 355–382. https://doi.org/10.1093/sf/sou069

Macrides, E., Miliou, O., & Angeli, C. (2021). Programming in early childhood education: A systematic review. *International Journal of Child-Computer Interaction*, 100396. https://doi.org/10.1016/j.ijcci.2021.100396

Maguire, M., & Delahunt, B. (2017). Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Higher Education*, *9*(3), Article 3. https://ojs.aishe.org/index.php/aishe-j/article/view/335

Mahoney, M. J. (1977). Publication prejudices: An experimental study of confirmatory bias in the peer review system. *Cognitive Therapy and Research*, *1*(2), 161–175. https://doi.org/10.1007/BF01173636

Mandler, G. (1995). Origins and Consequences of Novelty. In S. M. Smith, T. B. Ward, & R. A. Finke (Eds.), *The Creative Cognition Approach* (pp. 9–25). MIT Press. https://ezproxy-prd.bodleian.ox.ac.uk:3076/books/book/4754/chapter/217174/Origins-and-Consequences-of-Novelty

Mann, H. B. (1945). Nonparametric Tests Against Trend. *Econometrica*, *13*(3), 245–259. https://doi.org/10.2307/1907187

Markopoulos, P., Read, J., Hoÿsniemi, J., & MacFarlane, S. (2008). Child computer interaction: Advances in methodological research. *Cognition, Technology & Work*, *10*(2), 79–81. https://doi.org/10.1007/s10111-007-0065-0

Martens, M., Rinnert, G. C., & Andersen, C. (2018). Child-Centered Design: Developing an Inclusive Letter Writing App. *Frontiers in Psychology*, *9*. https://www.frontiersin.org/articles/10.3389/fpsyg.2018.02277

Maxwell, J. A. (2016). Expanding the History and Range of Mixed Methods Research. *Journal of Mixed Methods Research*, *10*(1), 12–27. https://doi.org/10.1177/1558689815571132

McHoul, A., & Grace, W. (1993). *A Foucault Primer: Discourse, Power and the Subject*. Routledge. https://doi.org/10.4324/9780203501122

McLaughlin, N. (1998). How to Become a Forgotten Intellectual: Intellectual Movements and the Rise and Fall of Erich Fromm. *Sociological Forum*, *13*(2), 215–246.

McLaughlin, N. (2000). Revision from the Margins: Fromm’s Contributions to Psychoanalysis. *International Forum of Psychoanalysis*, *9*(3–4), 241–247. https://doi.org/10.1080/080370601300055679

McLaughlin, N. (2001). Optimal Marginality: Innovation and Orthodoxy in Fromm’s Revision of Psychoanalysis. *The Sociological Quarterly*, *42*(2), 271–288. https://doi.org/10.1111/j.1533-8525.2001.tb00034.x

Menary, J., Stetkiewicz, S., Nair, A., Jorasch, P., Nanda, A. K., Guichaoua, A., Rufino, M., Fischer, A. R. H., & Davies, J. A. C. (2021). Going virtual: Adapting in-person interactive focus groups to the online environment. In *Emerald Open Research* (Vol. 3, Issue 6). https://doi.org/10.35241/emeraldopenres.14163.2

Mertens, D. M. (2012). What Comes First? The Paradigm or the Approach? *Journal of Mixed Methods Research*, *6*(4), 255–257. https://doi.org/10.1177/1558689812461574

Merton, R. K. (1968). The Matthew Effect in Science. *Science*, *159*(3810), 56–63. https://doi.org/10.1126/science.159.3810.56

Merton, R. K. (1973). *The Sociology of Science: Theoretical and Empirical Investigations* (N. W. Storer, Ed.). University of Chicago Press. https://press.uchicago.edu/ucp/books/book/chicago/S/bo28451565.html

Microsoft. (2022). *Welcome to Microsoft Teams. Microsoft Teams* (4.11.12.0). Microsoft. https://docs.microsoft.com/en-us/microsoftteams/teams-overview

Mikolov, T., Chen, K., Corrado, G., & Dean, J. (2013). Efficient Estimation of Word Representations in Vector Space. *ICLR*, Article arXiv:1301.3781. https://doi.org/10.48550/arXiv.1301.3781

Mikolov, T., Sutskever, I., Chen, K., Corrado, G., & Dean, J. (2013). Distributed representations of words and phrases and their compositionality. *Proceedings of the 26th International Conference on Neural Information Processing Systems*, *2*, 3111–3119. https://doi.org/arXiv:1310.4546

Miller, A. N., Taylor, S. G., & Bedeian, A. G. (2011). Publish or perish: Academic life as management faculty live it. *Career Development International*, *16*(5), 422–445. https://doi.org/10.1108/13620431111167751

Mimno, D., Wallach, H. M., Talley, E., Leenders, M., & McCallum, A. (2011). Optimizing semantic coherence in topic models. *Proceedings of the Conference on Empirical Methods in Natural Language Processing*, 262–272.

Mohri, M., Rostamizadeh, A., & Talwalkar, A. (2012). *Foundations of Machine Learning*. MIT Press.

Molina-Azorín, J. F. (2011). The Use and Added Value of Mixed Methods in Management Research. *Journal of Mixed Methods Research*, *5*(1), 7–24. https://doi.org/10.1177/1558689810384490

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: A comparative analysis. *Scientometrics*, *106*(1), 213–228. https://doi.org/10.1007/s11192-015-1765-5

Moran-Ellis, J., Alexander, V. D., Cronin, A., Dickinson, M., Fielding, J., Sleney, J., & Thomas, H. (2006). Triangulation and integration: Processes, claims and implications. *Qualitative Research*, *6*(1), 45–59. https://doi.org/10.1177/1468794106058870

Morgan, D. L. (1995). Why Things (Sometimes) Go Wrong in Focus Groups. *Qualitative Health Research*, *5*(4), 516–523. https://doi.org/10.1177/104973239500500411

Morgan, D. L. (1997). *Focus Groups as Qualitative Research* (2nd ed.). SAGE Publications, Inc. https://psycnet.apa.org/doi/10.4135/9781412984287

Morgan, D. L. (1998). Practical strategies for combining qualitative and quantitative methods: Applications to health research. *Qualitative Health Research*, *8*(3), 362–376. https://doi.org/10.1177/104973239800800307

Morgan, D. L. (2015). *Essentials of Dyadic Interviewing*. Left Coast Press.

Morgan, D. L., Ataie, J., Carder, P., & Hoffman, K. (2013). Introducing Dyadic Interviews as a Method for Collecting Qualitative Data. *Qualitative Health Research*, *23*(9), 1276–1284. https://doi.org/10.1177/1049732313501889

Morgan, D. L., Eliot, S., Lowe, R. A., & Gorman, P. (2016). Dyadic Interviews as a Tool for Qualitative Evaluation. *American Journal of Evaluation*, *37*(1), 109–117. https://doi.org/10.1177/1098214015611244

Morgan, D. L., & Hoffman, K. (2018). A System for Coding the Interaction in Focus Groups and Dyadic Interviews. *The Qualitative Report*, *23*(3), 519–531. https://doi.org/10.46743/2160-3715/2018.2733

Morrison, K. (2005). Structuration Theory, Habitus and Complexity Theory: Elective Affinities or Old Wine in New Bottles? *British Journal of Sociology of Education*, *26*(3), 311–326.

Morse, J. M. (1991). Approaches to Qualitative-Quantitative Methodological Triangulation. *Nursing Research*, *40*(2), 120–123.

Morse, J. M. (2003). Principles of Mixed Methods and Multimethod Research Design. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of Mixed Methods in Social & Behavioral Research* (pp. 189–208). SAGE.

Morse, J. M. (2010). Procedures and practice of mixed method design: Maintaining control, rigoe, and complexity. In A. Tashakkori & C. Teddlie (Eds.), *SAGE Handbook of Mixed Methods in Social & Behavioral Research* (2nd Edition, pp. 339–352). SAGE Publications, Inc. https://dx.doi.org/10.4135/9781506335193

Morse, J. M., & Niehaus, L. (2009). *Mixed Method Design: Principles and Procedures*. Routledge.

Muchene, L., & Safari, W. (2021). Two-stage topic modelling of scientific publications: A case study of University of Nairobi, Kenya. *PLOS ONE*, *16*(1), e0243208. https://doi.org/10.1371/journal.pone.0243208

Mueller, J. S., Melwani, S., & Goncalo, J. A. (2012). The Bias Against Creativity: Why People Desire but Reject Creative Ideas. *Psychological Science*, *23*(1), 13–17. https://doi.org/10.1177/0956797611421018

Muñoz Cardona, J. E., Chandra, S., Rios Rincon, A., Wood, L. J., & Dautenhahn, K. (2021). Designing Games for and with Children. Co-design Methodologies for playful activities using AR/VR and Social Agents. *Interaction Design and Children*, 662–665. https://doi.org/10.1145/3459990.3460517

Munoz-Najar Galvez, S., Heiberger, R., & McFarland, D. (2020). Paradigm Wars Revisited: A Cartography of Graduate Research in the Field of Education (1980–2010). *American Educational Research Journal*, *57*(2), 612–652. https://doi.org/10.3102/0002831219860511

Murphy, B., Talukdar, P., & Mitchell, T. (2012). Learning Effective and Interpretable Semantic Models using Non-Negative Sparse Embedding. *Proceedings of COLING 2012*, 1933–1950. https://aclanthology.org/C12-1118

Muschelli, J. (2019). *rscopus: Scopus Database 'API' Interface.* (R package version 0.6.6). Comprehensive R Archive Network (CRAN). https://CRAN.R-project.org/package=rscopus

Muthukrishna, M., & Henrich, J. (2016). Innovation in the collective brain. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1690), 20150192. https://doi.org/10.1098/rstb.2015.0192

Nedeva, M., Boden, R., & Nugroho, Y. (2012). Rank and File: Managing Individual Performance in University Research. *Higher Education Policy*, *25*(3), 335–360. https://doi.org/10.1057/hep.2012.12

Neill, U. S. (2008). Publish or perish, but at what cost? *The Journal of Clinical Investigation*, *118*(7), 2368. https://doi.org/10.1172/JCI36371

Newman, D., Lau, J. H., Grieser, K., & Baldwin, T. (2010). Automatic evaluation of topic coherence. *Human Language Technologies: The 2010 Annual Conference of the North American Chapter of the Association for Computational Linguistics*, 100–108.

Nguyen, H., & Jenkins, J. (2020). In or Out of Sync: Federal Funding and Research in Early Childhood. *AERA Open*, *6*(4), 2332858420979568. https://doi.org/10.1177/2332858420979568

Nikita, M. (2020). ldatuning: Tuning of the Latent Dirichlet Allocation Models Parameters. *R Package Version 1.0.2*. https://CRAN.R-project.org/package=ldatuning

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*, *16*(1), 1609406917733847. https://doi.org/10.1177/1609406917733847

O'Cathain, A. (2009). Reporting Results. In S. Andrew & E. J. Halcomb (Eds.), *Mixed Methods Research for Nursing and the Health Sciences* (p. 250). Wiley-Blackwell.

O'Cathain, A., Murphy, E., & Nicholl, J. (2007). Integration and Publications as Indicators of 'Yield' From Mixed Methods Studies. *Journal of Mixed Methods Research*, *1*(2), 147–163. https://doi.org/10.1177/1558689806299094

O'Cathain, A., Murphy, E., & Nicholl, J. (2008). The quality of mixed methods studies in health services research. *Journal of Health Services Research & Policy*, *13*(2), 92–98. https://doi.org/10.1258/jhsrp.2007.007074

Ofcom. (2021). *Children and parents: Media use and attitudes report 2020/21*. Ofcom. https://www.ofcom.org.uk/__data/assets/pdf_file/0025/217825/children-and-parents-media-use-and-attitudes-report-2020-21.pdf

Ofcom. (2022). *Children and Parents: Media Use and Attitudes Report 2022*. Ofcom. https://www.ofcom.org.uk/research-and-data/media-literacy-research/childrens/children-and-parents-media-use-and-attitudes-report-2022

Olsen, R. (2008). Self-selection bias. In P. J. Lavrakas (Ed.), *Encyclopedia of Survey Research Methods* (pp. 808–810). SAGE Publications, Inc. https://dx.doi.org/10.4135/9781412963947

Omona, J. (2013). Sampling in Qualitative Research: Improving the Quality of Research Outcomes in Higher Education. *Makerere Journal of Higher Education*, *4*(2), Article 2. https://doi.org/10.4314/majohe.v4i2.4

Oni, T., Sciarrino, F., Adesso, G., & Knight, R. (2016). Let researchers try new paths. *Nature*, *538*(7626), 451–453. https://doi.org/10.1038/538451a

Önöz, B., & Bayazit, M. (2003). The Power of Statistical Tests for Trend Detection. *Turkish Journal of Engineering and Environmental Sciences*, *27*(4), Article 4. https://doi.org/10.3906/sag-1205-120

Onwuegbuzie, A. J., & Johnson, R. B. (2006). The validity issue in mixed research. *Research in the Schools*, *13*(1), 48–63.

Oranç, C., & Küntay, A. C. (2019). Learning from the real and the virtual worlds: Educational use of augmented reality in early childhood. *International Journal of Child-Computer Interaction*, *21*, 104–111. https://doi.org/10.1016/j.ijcci.2019.06.002

Painter, D. T., Daniels, B. C., & Laubichler, M. D. (2021). Innovations are disproportionately likely in the periphery of a scientific network. *Theory in Biosciences*, *140*(4), 391–399. https://doi.org/10.1007/s12064-021-00359-1

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health*, *42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Papadakis, S. (2021). The Impact of Coding Apps to Support Young Children in Computational Thinking and Computational Fluency. A Literature Review. *Frontiers in Education*, *6*, 183. https://doi.org/10.3389/feduc.2021.657895

Papavlasopoulou, S., Giannakos, M. N., & Jaccheri, L. (2017). Empirical studies on the Maker Movement, a promising approach to learning: A literature review. *Entertainment Computing*, *18*, 57–78. https://doi.org/10.1016/j.entcom.2016.09.002

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books, Inc.

Park, S., Bak, J., & Oh, A. (2017). Rotated Word Vector Representations and their Interpretability. *Proceedings of the 2017 Conference on Empirical Methods in Natural Language Processing*, 401–411. https://doi.org/10.18653/v1/D17-1041

Patakamuri, S. K., & O'Brien, N. (2020). *modifiedmk: Modified Versions of Mann Kendall and Spearman's Rho Trend Tests* (R package version 1.5.0) [R]. Comprehensive R Archive Network (CRAN). https://CRAN.R-project.org/package=modifiedmk

Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods* (3rd ed.). SAGE Publications, Inc.

Pedhazur, E. J. (1997). *Multiple regression in behavioral research: Explanation and prediction* (3rd ed). Harcourt Brace College Publishers.

Pellas, N., Mystakidis, S., & Christopoulos, A. (2021). A Systematic Literature Review on the User Experience Design for Game-Based Interventions via 3D Virtual Worlds in K-12 Education. *Multimodal Technologies and Interaction*, *5*(6), Article 6. https://doi.org/10.3390/mti5060028

Pennington, J., Socher, R., & Manning, C. (2014). GloVe: Global Vectors for Word Representation. *Proceedings of the 2014 Conference on Empirical Methods in Natural Language Processing (EMNLP)*, 1532–1543. https://doi.org/10.3115/v1/D14-1162

Perry-Smith, J. E., & Shalley, C. E. (2003). The Social Side of Creativity: A Static and Dynamic Social Network Perspective. *The Academy of Management Review*, *28*(1), 89–106. https://doi.org/10.2307/30040691

Phillips, D. J., & Zuckerman, E. W. (2001). Middle-Status Conformity: Theoretical Restatement and Empirical Demonstration in Two Markets. *American Journal of Sociology*, *107*(2), 379–429. https://doi.org/10.1086/324072

Pires, A. C., Neto, I., Brulé, E., Malinverni, L., Metatla, O., & Hourcade, J. P. (2022). Co-Designing with Mixed-Ability Groups of Children to Promote Inclusive Education. *Interaction Design and Children*, 715–718. https://doi.org/10.1145/3501712.3536389

Pitsoe, V., & Letseka, M. (2013). Foucault's Discourse and Power: Implications for Instructionist Classroom Management. *Open Journal of Philosophy*, *3*(1), Article 1. https://doi.org/10.4236/ojpp.2013.31005

Plano Clark, V. L., & Ivankova, N. V. (2016). *Mixed Methods Research: A Guide to the Field*. SAGE Publications, Inc. https://dx.doi.org/10.4135/9781483398341

Polanyi, M. (1969). *Knowing and Being: Essays by Michael Polanyi* (M. Grene, Ed.). University of Chicago Press.

Porter, M. F. (1980). An algorithm for suffix stripping. *Program*, *14*(3), 130–137. https://doi.org/10.1108/00330330610681286

Poytner, R. (2010). *The Handbook of Online and Social Media Research: Tools and Techniques for Market Researchers*. John Wiley & Sons, Ltd.

Quayyum, F., Cruzes, D. S., & Jaccheri, L. (2021). Cybersecurity awareness for children: A systematic literature review. *International Journal of Child-Computer Interaction*, *30*, 100343. https://doi.org/10.1016/j.ijcci.2021.100343

Quinn, K. M., Monroe, B. L., Colaresi, M., Crespin, M. H., & Radev, D. R. (2010). How to Analyze Political Attention with Minimal Assumptions and Costs. *American Journal of Political Science*, *54*(1), 209–228. https://doi.org/10.1111/j.1540-5907.2009.00427.x

Radford, G. P. (2003). Trapped in Our Own Discursive Formations: Toward an Archaeology of Library and Information Science. *The Library Quarterly: Information, Community, Policy*, *73*(1), 1–18.

Ramisch, C., Schreiner, P., Idiart, M., & Villavicencio, A. (2008). An evaluation of methods for the extraction of multiword expressions. *In Proceedings of the LREC Workshop Towards a Shared Task for Multiword Expressions (MWE 2008)*, 50–53.

Rao, H., Monin, P., & Durand, R. (2005). Border Crossing: Bricolage and the Erosion of Categorical Boundaries in French Gastronomy. *American Sociological Review*, *70*(6), 968–991.

Rawat, S., & Meena, S. (2014). Publish or perish: Where are we heading? *Journal of Research in Medical Sciences : The Official Journal of Isfahan University of Medical Sciences*, *19*(2), 87–89.

Read, J. C., & Bekker, M. M. (2011). The nature of child computer interaction. *Proceedings of the 25th BCS Conference on Human-Computer Interaction*, 163–170. https://doi.org/10.14236/ewic/HCI2011.43

Read, J. C., & Hourcade, J. P. (2013). Enhancing the research infrastructure for child-computer interaction. *CHI '13 Extended Abstracts on Human Factors in Computing Systems*, 2481–2484. https://doi.org/10.1145/2468356.2468810

Read, J. C., Hourcade, J. P., Markopoulos, P., & Druin, A. (2011). Child computer interaction invited SIG: IDC remixed, CCI remapped. *CHI '11 Extended Abstracts on Human Factors in Computing Systems*, 689–691. https://doi.org/10.1145/1979742.1979540

Read, J. C., & Markopoulos, P. (2013). Child–computer interaction. *International Journal of Child-Computer Interaction*, *1*(1), 2–6. https://doi.org/10.1016/j.ijcci.2012.09.001

Read, J. C., Markopoulos, P., Parés, N., Hourcade, J. P., & Antle, A. N. (2008). Child computer interaction. *CHI '08 Extended Abstracts on Human Factors in Computing Systems*, 2419–2422. https://doi.org/10.1145/1358628.1358697

Reeves, S. (2015). Human-computer interaction as science. *Proceedings of The Fifth Decennial Aarhus Conference on Critical Alternatives*, 73–84. https://doi.org/10.7146/aahcc.v1i1.21296

Reichardt, C. S., & Rallis, S. F. (1994). The relationship between the qualitative and quantitative research traditions. *New Directions for Program Evaluation*, *1994*(61), 5–11. https://doi.org/10.1002/ev.1663

Reid, D. J., & Reid, F. J. M. (2005). Online Focus Groups: An In-depth Comparison of Computer-mediated and Conventional Focus Group Discussions. *International Journal of Market Research*, *47*(2), 131–162. https://doi.org/10.1177/147078530504700204

Resnik, D. B. (2007). *The Price of Truth: How Money Affects the Norms of Science*. Oxford University Press.

Rideout, V. (2017). *The Common Sense census: Media use by kids age zero to eight*. Common Sense Media.

Rideout, V., & Robb, M. B. (2020). *The Common Sense census: Media use by kids age zero to eight, 2020*. Common Sense Media.

Roberts, M. E., Stewart, B. M., & Airoldi, E. M. (2016). A Model of Text for Experimentation in the Social Sciences. *Journal of the American Statistical Association*, *111*(515), 988–1003. https://doi.org/10.1080/01621459.2016.1141684

Roberts, M. E., Stewart, B. M., & Tingley, D. (2016). Navigating the Local Modes of Big Data: The Case of Topic Models. In R. M. Alvarez (Ed.), *Computational Social Science: Discovery and Prediction* (pp. 51–97). Cambridge University Press. https://doi.org/10.1017/CBO9781316257340.004

Roberts, M. E., Stewart, B. M., & Tingley, D. (2019). stm: R Package for Structural Topic Models. *Journal of Statistical Software*, *91*(2), 1–40. https://doi.org/10.18637/jss.v091.i02

Roberts, M. E., Stewart, B. M., Tingley, D., & Airoldi, E. M. (2013). The structural topic model and applied social science. *Neural Information Processing Society*.

Roberts, M. E., Stewart, B. M., Tingley, D., & Benoit, K. (2020). *stm: Estimation of the structural topic model* (R package version 1.3.6) [R]. Comprehensive R Archive Network (CRAN). https://cran.r-project.org/web/packages/stm/stm.pdf

Roberts, M. E., Stewart, B. M., Tingley, D., Lucas, C., Leder-Luis, J., Gadarian, S. K., Albertson, B., & Rand, D. G. (2014). Structural Topic Models for Open-Ended Survey Responses. *American Journal of Political Science*, *58*(4), 1064–1082. https://doi.org/10.1111/ajps.12103

Rocco, T. S., Bliss, L. A., Gallagher, S. J., Perez-Prado, A., Alacaci, C., Dwyer, E., Fine, J., & Pappamihiel, E. (2003). The pragmatic and dialectical lenses: Two views of mixed methods use in education. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 595–615). SAGE Publications Ltd.

Rodríguez-Sánchez, F., Jackson, C. P., & Hutchins, S. D. (2022). *grateful: Facilitate Citation of R Packages* (R package version 0.1.5). https://github.com/Pakillo/grateful

Rogers, Y. (2012). HCI Theory: Classical, Modern, and Contemporary. *Synthesis Lectures on Human-Centered Informatics*, *5*(2), 1–129. https://doi.org/10.2200/S00418ED1V01Y201205HCI014

Rogers, Y., Scaife, M., Gabrielli, S., Smith, H., & Harris, E. (2002). A conceptual framework for mixed reality environments: Designing novel learning activities for young children. *Presence: Teleoperators and Virtual Environments*, *11*(6), 677–686. https://doi.org/10.1162/105474602321050776

Rojabi, A. R. (2020). Exploring EFL Students’ Perception of Online Learning via Microsoft Teams: University Level in Indonesia. *English Language Teaching Educational Journal*, *3*(2), Article 2. https://doi.org/10.12928/eltej.v3i2.2349

Roulston, K. (2010). *Reflective Interviewing: A Guide to Theory and Practice*. SAGE Publications Ltd.

Safadi, H., Johnson, S. L., & Faraj, S. (2021). Who Contributes Knowledge? Core-Periphery Tension in Online Innovation Communities. *Organization Science*, *32*(3), 752–775. https://doi.org/10.1287/orsc.2020.1364

Sale, J. E. M., & Brazil, K. (2004). A Strategy to Identify Critical Appraisal Criteria for Primary Mixed-Method Studies. *Quality & Quantity*, *38*(4), 351–365. https://doi.org/10.1023/b:ququ.0000043126.25329.85

Sandelowski, M. (1986). The problem of rigor in qualitative research. *ANS. Advances in Nursing Science*, *8*(3), 27–37. https://doi.org/10.1097/00012272-198604000-00005

Sanders, L. (2008). An evolving map of design practice and design research. *Interactions*, *15*(6), 13–17. https://doi.org/10.1145/1409040.1409043

Santhosh, L., Rojas, J. C., & Lyons, P. G. (2021). Zooming into Focus Groups: Strategies for Qualitative Research in the Era of Social Distancing. *ATS Scholar*, *2*(2), 176–184. https://doi.org/10.34197/ats-scholar.2020-0127PS

Schilling, M. A. (2005). A 'Small-World' Network Model of Cognitive Insight. *Creativity Research Journal*, *17*(2–3), 131–154. https://doi.org/10.1080/10400419.2005.9651475

Schoonenboom, J., & Johnson, R. B. (2017). How to Construct a Mixed Methods Research Design. *Kolner Zeitschrift Fur Soziologie Und Sozialpsychologie*, *69*(Suppl 2), 107–131. https://doi.org/10.1007/s11577-017-0454-1

Schumpeter, J. A. (1939). *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*. McGraw-Hill.

Schütz, A., & Luckmann, T. (1973). *The Structures of the Life-world* (R. M. Zaner & T. Engelhardt Jr., Trans.; Vol. 1). Northwestern University Press.

Scott, S. B., Bergeman, C. S., Verney, A., Longenbaker, S., Markey, M. A., & Bisconti, T. L. (2007). Social Support in Widowhood: A Mixed Methods Study. *Journal of Mixed Methods Research*, *1*(3), 242–266. https://doi.org/10.1177/1558689807302453

Seale, C. (1999). Quality in Qualitative Research. *Qualitative Inquiry*, *5*(4), 465–478. https://doi.org/10.1177/107780049900500402

Senel, L. K., Utlu, I., Yucesoy, V., Koc, A., & Cukur, T. (2018). Semantic Structure and Interpretability of Word Embeddings. *IEEE/ACM Transactions on Audio, Speech and Language Processing*, *26*(10), 1769–1779. https://doi.org/10.1109/TASLP.2018.2837384

Sgourev, S. V. (2013). How Paris Gave Rise to Cubism (and Picasso): Ambiguity and Fragmentation in Radical Innovation. *Organization Science*, *24*(6), 1601–1617.

Shahid, N. M. I., Law, E. L.-C., & Verdezoto, N. (2021). Technology-enhanced support for children with Down Syndrome: A systematic literature review. *International Journal of Child-Computer Interaction*, 100340. https://doi.org/10.1016/j.ijcci.2021.100340

Shannon, C. E. (1948). A mathematical theory of communication. *The Bell System Technical Journal*, *27*(3), 379–423. https://doi.org/10.1002/j.1538-7305.1948.tb01338.x

Sharma, D., Kumar, B., & Chand, S. (2019). A Trend Analysis of Machine Learning Research with Topic Models and Mann-Kendall Test. *International Journal of Intelligent Systems and Applications*. https://doi.org/10.5815/IJISA.2019.02.08

Sharma, K., & Giannakos, M. (2021). Sensing technologies and child-computer child–computer interaction: Opportunities, challenges and ethical considerations. *International Journal of Child-Computer Interaction*, *30*, 100331. https://doi.org/10.1016/j.ijcci.2021.100331

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*(2), 63–75. https://doi.org/10.3233/EFI-2004-22201

Shorten, A., & Smith, J. (2017). Mixed methods research: Expanding the evidence base. *Evidence-Based Nursing*, *20*(3), 74–75. https://doi.org/10.1136/eb-2017-102699

Siler, K., Lee, K., & Bero, L. (2015). Measuring the effectiveness of scientific gatekeeping. *Proceedings of the National Academy of Sciences*, *112*(2), 360–365. https://doi.org/10.1073/pnas.1418218112

Sim, J., & Waterfield, J. (2019). Focus group methodology: Some ethical challenges. *Quality & Quantity*, *53*(6), 3003–3022. https://doi.org/10.1007/s11135-019-00914-5

Singh, J., & Fleming, L. (2010). Lone Inventors as Sources of Breakthroughs: Myth or Reality? *Management Science*, *56*(1), 41–56. https://doi.org/10.1287/mnsc.1090.1072

Skamagki, G., King, A., Carpenter, C., & Wåhlin, C. (2022). The concept of integration in mixed methods research: A step-by-step guide using an example study in physiotherapy. *Physiotherapy Theory and Practice*, *0*(0), 1–8. https://doi.org/10.1080/09593985.2022.2120375

Skovbjerg, H. M., Bekker, T., d'Anjou, B., Johry, A., & Quinones, K. K. P. (2022). Examining theory use in design research on fantasy play. *International Journal of Child-Computer Interaction*, *32*, 100400. https://doi.org/10.1016/j.ijcci.2021.100400

Slegers, K., Duysburgh, P., & Jacobs, A. (2013). The 'Relay Ideation' Technique: Moving from Problem Understanding to Problem Solving in the Design Process. In P. Kotzé, G. Marsden, G. Lindgaard, J. Wesson, & M. Winckler (Eds.), *Human-Computer Interaction – INTERACT 2013* (pp. 651–658). Springer. https://doi.org/10.1007/978-3-642-40498-6_57

Smith, R. C., Iversen, O. S., Hjermitslev, T., & Lynggaard, A. B. (2013). Towards an ecological inquiry in child-computer interaction. *Proceedings of the 12th International Conference on Interaction Design and Children*, 183–192. https://doi.org/10.1145/2485760.2485780

Smithson, J. (2000). Using and analysing focus groups: Limitations and possibilities. *International Journal of Social Research Methodology*, *3*(2), 103–119. https://doi.org/10.1080/136455700405172

Sobaih, A. E. E., Salem, A. E., Hasanein, A. M., & Elnasr, A. E. A. (2021). Responses to COVID-19 in Higher Education: Students' Learning Experience Using Microsoft Teams versus Social Network Sites. *Sustainability*, *13*(18), Article 18. https://doi.org/10.3390/su131810036

Social Research Association. (2021). *Research Ethics Guidance*. Social Research Association. https://the-sra.org.uk/common/Uploaded%20files/Resources/SRA%20Research%20Ethics%20guidance%202021.pdf

Spiel, K., Frauenberger, C., Keyes, O., & Fitzpatrick, G. (2019). Agency of Autistic Children in Technology Research—A Critical Literature Review. *ACM Transactions on Computer-Human Interaction*, *26*(6), 38:1-38:40. https://doi.org/10.1145/3344919

Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. *Management Decision*, *39*(7), 551–556. https://doi.org/10.1108/EUM0000000005801

Stevens, K., Kegelmeyer, P., Andrzejewski, D., & Buttler, D. (2012). Exploring topic coherence over many models and many topics. *Proceedings of the 2012 Joint Conference on Empirical Methods in Natural Language Processing and Computational Natural Language Learning*, 952–961.

Stewart, D. W., & Shamdasani, P. (2017). Online Focus Groups. *Journal of Advertising*, *46*(1), 48–60. https://doi.org/10.1080/00913367.2016.1252288

Steyvers, M., & Griffiths, T. L. (2007). Probabilistic Topic Models. In T. landauer, D. McNamara, S. Dennis, & W. Kintsch (Eds.), *Latent Semantic Analysis: A Road to Meaning*. Laurence Erlbaum.

Stolterman, E. (2008). The Nature of Design Practice and Implications for Interaction Design Research. *International Journal of Design*, *2*, 55–65.

Stolterman, E., & Wiberg, M. (2010). Concept-Driven Interaction Design Research. *Human–Computer Interaction*, *25*(2), 95–118. https://doi.org/10.1080/07370020903586696

Sun, F., Guo, J., Lan, Y., Xu, J., & Cheng, X. (2016). Sparse word embeddings using l1 regularized online learning. *Proceedings of the Twenty-Fifth International Joint Conference on Artificial Intelligence*, 2915–2921.

Sutarsyah, S., & Yoganingrum, A. (2019). The Potential Bias in Using Scopus to Measure the Researchers Productivity. *Proceeding of International Conference on Documentation and Information*, *2*, 127–137. https://doi.org/10.14203/icdi.v2i.73

Sutcliffe, A. (2000). On the effective use and reuse of HCI knowledge. *ACM Transactions on Computer-Human Interaction*, *7*(2), 197–221. https://doi.org/10.1145/353485.353488

Syed, S., & Spruit, M. (2017). Full-Text or Abstract? Examining Topic Coherence Scores Using Latent Dirichlet Allocation. *2017 IEEE International Conference on Data Science and Advanced Analytics (DSAA)*, 165–174. https://doi.org/10.1109/DSAA.2017.61

Tan, C., Casanova, D., Huet, I., & Alhammad, M. (2022). Online Collaborative Learning Using Microsoft Teams in Higher Education Amid COVID-19. *International Journal of Mobile and Blended Learning (IJMBL)*, *14*(1), 1–18. https://doi.org/10.4018/IJMBL.297976

Tang, J., Meng, Z., Nguyen, X., Mei, Q., & Zhang, M. (2014). Understanding the Limiting Factors of Topic Modeling via Posterior Contraction Analysis. *Proceedings of the 31st International Conference on Machine Learning*, 190–198. https://proceedings.mlr.press/v32/tang14.html

Tashakkori, A., & Creswell, J. W. (2007). Editorial: Exploring the Nature of Research Questions in Mixed Methods Research. *Journal of Mixed Methods Research*, *1*(3), 207–211. https://doi.org/10.1177/1558689807302814

Tashakkori, A., Johnson, R. B., & Teddlie, C. (2020). *Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioral Sciences* (2nd ed.). SAGE Publications.

Tashakkori, A., & Teddlie, C. (1998). *Mixed Methodology: Combining Qualitative and Quantitative Approaches*. SAGE Publications, Inc.

Tashakkori, A., & Teddlie, C. (Eds.). (2003). *Handbook of Mixed Methods in Social & Behavioral Research*. SAGE.

Tashakkori, A., & Teddlie, C. (2008). Quality of inferences in mixed methods research: Calling for an integrative framework. In M. M. Bergman (Ed.), *Advances in mixed methods research* (pp. 101–119). SAGE Publications Ltd. https://dx.doi.org/10.4135/9780857024329.d10

Tashakkori, A., & Teddlie, C. (2010). *SAGE Handbook of Mixed Methods in Social & Behavioral Research* (2nd Edition). SAGE Publications, Inc. https://dx.doi.org/10.4135/9781506335193

Tates, K., Zwaanswijk, M., Otten, R., van Dulmen, S., Hoogerbrugge, P. M., Kamps, W. A., & Bensing, J. M. (2009). Online focus groups as a tool to collect data in hard-to-include populations: Examples from paediatric oncology. *BMC Medical Research Methodology*, *9*(1), 15. https://doi.org/10.1186/1471-2288-9-15

Teddlie, C., & Tashakkori, A. (2006). A general typology of research designs featuring mixed methods. *Research in the Schools*, *13*(1), 12–28.

Teddlie, C., & Tashakkori, A. (2010). Overview of contemporary issues in mixed methods research. In A. Tashakkori & C. Teddlie (Eds.), *SAGE handbook of mixed methods in social & behavioral research* (2nd Edition, pp. 1–42). SAGE Publications, Inc. https://dx.doi.org/10.4135/9781506335193

Teh, Y. W., Jordan, M. I., Beal, M. J., & Blei, D. M. (2004). Sharing clusters among related groups: Hierarchical Dirichlet processes. *Proceedings of the 17th International Conference on Neural Information Processing Systems*, 1385–1392.

Tennant, J. P. (2020). Web of Science and Scopus are not global databases of knowledge. *European Science Editing*, *46*, e51987. https://doi.org/10.3897/ese.2020.e51987

Thakur, K., & Kumar, V. (2021). Application of Text Mining Techniques on Scholarly Research Articles: Methods and Tools. *New Review of Academic Librarianship*, *0*(0), 1–25. https://doi.org/10.1080/13614533.2021.1918190

Theodoropoulos, A., & Lepouras, G. (2021). Augmented Reality and programming education: A systematic review. *International Journal of Child-Computer Interaction*, *30*, 100335. https://doi.org/10.1016/j.ijcci.2021.100335

Tobin, G. A., & Begley, C. M. (2004). Methodological rigour within a qualitative framework. *Journal of Advanced Nursing*, *48*(4), 388–396. https://doi.org/10.1111/j.1365-2648.2004.03207.x

Tolich, M. (2009). The Principle of Caveat Emptor: Confidentiality and Informed Consent as Endemic Ethical Dilemmas in Focus Group Research. *Journal of Bioethical Inquiry*, *6*(1), 99–108. https://doi.org/10.1007/s11673-008-9124-3

Torres-Carrión, P., González-González, C., Bernal-Bravo, C., & Infante-Moro, A. (2019). Gesture-Based Children Computer Interaction for Inclusive Education: A Systematic Literature Review. In M. Botto-Tobar, G. Pizarro, M. Zúñiga-Prieto, M. D'Armas, & M. Zúñiga Sánchez (Eds.), *Technology Trends* (Vol. 895, pp. 133–147). Springer International Publishing. https://doi.org/10.1007/978-3-030-05532-5_10

Trapido, D. (2015). How novelty in knowledge earns recognition: The role of consistent identities. *Research Policy*, *44*(8), 1488–1500. https://doi.org/10.1016/j.respol.2015.05.007

Tsvyatkova, D., & Storni, C. (2019). A review of selected methods, techniques and tools in Child–Computer Interaction (CCI) developed/adapted to support children's involvement in technology development. *International Journal of Child-Computer Interaction*, *22*, 100148. https://doi.org/10.1016/j.ijcci.2019.100148

Tuckett, A. G. (2005). Applying thematic analysis theory to practice: A researcher's experience. *Contemporary Nurse*, *19*(1–2), 75–87. https://doi.org/10.5172/conu.19.1-2.75

Tuttas, C. A. (2015). Lessons Learned Using Web Conference Technology for Online Focus Group Interviews. *Qualitative Health Research*, *25*(1), 122–133. https://doi.org/10.1177/1049732314549602

Ullrich, P., & Keller, R. (2014). Comparing Discourse between Cultures: A Discursive Approach to Movement Knowledge. In B. Baumgarten, P. Daphi, & P. Ullrich (Eds.), *Conceptualizing Culture in Social Movement Research* (pp. 113–139). Palgrave Macmillan UK. https://doi.org/10.1057/9781137385796_6

Underhill, C., & Olmsted, M. G. (2003). An Experimental Comparison of Computer-Mediated and Face-to-Face Focus Groups. *Social Science Computer Review*, *21*(4), 506–512. https://doi.org/10.1177/0894439303256541

Uzzi, B., Mukherjee, S., Stringer, M., & Jones, B. (2013). Atypical Combinations and Scientific Impact. *Science*, *342*(6157), 468–472. https://doi.org/10.1126/science.1240474

Van Dalen, H. P., & Klamer, A. (2005). Is Science A Case of Wasteful Competition? *Kyklos*, *58*(3), 395–414. https://doi.org/10.1111/j.0023-5962.2005.00294.x

van der Maaten, L., & Hinton, G. (2008). Visualizing Data using t-SNE. *Journal of Machine Learning Research*, *9*(86), 2579–2605.

Van Mechelen, M., Baykal, G. E., Dindler, C., Eriksson, E., & Iversen, O. S. (2020). 18 Years of ethics in child-computer interaction research: A systematic literature review. *Proceedings of the Interaction Design and Children Conference*, 161–183. https://doi.org/10.1145/3392063.3394407

Van Mechelen, M., Gilutz, S., Hourcade, J. P., Baykal, G. E., Gielen, M., Eriksson, E., Walsh, G., Read, J., & Iversen, O. S. (2020). Teaching the next generation of child-computer interaction researchers and designers. *Proceedings of the 2020 ACM Interaction Design and Children Conference: Extended Abstracts*, 69–76. https://doi.org/10.1145/3397617.3398068

Van Mechelen, M., Have Musaeus, L., Iversen, O. S., Dindler, C., & Hjorth, A. (2021). A Systematic Review of Empowerment in Child-Computer Interaction Research. *Interaction Design and Children*, 119–130. https://doi.org/10.1145/3459990.3460701

Verbruggen, S., Depaepe, F., & Torbeyns, J. (2021). Effectiveness of educational technology in early mathematics education: A systematic literature review. *International Journal of Child-Computer Interaction*, *27*, 100220. https://doi.org/10.1016/j.ijcci.2020.100220

Wakkary, R., Odom, W., Hauser, S., Hertz, G., & Lin, H. (2015). Material Speculation: Actual Artifacts for Critical Inquiry. *Aarhus Series on Human Centered Computing*, *1*(1), Article 1. https://doi.org/10.7146/aahcc.v1i1.21299

Waltman, L. (2016). A review of the literature on citation impact indicators. *Journal of Informetrics*, *10*(2), 365–391. https://doi.org/10.1016/j.joi.2016.02.007

Wang, C., & Blei, D. M. (2013). Variational inference in nonconjugate models. *The Journal of Machine Learning Research*, *14*(1), 1005–1031.

Wang, D., Song, C., & Barabási, A.-L. (2013). Quantifying Long-Term Scientific Impact. *Science*, *342*(6154), 127–132. https://doi.org/10.1126/science.1237825

Wang, F., Shao, W., Yu, H., Kan, G., He, X., Zhang, D., Ren, M., & Wang, G. (2020). Re-evaluation of the Power of the Mann-Kendall Test for Detecting Monotonic Trends in Hydrometeorological Time Series. *Frontiers in Earth Science*, *8*(14). https://doi.org/10.3389/feart.2020.00014

Wang, Y. (2017). Education policy research in the big data era: Methodological frontiers, misconceptions, and challenges. *Education Policy Analysis Archives*, *25*(94), 1–24. https://doi.org/10.14507/epaa.25.3037

Watts, M., & Ebbutt, D. (1987). More Than the Sum of the Parts: Research Methods in Group Interviewing. *British Educational Research Journal*, *13*(1), 25–34.

Weedon, C. (1987). *Feminist Practice and Postculturalist Theory*. Blackwell.

Weiszfeld, E., & Plastria, F. (2009). On the point for which the sum of the distances to n given points is minimum. *Annals of Operations Research*, *167*(1), 7–41. https://doi.org/10.1007/s10479-008-0352-z

Weitzman, M. L. (1996). Hybridizing Growth Theory. *The American Economic Review*, *86*(2), 207–212.

Weitzman, M. L. (1998). Recombinant growth. *Quarterly Journal of Economics*, *113*(2), 331–360.

Wells, P. K. (2004). *Uncovering 'regimes of truth': Locating and defining discourses associated with hydro-electric development in New Zealand* [Thesis, Auckland University of Technology]. https://openrepository.aut.ac.nz/handle/10292/332

Westergaard, D., Stærfeldt, H.-H., Tønsberg, C., Jensen, L. J., & Brunak, S. (2018). A comprehensive and quantitative comparison of text-mining in 15 million full-text articles versus their corresponding abstracts. *PLoS Computational Biology*, *14*(2), e1005962. https://doi.org/10.1371/journal.pcbi.1005962

Whittaker, S., Terveen, L., & Nardi, B. A. (2000). Let's Stop Pushing the Envelope and Start Addressing It: A Reference Task Agenda for HCI. *Human–Computer Interaction*, *15*(2–3), 75–106. https://doi.org/10.1207/S15327051HCI1523_2

Wilson, V. (2016). Research Methods: Focus Groups. *Evidence Based Library and Information Practice*, *11*(1(S)), Article 1(S). https://doi.org/10.18438/B87S64

Wisdom, J. P., Cavaleri, M. A., Onwuegbuzie, A. J., & Green, C. A. (2012). Methodological Reporting in Qualitative, Quantitative, and Mixed Methods Health Services Research Articles. *Health Services Research*, *47*(2), 721–745. https://doi.org/10.1111/j.1475-6773.2011.01344.x

Woolley, C. M. (2009). Meeting the Mixed Methods Challenge of Integration in a Sociological Study of Structure and Agency. *Journal of Mixed Methods Research*, *3*(1), 7–25. https://doi.org/10.1177/1558689808325774

Wu, H., Soh, L.-K., Samal, A., & Chen, X.-H. (2008). Trend Analysis of Streamflow Drought Events in Nebraska. *Water Resources Management*, *22*(2), 145–164. https://doi.org/10.1007/s11269-006-9148-6

Wu, L., Yen, I. E.-H., Xu, K., Xu, F., Balakrishnan, A., Chen, P.-Y., Ravikumar, P., & Witbrock, M. J. (2018). Word Mover's Embedding: From Word2Vec to Document Embedding. *Proceedings of the 2018 Conference on Empirical Methods in Natural Language Processing*, 4524–4534. https://doi.org/10.18653/v1/D18-1482

Wu, P., Yu, S., & Wang, D. (2018). Using a Learner-Topic Model for Mining Learner Interests in Open Learning Environments. *Journal of Educational Technology & Society*, *21*(2), 192–204.

Wuchty, S., Jones, B. F., & Uzzi, B. (2007). The Increasing Dominance of Teams in Production of Knowledge. *Science*, *316*(5827), 1036–1039. https://doi.org/10.1126/science.1136099

Yang, S., & Deravi, F. (2022). Re-Engineered Word Embeddings for Improved Document-Level Sentiment Analysis. *Applied Sciences*, *12*(18), Article 18. https://doi.org/10.3390/app12189287

Yarosh, S., Radu, I., Hunter, S., & Rosenbaum, E. (2011). Examining values: An analysis of nine years of IDC research. *Proceedings of the 10th International Conference on Interaction Design and Children*, 136–144. https://doi.org/10.1145/1999030.1999046

Yee, N., Bailenson, J. N., Urbanek, M., Chang, F., & Merget, D. (2007). The unbearable likeness of being digital: The persistence of nonverbal social norms in online virtual environments. *Cyberpsychology & Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society*, *10*(1), 115–121. https://doi.org/10.1089/cpb.2006.9984

Yin, R. K. (2006). Mixed Methods Research: Are the Methods Genuinely Integrated or Merely Parallel? *Research in the Schools*, *13*(1), 41–47.

Zaman, B., Vanden Abeele, V., Markopoulos, P., & Marshall, P. (2012). The evolving field of tangible interaction for children: The challenge of empirical validation. *Personal and Ubiquitous Computing*, *16*(4), 367–378. https://doi.org/10.1007/s00779-011-0409-x

Zhang, W., & Creswell, J. (2013). The use of 'mixing' procedure of mixed methods in health services research. *Medical Care*, *51*(8), e51-57. https://doi.org/10.1097/MLR.0b013e31824642fd

Zhong, S., Geng, Y., Liu, W., Gao, C., & Chen, W. (2016). A bibliometric review on natural resource accounting during 1995–2014. *Journal of Cleaner Production*, *139*, 122–132. https://doi.org/10.1016/j.jclepro.2016.08.039

Zimmerman, J., Forlizzi, J., & Evenson, S. (2007). Research through design as a method for interaction design research in HCI. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 493–502. https://doi.org/10.1145/1240624.1240704

Zimmerman, J., Stolterman, E., & Forlizzi, J. (2010). An analysis and critique of Research through Design: Towards a formalization of a research approach. *Proceedings of the 8th ACM*

Conference on Designing Interactive Systems, 310–319. https://doi.org/10.1145/1858171.1858228

Zook, M., Barocas, S., Boyd, D., Crawford, K., Keller, E., Gangadharan, S. P., Goodman, A., Hollander, R., Koenig, B. A., Metcalf, J., Narayanan, A., Nelson, A., & Pasquale, F. (2017). Ten simple rules for responsible big data research. *PLOS Computational Biology*, *13*(3), e1005399. https://doi.org/10.1371/journal.pcbi.1005399

Zwaanswijk, M., & van Dulmen, S. (2014). Advantages of asynchronous online focus groups and face-to-face focus groups as perceived by child, adolescent and adult participants: A survey study. *BMC Research Notes*, *7*, 756. https://doi.org/10.1186/1756-0500-7-756

Appendices

Appendix A. Methodological and Inference Quality Criteria

Criteria adapted from the McMaster University Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018), O'Cathain et al.'s (2008) guidelines for Good Reporting of A Mixed Methods Study (GRAMMS), and Tashakkori and Teddlie's (2008) integrative model of inference quality in mixed methods research.

	Methodological/ Inference Quality Criteria	Indicator/ Audit	Notes/Comments
Design Quality	***Design Suitability***	Are there clear research questions?	See Section 4.1.2
		Is there an adequate justification or rationale for use of a mixed methods approach to address the research question(s)?	See Section 4.1
		Is the design described in terms of the purpose, priority, and sequence of methods?	See Section 4.2
		Are the methods of study appropriate for answering the research question(s)?	See Section 4.1
	Design Adequacy/ Fidelity	Do the various components of the study adhere to criteria of quality and rigour associated with each tradition of the methods involved?	See Sections 4.3, 4.4.4, and 4.5.3
		Are the methods capable of capturing the meanings, effects, or the relationship of interest?	
		Are the components of the design (e.g., sampling, data collection procedures, data analysis procedures) implemented adequately?	See Sections 4.4 and 4.5
		Are there limitations of one methods associated with the presence of the other method(s)?	See Section 9.2
	Within-Design Consistency	Do the components of the design fit together in a seamless manner (i.e., within-design consistency)?	See Section 4.2

	Analytic Adequacy	Do the collected data facilitate analysis addressing the research question(s)? Are the data analysis procedures appropriate and adequate to provide answers to the research question(s)?	See **Sections 4.4.1** and **4.5.1** See **Sections 4.4.2**, **4.4.3**, and **4.5.2**
Interpretive Rigour	***Interpretive Consistency***	Are inferences supported by relevant findings in terms of type, scope, and intensity? Are the multiple inferences made on the basis of the same findings consistent with each other?	See **Chapter Eight** and **Nine** for all issues of interpretive rigour
	Theoretical Consistency	Are the inferences consistent with theory and the state of knowledge in the field?	
	Interpretive Agreement	Do other scholars reach similar conclusions on the basis of the same results (i.e., peer agreement)? Do inferences match participants' constructions (i.e., research-participant agreement)?	
	Interpretive Distinctiveness	Is each inference distinctively more plausible than other possible conclusions which may be made on the basis of the same results?	
	Integrative Efficacy	Are different components of the study effectively integrated to answer the research question(s)? Are insights gained from mixing or integrating methods evident? Are outputs of the integration of qualitative and quantitative components adequately interpreted? Are divergences and inconsistencies between qualitative and quantitative results adequately addressed? Do meta-inferences adequately incorporate inferences made from qualitative and quantitative components of the study?	

Appendix B. Publication Venues Included in Search Queries

Journal
International Journal of Child-Computer Interaction (IJCCI), Elsevier
JMIR Serious Games (JSG), JMIR Publications Inc.
Interacting with Computers (IwC), Oxford University Press
International Journal of Human Computer Studies (IJHCS), Elsevier
Computers in Human Behavior, Elsevier
Transactions on Human-Machine Systems, IEEE (Institute of Electrical and Electronics Engineers)
Information Technology and People, Emerald
Design Studies, Elsevier
Interactions, ACM (Association for Computing Machinery)
Interaction Design and Architecture(s) (IxD&A), Scuola IaD
Cognition, Technology and Work, Springer Nature
Transactions on Computer-Human Interaction (ToCHI), ACM
Behaviour and Information Technology (BIT), Taylor & Francis
International Journal of Mobile Human Computer Interaction (IJMHCI), The Information Resources Management Association
International Journal of Human-Computer Interaction (IJHCI), Taylor & Francis
Foundations and Trends in Human-Computer Interaction, Now Publishers Inc.
British Journal of Educational Technology (BJET), Wiley-Blackwell
CoDesign, Taylor & Francis
Proceedings of the ACM on Human-Computer Interaction (PACMHCI), ACM
Human-Computer Interaction (HCI), Taylor & Francis
Advances in Human-Computer Interaction, Hindawi
Cyberpsychology, Behavior, and Social Networking, Mary Ann Liebert
Computers and Education, Elsevier
Computer Supported Cooperative Work (CSCW), Springer Nature
Digital Creativity, Taylor & Francis
Paladyn, Walter de Gruyter
Psychology, Psychology Journal
International Journal of Social Robotics, Springer Nature
Human Behavior and Emerging Technologies (HBET), Wiley-Blackwell
Interactive Learning Environments, Taylor & Francis

Conference
Interaction Design and Children Conference, ACM
Conference on Human Factors in Computing Systems, ACM
British Human Computer Interaction Conference
British Computer Society Conference on Human-Computer Interaction, ACM
IFIP International Conference on Human-Computer Interaction (INTERACT), Springer Nature
Nordic Conference on Human-Computer Interaction, ACM
Australasian Computer-Human Interaction Conference, ACM
International Conference On Human-Computer Interaction, Springer
International Conference on Association Francophone d'Interaction Homme-Machine, ACM
[Symposium on] Computer-Human Interaction in Play, ACM
Association for Information Science and Technology Annual Meeting, ACM
Association for Information Science and Technology Annual Meeting, ACM
International Conference on Computer Support for Collaborative Learning, ACM

International Conference on Mobile Human-Computer Interaction, ACM
Designing Interactive Systems (DIS) Conference, ACM
Conference on Computer Supported Cooperative Work, ACM
International Conference on Intelligent Human-Computer Interaction, Springer
Asia Pacific Conference on Computer Human Interaction, ACM
European Conference on Games Based Learning, ACI (Academic Conferences International)
European Conference on e-Learning, ACI
International Conference on Tangible, Embedded and Embodied Interaction, ACM
Advances in Intelligent Systems and Computing (AISC), Springer Nature

Appendix C. Correlated Topic Model Generative Process

The Correlated Topic Model (CTM) assumes an N-word document arises through the following generative process (Blei & Lafferty, 2007; Roberts et al., 2019). Given topics $\beta_{1:k}$, K multinomials over a fixed vocabulary, and [μ, Σ], a K-dimensional mean and covariance matrix:

1. Draw $\eta \mid [\mu, \Sigma] \sim N(\mu, \Sigma)$.
2. For each word in the document, $n \in \{1, \ldots, N_d\}$:
   a. Draw the word's topic assignment, $Z_n \mid \eta$, from the document-specific distribution over topics, Mult($f(\eta)$);
   b. Conditional on the topic chosen, draw an observed word, $W_n \mid \{Z_n, \beta_{1:k}\}$, from that topic, Mult($\beta_{Z_n}$);

where $f(\eta)$ maps a natural parameterisation of the topic proportions to the mean parameterisation simplex,

$$\theta = f(\eta) = \frac{\exp\{\eta\}}{\sum_i \exp\{\eta_i\}}$$

This process is illustrated below (see **Figure C.1**) as a probabilistic graphical model, wherein nodes denote random variables and edges denote potential dependencies therebetween.

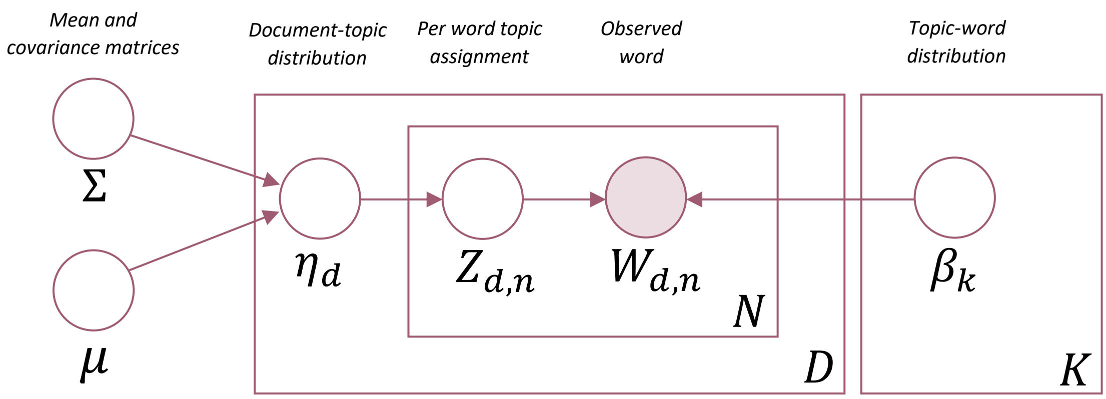


Figure C.1. *Probabilistic graphical model representation of the Correlated Topic Model (CTM). Note, $W_{d,n}$ is shaded, indicating that words are the only observable values in the model. Adapted from Blei & Lafferty (2009).*

Appendix D. Correlated Topic Model Posterior Inference

Given a document w and a model $\{\beta_{1:K}, \mu, \Sigma\}$, the posterior distribution of per-document latent variables is

$$p(\eta, z|w, \beta_{1:K}, \mu, \Sigma)\ \frac{p(\eta|\mu, \Sigma)\prod_{n=1}^{N} p(z_n|\eta)p(w_n|z_n, \beta_{1:K})}{\int p(\eta|\mu, \Sigma)\prod_{n=1}^{N}\sum_{z_n=1}^{K} p(z_n|\eta)p(w_n|z_n, \beta_{1:K})d\eta},$$

which, notably, is intractable to compute due to the integral in the denominator, here the marginal probability of the document on which the variables are conditioned (Blei & Lafferty, 2007). Consequently, an approximate posterior is inferred through an approximate variational expectation-maximisation algorithm using a Laplace approximation to the expectations rendered intractable by the non-conjugacy (Roberts, Stewart, & Airoldi, 2016). Inference involves identification of the approximate posterior which maximizes the approximate evidence lower bound (ELBO),

$$\begin{aligned}\text{ELBO} \approx \sum_{d=1}^{D} E_q[\log p(\eta_d|\mu_d, \Sigma)] + \sum_{d=1}^{D}\sum_{n=1}^{N} E_q\left[\log p\left(z_{n,d}|\eta_d\right)\right] \\ + \sum_{d=1}^{D}\sum_{n=1}^{N} E_q\left[\log p\left(w_{n,d}|z_{n,d}, \beta_{d,k=z_{d,n}}\right)\right] - H(q)\,,\end{aligned}$$

where *H(q)* denotes the entropies of the approximating distributions (Roberts, Stewart, & Airoldi, 2016), with respect to the variational parameters, "thereby tightening the bound on the marginal probability of the observations as much as the structure of variational distribution allows" (Blei & Lafferty, 2007, p. 24).

Appendix E. HDBSCAN Clustering Results

Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN) clustering of Child-Computer Interaction research papers. Coordinates of documents represent t-Distributed position in tf-idf (term frequency-inverse document frequency) vector space dimensionally reduced through t-Stochastic Neighbour Embedding (t-SNE) of a cosine distance matrix. 31 Clusters were identified, with 2,607 noise points (i.e., documents which were not allocated to a cluster; R^2 = .61, BIC = 16177.14). Clusters are labelled based on review of top loading terms.

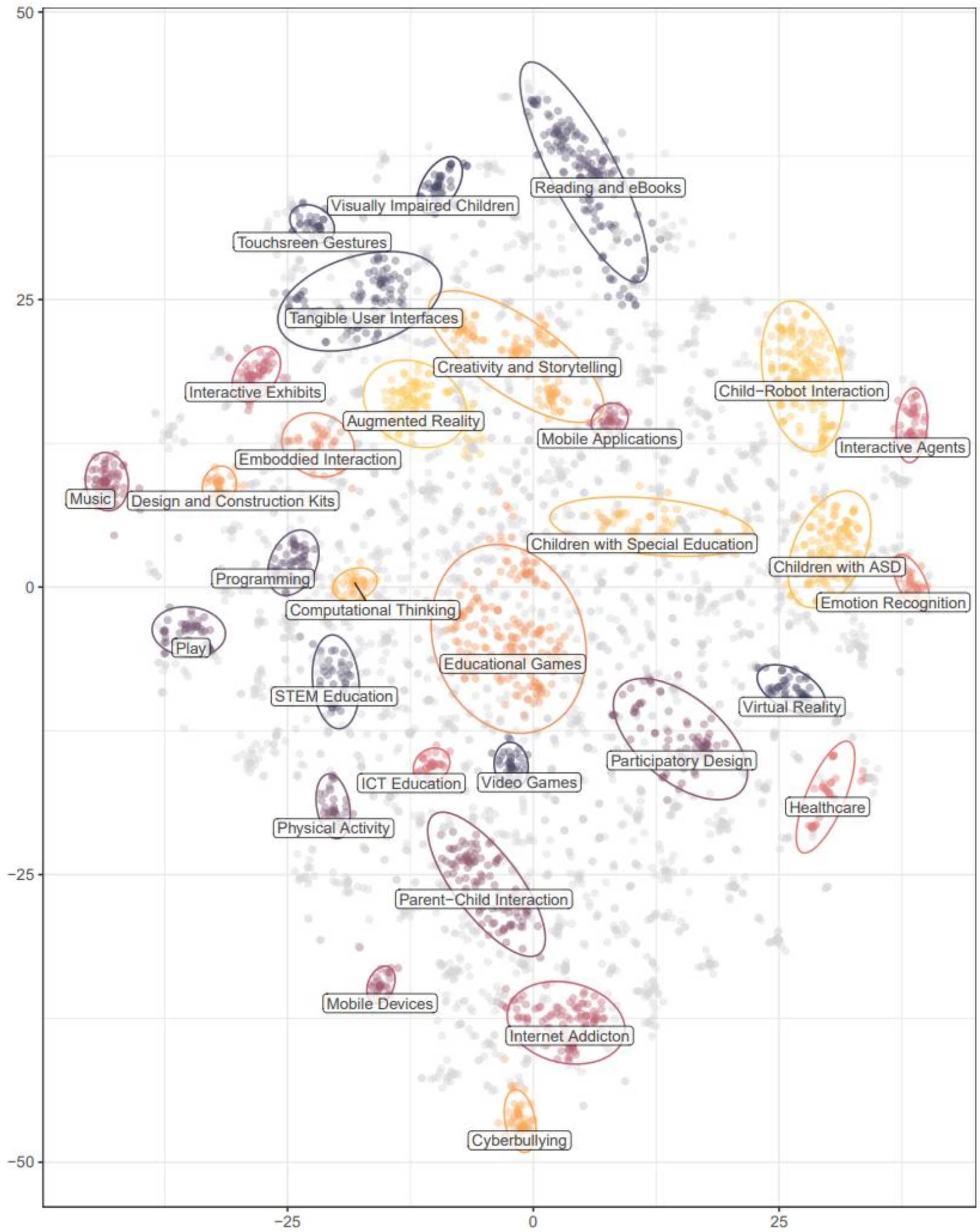


Figure E.1. *HDBSCAN clustering of Child-Computer Interaction research papers (t-SNE projection). 31 Clusters and 2,607 noise points (grey) indicated.*

Appendix F. Latent Topic Number Estimation Metrics

Metrics for estimation of the natural number of latent topics present within the corpus (Cao et al., 2009; Deveaud et al., 2014) calculated for Latent Dirichlet Allocation (LDA) models fitted for an appropriate level of granularity. Note, values are rescaled from 0 (minimum value) to 1 (maximum value) for each measure.

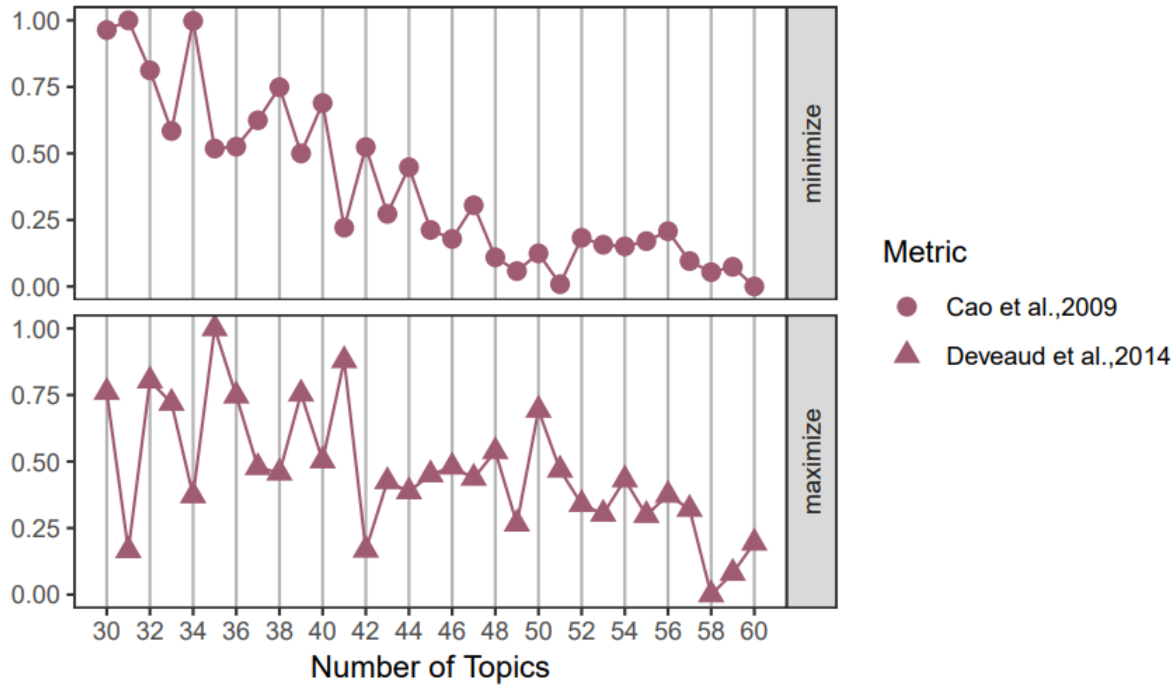


Figure F.1. *Latent topic number estimation based on metrics developed by Cao et al. (2009) and Deveaud et al. (2014)*

Appendix G. Candidate Correlated Topic Model Diagnostic Metrics

Diagnostic metrics – mean topic semantic coherence and exclusivity (Boyd-Graber et al., 2014),, and marginal probability of held-out documents under models (Boyd-Graber et al., 2014) – calculated for Correlated Topic Models (CTM) fitted at an appropriate level of granularity.

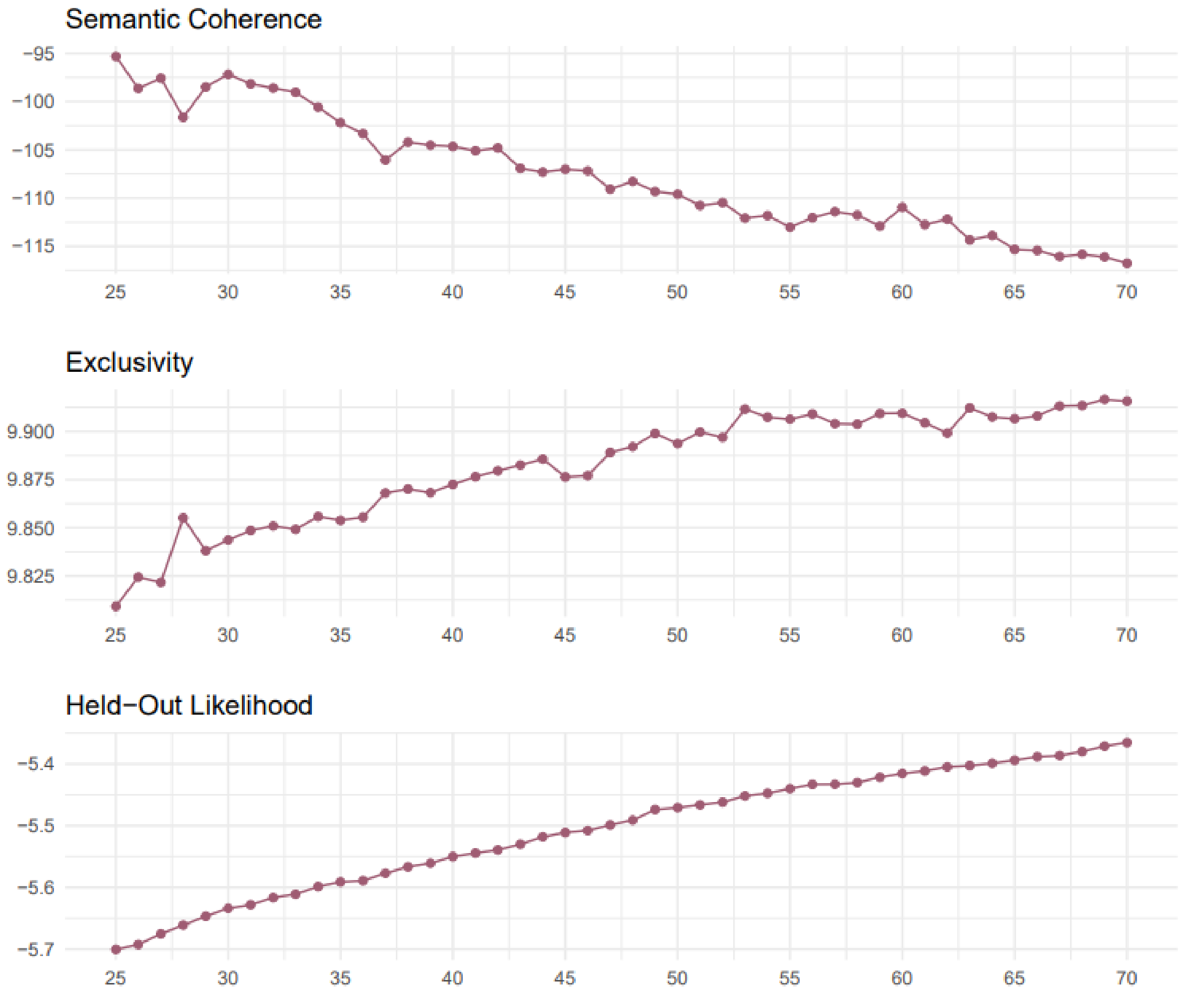


Figure G.1. *Candidate CTM model topic diagnostics (mean topic values).*

Appendix H. Candidate Model Representative Terms and Documents

Terms (based on topic-word distribution, β_k) and documents (based on document-topic distribution, θ_d) representative of topics inferred through candidate Correlated Topic Models – here, models inferring 32, 41, 48, and 56 topics respectively – and initial evaluation and interpretation (i.e., proposed topic labels) thereof.

Table H.1. *Interpretation of, and terms and documents associated with, topics inferred through a candidate Correlated Topic Model fitted for 32 topics.*

Number of Topics Modelled: 32		
Initial Interpretation	**Probable Terms**	**Probable document**
Participatory Design (Processes and Methods)	design, process, participatori, participatori design, design process, children design, particip	Mixing ideas: A new technique for working with young children as design partners
Child-Robot Interaction/ Social, Educational, and Assistive Robots	robot, interact, social, human, social robot, child, humanoid, robot interact, companion	Investigating the nature of children's altruism using a social humanoid robot
Computational Thinking and Programming/ Programming and Coding	comput, program, think, code, comput think, construct, scienc, model, concept, environ, kit	Aiding the transition from novice to traditional programming environments
Social Media	social, media, social interact, support, social media, peer, share, social skill, engag, children	Do I stay or do I go? Motivations and decision making in social media non-use and reversion
Educational Digital (/Computer) Games (inc. Design and Game-based Learning)	game, game design, player, comput game, educ game, develop, gamebas, game children	Merging gameplay and learning in educational game design: The gameplay loop methodology in antura and the letters
Cyberbullying (and Cybervictimization)	adolesc, cyberbulli, gender, factor, youth, victim, perceiv, differ, age, percept, behavior	Longitudinal Associations in Youth Involvement as Victimized, Bullying, or Witnessing Cyberbullying
Internet and Smartphone Addiction	internet, adolesc, scale, addict, valid, relationship, mediat, measur, questionnair, factor	Psychological security and deviant peer affiliation as mediators between teacher-student relationship and adolescent Internet addiction
Interaction Design/ Child-Computer Interaction and Design (General) [vague]	interact, interact design, design, child, develop, comput, children interact, evalu, childcomput	Child-computer interaction SIG: Looking forward after 18 years
Mobile Devices and Applications	mobil, applic, devic, app, tablet, phone, develop, mobil devic, mobil phone, user, mobil applic	Designing mobile phones for children: Is there a difference?
Reading (and Literacy)	read, literaci, book, preschool, word, comprehens, text, skill, preschool children, print, improv	Reading electronic books as a support for vocabulary, story comprehension and word reading in kindergarten and first grade
Experiment	perform, test, task, assess, measur, condit, compar, cognit, control, feedback, abil, write	On the correlation between children's performances on electronic board tasks and

		nonverbal intelligence test measures
Special Educational Needs and Disabilities/ Visual Impairments [focuses more specifically on vi]	visual, disabl, special, inclus, impair, access, wearabl, feedback, visual impair, spatial	Audible beacons and wearables in schools: Helping young visually impaired children play and move independently
(Effects of) Video Game Play and Screen Time (on Cognition and Behaviour)	video, behavior, video game, time, girl, aggress, boy, increas, relationship, exposur, screen, age	Effects of Violent Video Games on Aggressive Cognition and Aggressive Behavior
Collaborative Learning (Environments)/ Collaborative and Interactive Learning (Environments)	learn, environ, learner, collabor, learn environ, support, children learn, mathemat, scienc	Fostering deeper learning in a flipped classroom: Effects of knowledge graphs versus concept maps
STEM (/STEAM) Education/ STEM (/STEAM) and Digital Fabrication	educ, teacher, develop, teach, technolog, digit, classroom, stem, school, practic, framework, integr	STEAM in Oulu: Scaffolding the development of a Community of Practice for local educators around STEAM and digital fabrication
Data and Information Collection/ User Experience Evaluations/ Web Literacy [mixed]	data, inform, collect, evalu, usabl, web, adult, softwar, understand, interview, search, age	An exploration of graphical password authentication for children
Autism Spectrum Disorders	autism, asd, disord, spectrum, children autism, autism spectrum, spectrum disord	Effectiveness of Video Modelling to Improve Playing Skills of Children with Autism Spectrum Disorders
Primary School ICT/ ICT in (Primary School) Classrooms/ Schools	student, school, primari, elementari, primari school, classroom, school student	The contribution of pupil, classroom and school level characteristics to primary school pupils' ICT competences: A performance-based approach
Play (inc. Outdoor Play and Toys)	play, toy, outdoor, children play, observ, interact, experi, design, explor, age, children age, role	Video playdate: Toward free play across distance
Embodied Interaction (Movement and Gestures)	interact, embodi, bodi, gestur, touch, adult, display, input, screen, movement, touchscreen	Biting, whirling, crawling – Children's embodied interaction with walk-through displays
Online Safety and Privacy/ Social Network Content, Safety, and Privacy	onlin, person, network, content, privaci, social network, peopl, user, risk, safeti, site, profil, share	Adolescents' Reasons to Unfriend on Facebook
Virtual Reality (inc. Immersive Experiences, Simulations, and Training)	virtual, environ, train, realiti, virtual realiti, charact, world, immers, vr, real, virtual environ	Virtualizing the real: a virtual reality contemporary sculpture park for children
Culture and Community/ Communities of Support/ Ethics in CCI [very mixed, unclear]	technolog, support, cultur, communiti, practic, challeng, discuss, live, opportun	Designing cultural probes for children
Tangible User Interfaces/ Tangible Technologies and (Tangible) User Interfaces	tangibl, interfac, user, user interfac, system, prototyp, manipul, design, physic	Tangible voting: A technique for interacting with group choices on a tangible tabletop
Intelligent Communication Systems (inc. Speech, Sign Language, and Emotion Detection) [mixed, includes elements of voice, language, and speech, but also emotion]	system, communic, emot, languag, express, develop, speech, intellig, convers, agent	Exploring sensor gloves for teaching children sign language

(User Experiences of) Assistive and Therapeutic Technologies/ Neurodiverse Children's Technology Experiences	experi, assist, evalu, user, autist, therapi, user experi, technolog, assist technolog, autist children	Experiences of autistic children with technologies
Healthcare (inc. Mental Health, Preventative, Paediatric, and Hospital)	health, care, intervent, mental, manag, support, patient, treatment, hospit, anxieti	Exploring gaps in cancer care using a systems safety perspective
Storytelling/ Story Creation and Sharing	digit, collabor, tool, stori, creat, storytel, support, narrat, creation, share, space, librari	Reviewing children's collaboration practices in storytelling environments
Physical Activity, Exercise, and Fitness/ Exercise, Fitness and Healthy Habit Promotion	activ, physic, motiv, engag, physic activ, encourag, exercis, movement, particip, activ	Effects of the FIT game on physical activity in sixth graders: A pilot reversal design intervention study
Parent (Technology) Monitoring and Control (Practices)/ Parent Technology Management (Practices)	parent, famili, child, home, time, mediat, parent children, parentchild, communic, mother	Fighting over smartphones? Parents' excessive smartphone use, lack of control over children's use, and conflict
Creativity/ Creative Expression (inc. Art and Music)	creativ, music, museum, sound, draw, express, art, exhibit, control, instrument, experi	Deceptive cadence: An interactive artwork for cooperative play
Augmented and Mixed Reality	augment, realiti, augment realiti, ar, applic, mix, realiti ar, experi, augment realiti ar, technolog	Impact of the textbooks' graphic design on the augmented reality applications tracking ability

Table H.2. *Interpretation of, and terms and documents associated with, topics inferred through a candidate Correlated Topic Model fitted for 41 topics.*

Number of Topics Modelled: 41		
Initial Interpretation	**Probable Terms**	**Probable document**
Design Methods, Principles, and Guidelines/ User-Centred Design Processes	design, process, develop, prototyp, children design, design process, framework, design children	The 'relay ideation' technique: Moving from problem understanding to problem solving in the design process
Child-Robot Interaction/ Social, Educational, and Assistive Robots	robot, interact, human, social robot, social, humanoid, robot interact, child, companion, humanoid robot	Investigating the nature of children's altruism using a social humanoid robot
Computer Programming	program, environ, scratch, electron, block, creat, languag, construct, programm, code, program environ	Aiding the transition from novice to traditional programming environments
Social Media (Interactions)	social, media, social interact, social media, social skill, peer, children social, design social, engag, theori	Does Social Media Close the Political Efficacy Gap to Participate in Politics?
Educational Digital (/Computer) Games (inc. Design and Game-based Learning)	game, game design, player, comput game, educ game, game children, digit game, gameplay, develop	A Literature Review for Non-player Character Existence in Educational Game
Cyberbullying (and Cybervictimization)	adolesc, gender, cyberbulli, victim, girl, factor, youth, differ,	Longitudinal Associations in Youth Involvement as Victimized,

	age, behavior, boy, relat, perceiv, intent	Bullying, or Witnessing Cyberbullying
Internet and Smartphone Addiction	internet, adolesc, addict, scale, valid, relationship, measur, correl, mediat, factor, problemat, questionnair	Psychological security and deviant peer affiliation as mediators between teacher-student relationship and adolescent Internet addiction
Interaction Design/ Design Evaluation [vague]	evalu, interact, child, usabl, interact design, fun, hci, design evalu, childcomput, childcomput interact	Using the fun toolkit and other survey methods to gather opinions in Child Computer Interaction
Mobile Devices and Applications	mobil, applic, app, devic, phone, mobil devic, develop, mobil phone, mobil applic, mobil learn, user, rural	Personal microdevices for wide-area location via mobile gateways
Reading (and Literacy)	read, book, word, comprehens, literaci, text, print, pictur, reader, stori, children read, skill, electron	Reading electronic books as a support for vocabulary, story comprehension and word reading in kindergarten and first grade
Experiment	test, task, perform, assess, compar, feedback, condit, write, measur, type, score, abil, differ, experiment	Causes of simultaneous keystrokes in children and adults
Visually Impaired and Mixed Visual Ability/ Special Educational Needs and Disabilities	visual, disabl, special, inclus, impair, access, visual impair, haptic, audio, feedback, peopl, special educ, spatial	Audible beacons and wearables in schools: Helping young visually impaired children play and move independently
(Effects of) Video Game Play and Screen Time (on Cognition and Behaviour)	video, behavior, video game, time, aggress, increas, exposur, game, screen, report, predict, associ, age	Effects of Violent Video Games on Aggressive Cognition and Aggressive Behavior
Collaborative Learning (Environments)/ Collaborative and Interactive Learning (Environments)	learn, environ, learn environ, children learn, teach, learner, languag, collabor learn, motiv	Comparative study of game-based learning on preschoolers' English vocabulary acquisition in Taiwan
STEM (/STEAM) Education and Digital Fabrication/ Educational Technologies in Schools	educ, teacher, develop, teach, stem, practic, sustain, school, classroom, technolog, maker, fabric, integr	STEAM in Oulu: Scaffolding the development of a Community of Practice for local educators around STEAM and digital fabrication
Data and Information Security and Protection/ Data Privacy, Security and Protection	inform, data, collect, web, search, interview, data collect, kid, sourc, understand, privaci, age, secur	Kidnapping WhatsApp – Rumors during the search and rescue operation of three kidnapped youth
Children with Autism Spectrum Disorder	autism, asd, disord, spectrum, children autism, autism spectrum, spectrum disord, autism spectrum	Effectiveness of Video Modelling to Improve Playing Skills of Children with Autism Spectrum Disorders
Primary (/Elementary) Schools/ ICT in (Primary School) Classrooms/ Schools	school, student, primari, elementari, primari school, classroom, teacher, elementari school, ict, school	Exploring factors related to primary school pupils' ICT self-efficacy: A multilevel approach
Play (inc. Outdoor Play and Toys)	play, toy, outdoor, children play, observ, interact, explor, role, age, engag, children age, natur, play learn	A little bit of coding goes a long way: Effects of coding on outdoor play

Touchscreen Gestures and Interaction	adult, tablet, gestur, age, touch, screen, interact, input, devic, user, children age, touchscreen	Toward a systematic understanding of children's touchscreen gestures
Online Safety and Privacy/ Social Network Content, Safety, and Privacy	onlin, person, network, content, social network, peopl, risk, site, user, safeti, adolesc, relat, profil, post	Adolescents' Reasons to Unfriend on Facebook
Virtual Reality (inc. Immersive Experiences, and Simulations)	virtual, environ, realiti, virtual realiti, world, real, charact, immers, vr, virtual environ, particip, experi	Virtualizing the real: a virtual reality contemporary sculpture park for children
Technology in Children’s (Everyday) Lives/ Ubiquitous Technology (/Computing) [mixed]	technolog, cultur, live, practic, technolog children, understand, context, opportun, discuss, engag	Designing cultural probes for children
Tangible User Interfaces/ Tangible Technologies and (Tangible) User Interfaces	tangibl, interfac, user, system, user interfac, manipul, physic, tangibl interact, tangibl user	Tangible voting: A technique for interacting with group choices on a tangible tabletop
Intelligent Communication Systems (inc. Speech, Sign Language, and Emotion Detection) [mixed, includes elements of voice, language, and speech, but also emotion]	communic, system, languag, express, convers, speech, recognit, agent, voic, sign, imag, develop, detect	Exploring sensor gloves for teaching children sign language
(Evaluation of) (Neurodiverse) Children’s User Experiences (of Assistive Technologies)	experi, user, autist, evalu, user experi, assist, autist children, empathi, assist technolog	Experiences of autistic children with technologies
Healthcare (inc. Mental Health, Preventative, Paediatric, and Clinical)	health, mental, care, intervent, manag, patient, anxieti, mental health, treatment, caregiv, stress	Making healthcare infrastructure work: Unpacking the Infrastructuring work of Individuals
Digital Libraries	digit, literaci, librari, develop, children digit, digit media, digit technolog, design digit, skill, world	Encapsulating streams of consciousness into the international children's digital library
Physical Activity, Exercise, and Fitness/ Physical Activity, Fitness and Healthy Habit Promotion	activ, physic, motiv, engag, physic activ, encourag, particip, increas, activ children, fit, exercis, platform	Effects of the FIT game on physical activity in sixth graders: A pilot reversal design intervention study
Parent (Technology/ Screen-Time) Monitoring and Control (Practices)	parent, famili, home, child, mediat, time, parent children, parentchild, children parent, interview	Fighting over smartphones? Parents' excessive smartphone use, lack of control over children's use, and conflict
Music and Movement/ Music (Education, Creation, and Performance)	music, movement, sound, motion, instrument, control, composit, color, express, perform, system, bodi, light	A Study on the Use of Motion Graphics and Kinect in LMA (Laban Movement Analysis) Expression Activities for Children with Intellectual Disabilities
Augmented and Mixed Reality	augment, realiti, augment realiti, ar, mix, applic, realiti ar, augment realiti ar, spatial, experi, system, technolog	Impact of the textbooks’ graphic design on the augmented reality applications tracking ability
Preschool and Kindergarten Children/ Early Years [strong elements of emotion	emot, preschool, regul, cognit, strategi, affect, preschool children, develop, intellig, perform, task	The effect of the external regulator's absence on children's speech use, manifested self-regulation, and task performance during learning tasks

Rehabilitative and Therapeutic Technologies	system, train, skill, attent, improv, adapt, develop, function, cognit, motor, therapi, test, control	A neurocognitive virtual rehabilitation system for children with cerebral palsy: A preliminary usability study
Computational Thinking (and Computer Science)	comput, think, solv, code, comput think, skill, develop, teach, concept, practic, children comput, algorithm	Towards a model of progression in computational empowerment in education
Communities of Support/ Technology Supports and Tools for (Children/ Parents)	support, share, support children, tool, awar, mother, infant, remot, space, role, technolog support	'Digital motherhood': How does technology support new mothers?
Creative and Collaborative Storytelling/ Storytelling	collabor, creativ, stori, creat, storytel, tool, draw, creation, narrat, construct, engag, kit, express, anim	StoryFaces: Pretend-play with ebooks to support social-emotional storytelling
Embodied (and Full-Body) Interactions (inc. Museum Exhibits and Experiences)	interact, embodi, bodi, museum, exhibit, children interact, display, experi, interact design, space	Biting, whirling, crawling - Children's embodied interaction with walk-through displays
Participatory Design (Values, Ethics, Roles, and Processes)	design, participatori, participatori design, reflect, particip, process, challeng, workshop, involv, ethic, pd	CHECk: A Tool to Inform and Encourage Ethical Practice in Participatory Design with Children
Science and Mathematics Education (in Schools)	student, scienc, learn, model, mathemat, knowledg, middl, engag, middl school, concept, scientif	How middle school students construct and critique graphs to explain cancer treatment
(Supports and Solutions for) Hospitalized Children	set, hospit, solut, develop, relat, potenti, phase, process, life, gamif, challeng, awar, design, deriv, unit	Complexity of the pediatric trauma care process: implications for multi-level awareness

Table H.3. *Interpretation of, and terms and documents associated with, topics inferred through a candidate Correlated Topic Model fitted for 48 topics.*

Number of Topics Modelled: 48		
Initial Interpretation	**Probable Terms**	**Probable document**
Design Methods, Principles, and Guidelines/ User-Centred Design Processes	design, prototyp, process, develop, children design, framework, design process, design children, iter	The 'relay ideation' technique: Moving from problem understanding to problem solving in the design process
Child-Robot Interaction/ Social, Educational, and Assistive Robots	robot, interact, social, social robot, human, humanoid, robot interact, companion, humanoid robot, assist	Investigating the nature of children's altruism using a social humanoid robot
(Computer) Programming	program, environ, scratch, block, programm, languag, code, creat, program environ, program languag	Aiding the transition from novice to traditional programming environments
Social Media (Interactions)	social, media, social interact, social media, social skill, children social, share, theori, design social, ecolog	Does Social Media Close the Political Efficacy Gap to Participate in Politics?

Educational Digital (/Computer) Games (inc. Design and Game-based Learning)	game, game design, player, comput game, educ game, game children, develop, digit game, gameplay	Merging gameplay and learning in educational game design: The gameplay loop methodology in antura and the letters
Cyberbullying (and Cybervictimization)	adolesc, behavior, cyberbulli, victim, gender, relat, age, risk, factor, youth, negat, femal, role, associ, differ	Longitudinal Associations in Youth Involvement as Victimized, Bullying, or Witnessing Cyberbullying
Internet and Smartphone Addiction/ Problematic Internet and Smartphone Use/ Internet and Smartphone Abuse	internet, addict, scale, adolesc, valid, measur, correl, problemat, relationship, mediat, factor, depress	The validation of the E-Victimisation Scale (E-VS) and the E-Bullying Scale (E-BS) for adolescents
Design Evaluation (inc. Heuristic and Usability Evaluation)/ Interaction Design [mixed]	evalu, child, interact, usabl, design evalu, childcomput, childcomput interact, interact design	Using the fun toolkit and other survey methods to gather opinions in Child Computer Interaction
Mobile Devices and Applications/ Mobile Technologies	mobil, devic, applic, phone, mobil devic, mobil phone, mobil applic, mobil learn, rural, user	A long-term field study on the adoption of smartphones by children in Panama
Reading (and Literacy)	read, book, comprehens, word, text, literaci, print, reader, pictur, children read, stori, electron, emerg, skill	Reading electronic books as a support for vocabulary, story comprehension and word reading in kindergarten and first grade
Experiment	assess, task, perform, test, write, compar, feedback, condit, score, measur, experiment, time, control	Causes of simultaneous keystrokes in children and adults
Visually Impaired and Mixed Visual Ability/ Special Educational Needs and Disabilities	visual, impair, feedback, visual impair, audio, haptic, spatial, map, multimod, vision, tactil, abil	Audible beacons and wearables in schools: Helping young visually impaired children play and move independently
(Effects of) Video Game (Play) and Screen Time (on Cognition and Behaviour)	video, video game, girl, boy, time, aggress, exposur, gender, game, age, increas, screen, relationship, boy girl	Effects of Violent Video Games on Aggressive Cognition and Aggressive Behavior
Interactive and Game-Based Learning (Environments)/ Technology-Enhanced Learning/ Interactive Learning Environments	learn, environ, learn environ, children learn, teach, experi, gamebas, english, interact learn	Comparative study of game-based learning on preschoolers' English vocabulary acquisition in Taiwan
Educational Technologies in Schools(/Classrooms/ STEM Education and Digital Fabrication	educ, teacher, technolog, teach, develop, stem, practic, classroom, school, sustain, integr, fabric, base	Makerspace in school—Considerations from a large-scale national testbed
Privacy and Security/ Web Searching and Information Seeking [mixed]	inform, web, search, kid, sourc, privaci, knowledg, secur, seek, understand, age, safeti, resourc	"Anon what what?": Children's understanding of the language of privacy
Children with Autism Spectrum Disorder	autism, asd, disord, spectrum, children autism, autism spectrum, spectrum disord	Effectiveness of Video Modelling to Improve Playing Skills of Children with Autism Spectrum Disorders
Primary (/Elementary) Schools / Primary School Students/ ICT in (Primary School) Classrooms	school, student, primari, elementari, primari school, classroom, teacher, elementari school, ict	Exploring factors related to primary school pupils' ICT self-efficacy: A multilevel approach

Play (inc. Outdoor Play and Toys)	play, toy, outdoor, children play, role, observ, explor, age, children age, play learn, interact	A little bit of coding goes a long way: Effects of coding on outdoor play
Touchscreen Gestures and Interaction/ Touch Gestures, Interactions and Inputs	adult, gestur, touch, user, input, interact, age, children adult, hand, touchscreen, perform, style, screen	Toward a systematic understanding of children's touchscreen gestures
Motivation [mixed, factors influencing, satisfaction and enjoyment] *	motiv, content, person, peopl, influenc, particip, age, perceiv, user, prefer, percept, factor, differ, increas	Predicting effectiveness of children participants in user testing based on personality characteristics
Virtual Reality (inc. Immersive Experiences, and Simulations)	virtual, environ, realiti, world, virtual realiti, real, immers, vr, virtual environ, particip, real world, experi	Virtualizing the real: a virtual reality contemporary sculpture park for children
Technology in Children's (Everyday) Lives/ Ubiquitous Technology (/Computing)	technolog, engag, cultur, communiti, experi, practic, understand, live, space, context, youth, discuss, explor	Designing cultural probes for children
Tangible User Interfaces/ Tangible Technologies and (Tangible) User Interfaces	tangibl, interfac, user, user interfac, system, manipul, tangibl interact, tangibl user, tangibl user interfac	Tangible voting: A technique for interacting with group choices on a tangible tabletop
Augmentative and Alternative Communication Technologies/ Systems [cleaner than prior models]	communic, system, languag, speech, softwar, develop, sign, recognit, voic, hear, messag, generat, base	Exploring sensor gloves for teaching children sign language
(Evaluation of) (Neurodiverse) Children's User Experiences (of Assistive Technologies)	experi, user, autist, user experi, autist children, evalu, empathi, card, sensori, situat, experi children	Experiences of autistic children with technologies
Mental Health (Treatment, Management, and Promotion)	health, intervent, mental, manag, anxieti, mental health, stress, psycholog, servic, prevent, reduc	Socially Assistive Robots as Mental Health Interventions for Children: A Scoping Review
Digital Libraries	digit, literaci, develop, librari, children digit, digit technolog, digit media, skill, design digit, public	Encapsulating streams of consciousness into the international children's digital library
Physical Activity, Exercise, and Fitness/ Physical Activity, Fitness and Healthy Habit/ Behaviour Promotion	activ, physic, physic activ, encourag, engag, activ children, particip, fit, motiv, balanc, increas, exercis, learn	Effects of the FIT game on physical activity in sixth graders: A pilot reversal design intervention study
Parent (Technology/ Screen-Time) Monitoring and Control (Practices)	parent, famili, home, mediat, child, time, parent children, parentchild, children parent, control, interview	Fighting over smartphones? Parents' excessive smartphone use, lack of control over children's use, and conflict
Music and Movement/ Music (Education, Creation, and Performance)	music, movement, sound, control, motion, instrument, composit, sequenc, perform, bodi, base	A Study on the Use of Motion Graphics and Kinect in LMA (Laban Movement Analysis) Expression Activities for Children with Intellectual Disabilities
Augmented and Mixed Reality	augment, realiti, augment realiti, ar, mix, realiti ar, augment realiti ar, applic, technolog, experi, combin	Impact of the textbooks' graphic design on the augmented reality applications tracking ability

Tutoring (and Leaning) Systems/ Tutoring (and Self-Regulated Leaning) Systems	strategi, cognit, learner, regul, learn, tutor, develop, perform, scaffold, process, task, skill, memori, mind	The effect of the external regulator's absence on children's speech use, manifested self-regulation, and task performance during learning tasks
Rehabilitative and Therapeutic Technologies	train, attent, skill, improv, adapt, therapi, system, motor, function, test, develop, rehabilit, control	A neurocognitive virtual rehabilitation system for children with cerebral palsy: A preliminary usability study
Computational Thinking (and Computer Science)/ Computational Thinking and Computer (Science) Skills Development	comput, think, code, solv, comput think, skill, develop, concept, teach, practic, algorithm, children comput	Towards a model of progression in computational empowerment in education
Tools and Supports for New Mothers (and Infants)/ Technology Support for New Mothers	support, share, tool, support children, mother, infant, remot, awar, technolog support, role	'Digital motherhood': How does technology support new mothers?
Storytelling/ Creative Storytelling/ Creativity and Construction	creativ, stori, creat, storytel, tool, construct, creation, narrat, kit, art, express, author, idea, toolkit, craft	Drawing the electric: Storytelling with conductive ink
Embodied Interaction (Interactive Spaces, Displays, and Systems)	interact, embodi, bodi, museum, interact design, exhibit, children interact, experi, concept, environ	Biting, whirling, crawling - Children's embodied interaction with walk-through displays
Participatory Design involving Children (Values, Roles, and Processes)	design, participatori, participatori design, process, particip, involv, reflect, design process, pd, challeng	Exploring challenging group dynamics in participatory design with children
Science and Mathematics Education (in Schools)/ STEM Education	student, scienc, model, learn, middl, middl school, knowledg, scientif, school, engag, mathemat, concept	How middle school students construct and critique graphs to explain cancer treatment
(Paediatric) Healthcare and Hospitals/ Healthcare and Healthcare Settings	care, patient, gamif, caregiv, hospit, pediatr, transit, healthcar, medic, clinic, set, applic, improv, procedur	From care plans to care coordination: Opportunities for computer support of teamwork in complex healthcare
Preschool (and Kindergarten) Children/ Tablet Applications and Preschool Children	app, preschool, tablet, draw, math, develop, mathemat, preschool children, age, kindergarten, color	Designing Drawing Apps for Children: Artistic and Technological Factors
Virtual, Robotic, and Conversational Agents and Emotion/ Emotional Expression and Recognition	emot, express, agent, anim, intellig, charact, convers, human, affect, facial, behavior, recognit, artifici	Acted Emotional Expressions of Game-playing Children: Investigating the Influence of Emotion Intensity on Recognition Rates
Collaborative Learning	collabor, collabor learn, tabletop, pair, children collabor, share, individu, tabl, learn, multitouch	Beyond one-size-fits-all: How interactive tabletops support collaborative learning
Social Networking/ Social Networks (Risks, Privacy, Safety, and Relationships)	onlin, peer, network, social network, site, risk, relationship, teen, adolesc, friend, social, safeti, relat, ident	The pervasiveness, connectedness, and intrusiveness of social network site use among young adolescents
Data Collection Methods [Includes sensors, cameras, tracking, wearables, but also traditional interviews]	data, collect, observ, interview, record, data collect, sensor, system, captur, awar, track, reflect, detect	Camera for the invisible

Assistive and Inclusive Technology (for Children with Special Education Needs/ Disabilities)	technolog, disabl, assist, special, inclus, access, develop, challeng, technolog children, assist technolog	A study of the challenges related to DIY Assistive Technology in the context of children with disabilities
Critical Reflection on Ethics/ Emerging Challenges and Future Directions [quite broad]	critic, challeng, ethic, emerg, hci, set, sensit, discuss, reflect, futur, concern, review, perspect, literatur	Empowering Children's Critical Reflections on AI, Robotics and Other Intelligent Technologies

Table H.4. *Interpretation of, and terms and documents associated with, topics inferred through a candidate Correlated Topic Model fitted for 56 topics.*

Number of Topics Modelled: 56		
Initial Interpretation	**Probable Terms**	**Probable document**
Design Methods, Principles, and Guidelines/ Design Processes and Techniques involving Children	design, process, develop, prototyp, children design, framework, design children, design process, iter	Development and application of a framework for comparing early design methods for young children
Child-Robot Interaction/ Social, Educational, and Assistive Robots	robot, social, social robot, interact, human, humanoid, robot interact, companion, humanoid robot, assist	Intentional acceptance of social robots: Development and validation of a self-report measure for children
(Computer) Programming	program, scratch, programm, languag, code, program environ, program languag, block, novic, creat, comput program, learn program	Aiding the transition from novice to traditional programming environments
Social Media (Platforms, Social Interaction)/ Social Media Design and Features	social, media, social interact, social media, social skill, share, children social, design social, theori, ecolog	Does Social Media Close the Political Efficacy Gap to Participate in Politics?
Educational Digital (/Computer) Games (inc. Design and Game-based Learning)	game, game design, player, comput game, educ game, game children, digit game, gameplay, develop	Effects of cooperative gaming and avatar customization on subsequent spontaneous helping behavior
Cyberbullying (and Cybervictimization)	adolesc, behavior, cyberbulli, victim, youth, relat, negat, risk, age, role, associ, intent, belief, predict, prevent	Longitudinal Associations in Youth Involvement as Victimized, Bullying, or Witnessing Cyberbullying
Internet and Smartphone Addiction/ Problematic Internet and Smartphone Use	internet, scale, addict, valid, measur, adolesc, correl, problemat, sampl, depress, factor, reliabl, questionnair	The validation of the E-Victimisation Scale (E-VS) and the E-Bullying Scale (E-BS) for adolescents
User Experience and Evaluation/ Design Evaluation	evalu, child, usabl, experi, user, fun, design evalu, user experi, develop, comput interact, age, child comput	Using the fun toolkit and other survey methods to gather opinions in Child Computer Interaction
Mobile Devices and Applications/ Mobile Technologies	mobil, applic, phone, devic, mobil devic, mobil phone, mobil applic, mobil learn, rural, develop, user	Designing mobile phones for children: Is there a difference?
Reading (and Literacy)	read, book, comprehens, word, text, literaci, reader, pictur,	Electronic books: Children's reading and comprehension

	children read, print, emerg, electron, stori, letter	
Performance Measurement/ (Computer-Based) Assessment and Feedback [mixed]	assess, perform, task, test, write, feedback, compar, type, featur, model, measur, error, correct	Identifying Developmental Dysgraphia Characteristics Utilizing Handwriting Classification Methods
Visually Impaired and Mixed Visual Ability	visual, impair, feedback, multimod, visual impair, audio, map, haptic, vision, tactil, represent, multisensori	Audible beacons and wearables in schools: Helping young visually impaired children play and move independently
(Effects of) Video Game (Play) and Screen Time (on Cognition and Behaviour)	video, video game, girl, boy, aggress, exposur, gender, boy girl, relationship, increas, report, age	Effects of Violent Video Games on Aggressive Cognition and Aggressive Behavior
Game-Based Learning/ Multimedia Enhanced Learning (Experiences)	learn, children learn, teach, gamebas, english, gamebas learn, experi, learn process, learn experi	Comparative study of game-based learning on preschoolers' English vocabulary acquisition in Taiwan
Educational Technologies in Schools / STEM Education and Digital Fabrication	educ, develop, technolog, teach, stem, fabric, formal, educ technolog, univers, framework, integr	Tangible ideas for children: Materials science as the future of educational technology
Information Seeking and Web Navigation	inform, web, kid, search, sourc, seek, process, navig, document, resourc, content, instruct, knowledg, path	Searching for spellcheckers: What kids want, what kids need
Children with Autism Spectrum Disorder	autism, asd, disord, spectrum, autism spectrum, spectrum disord, autism spectrum disord	Effectiveness of Video Modelling to Improve Playing Skills of Children with Autism Spectrum Disorders
Primary (/Elementary) Schools / ICT in (Primary School) Classrooms/ Schools	school, student, primari, elementari, primari school, elementari school, ict, level, school children	The contribution of pupil, classroom and school level characteristics to primary school pupils' ICT competences: A performance-based approach
Play (inc. Outdoor Play; Free, Exploratory and Role Play; and Toys)	play, outdoor, children play, role, observ, age, children age, explor, play learn, play children, free, experi, play interact, set, rule, pervas, natur	A little bit of coding goes a long way: Effects of coding on outdoor play
Touchscreen Gestures and Interaction/ Touch Gestures, Interactions and Inputs	adult, gestur, touch, user, input, age, children adult, touchscreen, style, hand, techniqu, perform, compar	Toward a systematic understanding of children's touchscreen gestures
(Effects/Influence of) Participant Characteristics (on Motivation and Attitudes) [unclear/mixed]	person, motiv, differ, content, particip, influenc, factor, age, perceiv, peopl, gender, experi, prefer	The effects of individual innovativeness on users' adoption of Internet content filtering software and attitudes toward children's Internet use
Virtual Reality (inc. Immersive Experiences, Displays, and Training)	virtual, realiti, virtual realiti, immers, vr, particip, experi, potenti, tradit, procedur, display, train, platform	Feasibility of articulated arm mounted oculus rift virtual reality goggles for adjunctive pain control during occupational therapy in pediatric burn patients

Technology in Children's (Everyday) Lives/ Ubiquitous Technology (/Computing) [mixed]	technolog, experi, cultur, understand, live, context, space, explor, everyday, technolog children, life, insight, technolog design	Designing cultural probes for children
Tangible User Interfaces/ Tangible Technologies and (Tangible) User Interfaces	tangibl, interfac, user, user interfac, manipul, tangibl interact, tangibl user, tangibl user interfac	Supporting children's creativity through tangible user interfaces
Augmentative and Alternative Communication Systems/ Intelligent Communication Systems	communic, languag, softwar, speech, sign, develop, aid, hear, messag, word, altern, verbal, base, contextu	Morphing images: A potential tool for teaching word recognition to children with severe learning difficulties
Therapeutic Technologies for Autistic Children/ Behavioural and Sensory Therapy for Autistic Children [mixed]	autism, autist, autist children, behavior, children autism, empathi, coordin, sensori, therapi, therapeut	Experiences of autistic children with technologies
Mental Health (Treatment, Management, and Promotion)	health, intervent, mental, manag, psycholog, mental health, stress, anxieti, treatment, promot, reduc	Socially Assistive Robots as Mental Health Interventions for Children: A Scoping Review
Digital Libraries	digit, literaci, librari, develop, children digit, digit media, digit technolog, design digit, creat, public	Encapsulating streams of consciousness into the international children's digital library
Physical Activity, Exercise, and Fitness/ Physical Activity, Fitness and Healthy Habit Promotion	activ, physic, physic activ, encourag, motiv, activ children, fit, particip, exercis, increas, promot, learn activ	Effects of the FIT game on physical activity in sixth graders: A pilot reversal design intervention study
Parent-Child Relationships/ Parent Technology Monitoring and Control (Practices)	parent, famili, home, mediat, child, parent children, parentchild, children parent, relationship, interview	Mediated parent-child contact in work-separated families
Music and Movement/ Music (Education, Creation, and Performance)	music, movement, sound, control, motion, instrument, sequenc, composit, perform, bodi, base, track	A Study on the Use of Motion Graphics and Kinect in LMA (Laban Movement Analysis) Expression Activities for Children with Intellectual Disabilities
Augmented and Mixed Reality	augment, realiti, augment realiti, ar, mix, realiti ar, augment realiti ar, applic, technolog, experi, combin	Impact of the textbooks' graphic design on the augmented reality applications tracking ability
External, Social, and Self Regulation/ Regulation, Guidance, and Prompting in Computer-Based Learning Tasks [mixed]	strategi, learner, regul, scaffold, learn, task, memori, cognit, process, develop, extern, perform, verbal	The effect of the external regulator's absence on children's speech use, manifested self-regulation, and task performance during learning tasks
Rehabilitative and Therapeutic Technologies/ Systems	system, attent, therapi, rehabilit, function, improv, system children, develop, disord, test, stimul, base	A neurocognitive virtual rehabilitation system for children with cerebral palsy: A preliminary usability study
Computational Thinking (and Computer Science) / Computational Thinking and Coding	comput, think, code, comput think, solv, develop, concept, teach, children comput, algorithm	Towards a model of progression in computational empowerment in education

Tools and Supports for New Mothers (and Infants)/ Technology Support for New Mothers	support, tool, support children, share, mother, infant, technolog support, role, tool suppor	'Digital motherhood': How does technology support new mothers?
Storytelling/ Creative Storytelling/ Story Creation Tools	creativ, stori, storytel, creat, creation, narrat, tool, author, generat, imagin, express	Sharing stories: Learning with stories
Embodied Interaction (Actions, Systems and Spaces)	interact, embodi, interact design, bodi, children interact, interact children, design interact, concept	Biting, whirling, crawling - Children's embodied interaction with walk-through displays
Participatory Design involving Children/ Participatory Design Processes Involving Children	design, participatori, participatori design, process, particip, involv, design process, pd, workshop	Enacting identities: Participatory design as a context for youth to reflect, project, and apply their emerging identities
Science and Mathematics Education (in Schools)/ STEM Education	student, scienc, model, middl, knowledg, middl school, school, school student, learn, student learn	How middle school students construct and critique graphs to explain cancer treatment
Healthcare (Patients, Settings, and Treatment)/ Child Patients	care, patient, gamif, caregiv, hospit, pediatr, transit, healthcar, medic	From care plans to care coordination: Opportunities for computer support of teamwork in complex healthcare
Preschool (and Kindergarten) Children/ Tablet Applications and Preschool Children	app, preschool, draw, mathemat, math, develop, preschool children, age, color, ipad, kindergarten	Designing Drawing Apps for Children: Artistic and Technological Factors
Emotion Expression and Recognition	emot, express, affect, recognit, facial, respons, automat, feel, featur, reaction, recogn, understand, imag	Acted Emotional Expressions of Game-playing Children: Investigating the Influence of Emotion Intensity on Recognition Rates
Collaborative Learning (Environments)	collabor, collabor learn, tabletop, share, pair, children collabor, individu, tabl, space, multitouch, solv	Beyond one-size-fits-all: How interactive tabletops support collaborative learning
Social Networks and Peer Relationships/ Online Peer Relationships and Networks	onlin, peer, network, relationship, social network, site, friend, relat, social, adolesc, contact, popular	The pervasiveness, connectedness, and intrusiveness of social network site use among young adolescents
Data Collection Methods	data, collect, observ, interview, record, awar, data collect, track, captur, detect, environment, qualit	Camera for the invisible
Assistive and Inclusive Technology (for Children with Special Education Needs/ Disabilities)	technolog, assist, disabl, special, inclus, access, develop, assist technolog, peopl, interact technolog	A study of the challenges related to DIY Assistive Technology in the context of children with disabilities
Challenges and Future Directions in CCI Research/ Critical Reflection on CCI Research	challeng, communiti, discuss, reflect, literatur, futur, perspect, critic, practic, hci, emerg, review	18 Years of ethics in child-computer interaction research: A systematic literature review
Interactive Exhibits, Displays, and Experiences/ Museum Exhibits and Experiences	engag, experi, museum, exhibit, display, children engag, engag children, art, audienc, flow, instal	Designing educational experiences using ubiquitous technology
Virtual and Interactive Learning Environments [includes transfer, real world, simulations]	environ, learn environ, world, real, interact learn, virtual	ProBoNO: Transferring knowledge of virtual environments to real world situations

	environ, interact learn environ, condit	
Screen Time/ Device Use and Screen Time	time, devic, tablet, screen, smart, smartphon, usag, increas, daili, spent, age, hour, day, entertain	Associations between duration and type of electronic screen use and cognition in US children
Teachers/ Teacher Classroom Practices/ Curriculum and Pedagogy	teacher, classroom, practic, teach, curriculum, role, interview, base, understand, authent, implement	A synchronous distance discussion procedure with reinforcement mechanism: Designed for elementary school students to achieve the attending and responding stages of the affective domain teaching goals within a class period
Construction Kits and Toys	toy, construct, electron, build, platform, kit, wearabl, model, maker, connect, creat, toolkit, held	Form & function toolkit: Printed electronics for unconventional interface
Intelligent Conversation Agents and Tutors/ Intelligent Agents, Animated Characters, and Tutors	agent, intellig, anim, charact, convers, question, human, tutor, voic, artifici, behavior, attribut	A team of presentation agents for edutainment
Experiment/ Cognitive and Motor Skill Development [mixed]	skill, train, cognit, improv, abil, control, develop, adapt, motor, spatial, experiment, week, measur	The effectiveness of an adaptive digital educational game for the training of early numerical abilities in terms of cognitive, noncognitive and efficiency outcomes
Privacy, Safety and Security/ Internet Privacy and Security Risks and Concerns	privaci, concern, risk, safeti, secur, servic, understand, share, user, protect, behaviour, internet, safe	'No telling passcodes out because they're private': Understanding children's mental models of privacy and security online

Appendix I. Innovation in Scientific Fields

The current appendix presents a review of literature pertaining to innovation and integration of novel concepts in scientific fields, undertaken following emergence of findings through qualitative analysis (Phase 2) related to Child-Computer Interaction researchers' strategic practices in pursuing publication and integration of innovative contributions. Along with findings derived through preceding qualitative analysis, this review of literature informed hypotheses addressed, and methods through which they were investigated, through subsequent quantitative analysis (Phase 3). Sequentially, therefore, this review of literature was completed following completion of Phase 2 (qualitative) analysis and prior to commencement of Phase 3 (quantitative) analysis (i.e., "connecting qualitative and quantitative phases", **Figure 4.1**).

It is noted that this supplemental review of literature is presented as an appendix, rather than within the main body of the thesis in order to preserve clarity concerning interests and subject matter with which the present study is primarily concerned (i.e., the field of Child-Computer Interaction) and faithfully represent the sequential design through which the present study proceeded (see **Figure 4.1** and **Section 4.2.4**).

I.1. Supplemental Review of Literature

Blackwell (2015) argues that the field of Human-Computer Interaction, to which Child-Computer Interaction is related, inherently pursues, and is driven by an expectation of, innovation "via breadth and exploration rather than stability and specialisation, with knowledge brought to bear in new ways that respond to technological opportunities and human challenges" (p. 509). Indeed, Blackwell (2015) proposes that the purpose of the field of HCI, rather than the development and maintenance of a stable body of knowledge, is to serve as a catalyst, or 'engine room' (Whittaker et al., 2000), of innovation. Despite such an apparent expectation of innovation, as well as the evident prominence of design and evaluation of novel artefacts and solutions as an approach to knowledge construction within the field (Barendregt et al., 2017; Höök & Löwgren, 2012), research is yet to investigate processes of innovation, and their consequences for knowledge construction, within the field of Child-Computer Interaction.

Innovation constitutes an engine of scientific discovery and a fundamental force driving scientific progress, propelling "science into uncharted territories and expands humanity's understanding of the natural and social world" (Hofstra et al., 2020, p. 9284; Iacopini et al., 2018; Mueller et al., 2012). Muthukrishna and Henrich (2016) propose three main sources of innovation: (a) *serendipity*, whereby innovation arise through fortuitous errors in asocial learning or imperfect cultural transmission rather than systematic and fully intentional investigation; (b) *recombination*, whereby existing, previously isolated elements or ideas are recombined in new ways; and (c) *incremental improvement*, involving gradual modification and improvement of prior advancements (often achieved through recombination or serendipity). Conceptualisation of innovation as *recombinant* (i.e., *recombinant innovation*; Schumpeter, 1939; Weitzman, 1998), involving production of concepts (i.e., ideas, information, knowledge, perspectives) which depart from established knowledge through recombination or reconfiguration of extant concepts, and thus novelty, an essential feature of innovations, as unconventional or unusual recombination of antecedents (Cattani et al., 2015, 2022; Uzzi et al., 2013), has become standard throughout research studying innovation (Fleming, 2001; Foster et al., 2015; Hofstra et al., 2020; Singh & Fleming, 2010; Trapido, 2015; Uzzi et al., 2013; Weitzman, 1996) in recent decades. Novel combinations of existing concepts drawn from previously isolated or disparate sources (i.e., novel recombination) or new relationships between previously combined concepts (i.e., novel reconfiguration) are commonly regarded as providing a foundation from which new knowledge (i.e., innovation) may spring (Leahey et al., 2017; Leahey & Moody, 2014), with knowledge thereby building upon itself in a "combinatoric feedback process", producing "endogenous aggregative growth" (Weitzman, 1998, pp. 331–332).

Notably, although a distinguishing feature of innovation beyond concepts which are merely well-conceived (Mueller et al., 2012), novelty does not, in itself, inherently imply innovation, with Painter et al. (2021) arguing that innovation also embodies recognition (i.e., adoption and propagation) of this novelty, reflecting perceived legitimacy and/or utility of a new idea or behaviour within a community (Brozen, 1951; Schumpeter, 1939). Thus, Painter et al. (2021) consider, and operationalise, 'persistent novelty' as a 'broad-sense identifier' of innovation. Within such a conception, innovation is "determined as much by the receptiveness of the field as by the intrinsic novelty and usefulness of individual outputs" (Cattani et al., 2015, p. 87).

Studies (e.g., Foster et al., 2015; Kolesnikov et al., 2018) investigating processes, and consequences, of innovation in scientific fields have commonly investigated the relationship between novelty of knowledge contributions and subsequent recognition of such contributions within specific fields, arguing that researchers are conscious of, and consider, the consequences of pursuing innovation in selecting research problems to pursue and strategies to utilise in so doing. Selection of research problems and strategies, through which various internal and external expectations and requirements are negotiated, are regarded as consequential, both influencing the researcher's career opportunities (Ayala-Bastidas et al., 2021; Heiberger et al., 2021; Hofstra et al., 2020) and position in a specific scientific field (Bourdieu, 1975, 2004; Foster et al., 2015) and, in aggregate, shaping knowledge and guiding its evolution and advancement within a field of study (Kolesnikov et al., 2018). Decisions concerning research problems and strategies, commonly characterised as risk-reward calculations (Ayala-Bastidas et al., 2021; Kolesnikov et al., 2018), are, Foster et al. (2015) suggest, patterned by an *essential tension* (T. S. Kuhn, 1978) between low-risk (i.e., more reliably achieve publication), productive adherence to the established research tradition and high-risk (i.e., greater likelihood of failure to achieve publication) pursuit of impactful innovation.

In particular, this tension is evident in the paradoxical dual implication and conflicting professional demands associated with novelty of scientific knowledge (Foster et al., 2015; Trapido, 2015), such that evaluating audiences expect original and transformative contributions which diverge from established knowledge and regard novelty as a major criterion of merit (Guetzkow et al., 2004) yet novelty and divergence from existing paradigms subjects contributions to greater scepticism and risk of rejection by evaluating audiences than incremental, 'normal science' contributions (Mueller et al., 2012). Studies (e.g., Boudreau et al., 2016; Mueller et al., 2012; Trapido, 2015) throughout various fields suggests that scientific audiences tend to recognise and value contributions when these contributions are consistent with the dominant knowledge canon or paradigm. Although T. S. Kuhn, (1970) proposes that audiences may be more receptive to highly novel contributions when the standards of dominant paradigms, in contrast to which novelty is defined, become ambiguous and fields undergo rare periods of paradigm shift (Rao et al., 2005; Sgourev, 2013), novelty is typically evaluated negatively, even when explicitly espoused as a preferable attribute, when first encountered amongst scientific audiences (Cattani et al., 2022; Mueller et al., 2012). Beyond merely expressing a preference for the status quo or familiar knowledge, literature indicates that such a negative disposition towards novelty may be attributable to implicit cognitive challenges, whereby audiences struggle to resolve incongruity with existing cognitive schemas and are biased against the ambivalence or uncertainty novelty may induce (see Mueller et al., 2012), and threats to the social structure of the field, whereby novelty may be perceived as destructive of existing values and standards which maintain an "advantageous arena for those who have fashioned it" (Cattani et al., 2022, p. 4; Mandler, 1995), which such contributions may pose.

Nonetheless, whilst often failing to attain recognition (i.e, publication and citation) due to such aversions to novelty, a broad range of studies (e.g., Antons et al., 2019; Foster et al., 2015; Heiberger et al., 2021; Hofstra et al., 2020; Leahey et al., 2017; Leahey & Moody, 2014; Uzzi et al., 2013) demonstrate that unfamiliar or atypical (i.e., novel) combinations of prior knowledge may increase the recognition of academic papers. Notably, however, while novelty may sustain benefits overall, studies (e.g., Fleming, 2001; Foster et al., 2015; Singh & Fleming, 2010) also document greater uncertainty of – or variance in – recognition associated with atypical and novel combinations of knowledge. Thus, novel recombination of concepts within research contributions generally represents a “high-risk, high-reward endeavor that often fails, but sometimes yields great success” (Heiberger et al., 2021, p. 1169).

Norms and practices throughout scientific research, posing conflicting professional demands, are thus regarded as having created a tension between broad research strategies and publication practices for accumulation of recognition and resources (Foster et al., 2015; Kolesnikov et al., 2018). Emerging imperatives such as “publish or perish” (Miller et al., 2011; Rawat & Meena, 2014) and increased competitiveness in publication and growing rates of manuscript rejection (Day, 2011) demand productivity, thereby encouraging adoption of reliable, low-risk research strategies, such as incremental contributions, at the expense of impact (Kolesnikov et al., 2018). Attainment of recognition, by contrast, typically requires original, transformative contributions which may be produced through pursuit of novel research directions at greater risk of rejection, deemphasising productivity and instead stressing higher-impact publications and knowledge products (Foster et al., 2015). Variously articulated as a dichotomy by a range of researchers – for instance, as reliable *succession* and risky *subversion* by Bourdieu (1975), and *conformity* or *discipline* and *dissent* or *rebellion* by Polanyi (1969) – Foster et al. (2015), drawing on T. S. Kuhn's (1978) *essential tension*, defines this strategic tension as *productive tradition* versus *risky innovation*.

Productive tradition, a conservative strategy, consists of broad adherence to the established research tradition in the relevant domain and pursuit of incremental improvements, with researchers achieving publication with high probability therethrough and appearing productive, but forgoing opportunities for novel contributions (Foster et al., 2015; Kolesnikov et al., 2018; T. S. Kuhn, 1970). *Risky innovation*, a risk-taking strategy, involves investigation of novel research problems and/or pursuit of novel solutions, through which researchers fail to publish more frequently and appear unproductive for sustained periods, but, when successful, may have profound impact, generating substantial new knowledge and attaining broad acclaim (Foster et al., 2015; T. S. Kuhn, 1970). Foster et al. (2015) argue that tradition and innovation represent distinct – although, contrary to T. S. Kuhn's (1978) assertions, not mutually exclusive – position-takings, or regions in the space of possible research claims, related to which researchers anticipate and weigh a certain risk and reward profile and in a particular mixture of which researchers invest through selection of research problems to investigate.

Examining the posited tension between productive tradition and risky innovation through analysis of the evolving state of chemical knowledge within approximately 6.5 million biomedical research paper abstracts, Foster et al. (2015) provide evidence that researchers' choice of research problem is shaped by strategic negotiation of the proposed essential tension. Findings suggest that innovation strategies, operationalised as the introduction of novel chemical relationships (i.e., combinations), although more richly rewarded with citations (IRR = 1.51, SE = .002, p <.001) than tradition strategies which repeat previously proposed relationships, are rare (evident in 14.2% of papers), implying substantially reduced likelihood of reaching publication – although this may only be estimated as strategies which failed to yield publishable findings are excluded. As the space of possible research questions (i.e., number of chemicals) expands over time, Foster et al. (2015) identify an increasing concentration on established knowledge (i.e., tradition) relative to new possibilities (i.e., innovation or novel opportunities). Notably, the authors utilise the database's (National Library of Medicine's MEDLINE collection) chemical annotations, which are not uniform over time, in identifying chemical relationships, and therefore neglect relationships which are not included in these annotations – thus, this trend may be, in part, a consequence of a lack of consistency in annotations within the data. The authors argue that a disposition toward tradition, generating and acknowledging as valid science those contributions which reproduce or reaffirm established knowledge, is reflected in, and reproduced by, this relationship between expected risk and reward, with pursuit of innovation a gamble which, despite occasional disproportionate receipt of recognition, offers insufficient reward, on average, to justify the risk. Regarding findings that "innovation is relatively unrewarded in the day-to-day currency of scientific credit (citations)" as surprising given the relative rarity and ostensive value of innovation, Foster et al. (2015) qualify that results may, in part, reflect insensitivity of the approach to innovation adopted beyond the combination of chemicals.

The identified disposition towards tradition, Foster et al., (2015) suggest, is, in part, modulated by the screening processes of scientific peer review, the main institution responsible for the evaluation, gestation, and elaboration of scientific research through processes of rejection, revision, and acceptance of research (Cattani et al., 2015; Siler et al., 2015). Whilst numerous scholars (e.g., Horrobin, 1990; Leahey & Moody, 2014; Mahoney, 1977) have expressed concern regarding the efficacy of peer review, particularly in relation to the apparent tendency to “protect the scientific status quo and suppress innovative findings” (Siler et al., 2015, p. 360), Siler et al.’s (2015) recent analysis of manuscripts (*n*=1,008) submitted to three elite medical journals indicates that gatekeepers (i.e., editors and reviewers) are “at least somewhat effective at recognizing and promoting quality” (p. 361), such that manuscripts attributed lower scores from peer reviewers typically received relatively fewer citations when eventually published, and reviewers prioritised novelty (as they perceived it) in their adjudications. Nonetheless, Siler et al. (2015) note that the 14 most-cited articles in the dataset were rejected (12 of which were desk-rejected), proposing that such exceptional or uncommon submissions may be particularly vulnerable to rejection “[b]ecause most new ideas tend to be bad ideas” (p. 364; Levinthal & March, 1993) and resistance towards unconventional contributions may therefore arise as a reasonable and efficient instinct for risk-averse gatekeepers with time and resource constraints – however, this finding cannot account for the possibility that rejected manuscripts may have been improved following the initial submission. Consistent with Foster et al.’s (2015) contentions, Siler et al. (2015) suggests that these findings raise concerns regarding whether peer review is ill-suited to recognise and gestate impactful ideas when perceived as unconventional or provocative.

Premised on the assertions of Bourdieu's (1975, 2004) field theory of science, which proposes that scientists occupy more or less dominant positions within specific scientific fields depending on the amount and types of scientifically recognised capital they have accumulated, Foster et al. (2015) contend that, although broadly characterised as productive and risky respectively, tradition and innovation strategies present differing stakes and consequences for those occupying different positions in the field. Such assertions align with the *Matthew Effect* proposed by Merton (1968), which posits that science tends to favour, and attribute disproportionate credit to (i.e., reward), work from eminent (i.e., high-status) academics merely by virtue of their previously attained status (Lynn, 2014; Siler et al., 2015). The *recognition premium* which prominent academics may reap is proposed to function through two nonexclusive mechanisms: (a) perceptions of competence and associated expectations arising from prior work may mediate recognition and produce better-than-merited evaluations of outputs; and (b) resources (e.g., funding) obtained due to prior recognition may mediate recognition through supporting higher-quality research and dissemination of results (Trapido, 2015).

Drawing on the notion that audience recognition is self-perpetuating (Leahey, 2007; Merton, 1968), Trapido (2015) further argues that audiences reward producers' consistency, particularly consistency with the producer's previously developed identity, such that the recognition premium associated with the work of highly acclaimed researchers disproportionately accrues to work consistent with their established identity. Regarding high novelty as a salient identity characteristic, Trapido (2015) proposes that, to the extent that researchers' identities are defined by consistent novelty of their work (i.e., have earned prior recognition for highly novel work), novelty in subsequent work is associated with greater audience recognition, whereas amongst those researchers demonstrating relatively modest records of acclaimed novel work the share of the recognition premium channelled towards subsequent highly novel works may "not be sufficient to compensate for the audiences' tendency to discount highly novel contributions" (p. 1489). Investigating the proposed relationship between novelty and recognition amongst information theory researchers (n=343), Trapido (2015) finds, consistent with the Matthew Effect, a positive relationship between prior recognition (i.e., citations) and recognition of subsequent publications (β=.10, SE=.02, p <.01), and significant interaction effects between novelty of publications and citations received for previous higher- (β=6.68, SE=1.62, p <.01) and lower-novelty (β=-6.37, SE=1.33, p <.01) work (defined as works exhibiting novelty greater or less than the sample median respectively) which indicate that novelty promotes recognition of publications to the extent that authors are recognised for previous novel work. However, the measure of novelty utilised (adopted from Dahlin & Behrens, 2005), quantifying the unusualness of combinations of references, although demonstrating acceptable validity (κ=.50; Fleiss et al., 2003), is limited, failing to differentially weight cited antecedents. Arguing that audiences prize novelty when simultaneously regarding the researcher as both high-status and creatively competent, but noting that high-status does not appear to inherently confer perceptions of creative competence, Trapido (2015) proposes that researchers are more likely to achieve audience recognition through visible commitment to novel rather than incremental, normal science work.

As evident in Foster et al.'s (2015) findings, a productivity-focused archetype increasingly dictates problem and strategy choices throughout research as researchers are encouraged – or pressured – by norms and practices of scientific fields, institutions (e.g., funding agencies, universities), and external stakeholders and authorities (Bloch et al., 2014; Felt et al., 2016; Nedeva et al., 2012; Resnik, 2007) to adopt a 'play-it-safe' research and publication strategy which allows them to "maintain high publication productivity and accelerate their career advancement" (Kolesnikov et al., 2018, p. 1995). Funding proposal evaluation processes, in particular, have been cited as incentivising productivity and discouraging innovation, with requirements to demonstrate a considerable publication track record in the specific domain of proposal and an anticipated inherent conservatism in peer review processes prompting researchers to censor or 'camouflage' the radical, innovative nature of proposed research "to make it appear more mainstream, and more in the safer core" (Luukkonen & Thomas, 2016, p. 113) of the field. Demand for steady outcomes, Oni et al. (2016) argue, often force researchers to adhere to the "less-fulfilling security of 'productivity'" and "ask safe but incremental questions" (p. 452), thereby stymying discovery and innovation and acting as an impediment to achieving impact. Kolesnikov et al. (2018), investigating the relationship between publishing productivity (i.e., number, and rate, of publications) and impact (i.e., citations) amongst chemistry (n = 227) and mechanical engineering (n=148) researchers, indicate that publishing at the higher margin of productivity is associated with stagnant or declining research impact – although, in mechanical engineering, greater productivity is consistently associated with greater publication impact, which Kolesnikov et al. (2018) attribute to a relative disinclination towards productivity-focused publication strategies therein. However, analyses related to both disciplines are based on limited samples, reducing the power and reliability thereof. Regarding productivity as a *risk-smoothing* research and publication strategy, Kolesnikov et al. (2018) therefore suggest that productivity is an "enemy of impact" and express concerns that, as selection of research problems "expected to incubate quickly enough for the production of required article counts" becomes increasingly attractive to, or necessary for, researchers, there is a growing likelihood that research will begin to produce knowledge exemplifying the cliché of "more and more about less and less" (p. 2013).

In addition to consideration of the strategic tension between productive tradition and risky innovation, a broadening body of research (e.g., Cattani et al., 2015; Safadi et al., 2021) conceptualises and investigates the pursuit of novelty and legitimacy as an ongoing tension between the core and periphery of the social and epistemic systems which define a field. A *core-periphery* structure is characterised by a cohesive subgroup of core actors, commonly key members of the community amongst whom dense interconnections and shared concepts and behaviours have developed, and a set of peripheral actors loosely connected to the core, residing closer to the boundaries of the community and typically less visible or engaged as those in the core (Borgatti & Everett, 2000; Cattani et al., 2015). An actor's position within a network of social interactions comprising a community is regarded as socially embedded or peripheral to the extent that actors interact with those positioned within the social core of the community, whilst an actor's contributions reflect a unique epistemic position based on their perspective, experience, and expertise which is conceived as epistemically marginal to the extent that the concepts they address are conceptually distant from the dominant discourse of the community (Cattani et al., 2015; Safadi et al., 2021). An actor's social and epistemic positions along respective core-periphery continua are proposed as consequential for the content, and reception, of contributions to the field.

Positioned at the periphery of the field, actors, weakly (if at all) embedded in the dominant culture and assimilated into existing conventions of the field, may "elude the homogenizing influences typical of an established institutional framework", and are thereby enabled to consider unconventional ideas, "cross boundaries and import ideas from external domains" (Cattani et al., 2022, p. 5), and adopt practices which diverge from, and make novel claims which may threaten, prevailing norms with relative impunity and freedom from normative pressures to conform (Cattani et al., 2015; Painter et al., 2021). A range of scholars (e.g., Cattani et al., 2015; Jeppesen & Lakhani, 2010; Merton, 1973) have recognised, and extolled, peripheral actors as sources of novelty and alternative perspectives, leveraging diverse and unique experiences in contributing novel concepts and solutions not readily apparent to 'insiders', with unexpected major theoretical contributions or technical innovations therefrom considered "part of the lore of science" (Gieryn & Hirsh, 1983, p. 87). However, Cattani et al. (2015) contend that, lacking the authority and privileged access to resources, relationships, and other external credibility markers of incumbents, peripheral actors possess limited ability to mobilise constituencies, solicit recognition, and gather support for contributions, and consequently typically face significant obstacles in marshalling legitimacy around novel claims (Cattani et al., 2017). Safadi et al. (2021) also argue that, due to the "sticky, localized nature" of knowledge, development and sharing of knowledge requires a clear link with, and contextualisation in, extant frameworks arising amongst community members through field-specific interactions, necessitating "a shared understanding of accepted practices for evaluating new contributions, and an embrace of the generative dance both between tacit and explicit knowledge, as well as between knowledge and knowing" (p. 753) which may be unfamiliar or inaccessible to peripheral (i.e., weakly embedded) actors.

Conversely, as actors, progressing towards the core, become embedded within the field's social and epistemic structure, "deviant ideas are foreclosed and adherence to the field's institutionalized norms and standards is increasingly stimulated and even rewarded" (Cattani et al., 2015, p. 76). Cattani et al. (2015) argue that, as the field "rewards those actors conforming to the dominant logic and penalizes those deviating from it", core actors experience little incentive to pursue work which, in diverging from established norms and standards, may challenge their current position "in terms both of status and control over symbolic and material resources" (p. 82). Thus, individuals entrenched in prevailing conventions may be increasingly likely to conform to, and reluctant to abandon, the norms and standards which characterise a specific field, reproducing concepts and arguments deemed acceptable and forgoing exploration of new areas (Cattani et al., 2015; Schilling, 2005). Cattani et al. (2015) contend, however, that persistence or permanence in the field core may, in the long run, become counterproductive, both as the "institutional logic may change" (p. 82) due to organised efforts by actors within the field or "external shocks", leading to a revision of the criteria by which actors' contributions are judged, and a risk that reduced exposure to diverse, novel concepts and perspectives may prompt a 'creative drought' (Perry-Smith & Shalley, 2003). As proximity to the core implies greater ability to enter the attention space of relevant audiences, core actors, in contrast with peripheral peers, are likely to gain swifter acceptance for work within the dense core of the field, where contributions may be readily recognised and legitimated (Cattani et al., 2015).

Thus, whereas peripheral actors are more likely to depart from the established research tradition, exploring and pursuing more divergent and innovative concepts and outcomes, but are believed to have limited ability to gather attention and foster consensus related to resultant contributions, core actors may be constrained in their capacity to deviate from convention and may develop a vested interest in resisting introduction of divergent ideas which may threaten their status as core member, but experience greater access to symbolic and material resources necessary to garner recognition and continue their work (Cattani et al., 2015; Crane, 1976; Phillips & Zuckerman, 2001). Consequently, the essence of core-periphery tensions, Cattani and Ferriani (2008) indicate, is that those individuals best equipped to make novel contributions – newcomers, outsiders, and marginal actors – are least able to enact it precisely due to their position. A core-periphery conceptualisation of a field's structure thereby articulates a 'trade-off' between production of more conventional (i.e., incremental or traditional) work, for which it is easier to gain legitimacy within the field, and less conventional (i.e., divergent or innovative) work, for which receiving legitimacy may prove challenging (Cattani et al., 2015; Cattani & Ferriani, 2008).

Investigating the origin of innovation within the conceptual landscape of the field of evolutionary medicine, Painter et al. (2021), through construction of a bibliographic coupling network representing over 6,000 research papers, identified a core-periphery structure in which innovative publications – here, papers (n=100) identified as introducing the greatest number of keywords not present in previous years which persist in subsequent years – occurred significantly more often in the periphery of the field than would be expected by chance alone (D=.158, p =.013). Notably, despite this peripheral positioning, innovative publications were found, on average, to accumulate citations at a significantly higher rate than the rest of the corpus (D=.23, p <.001), indicating, similar to Foster et al.'s (2015) findings, that innovation strategies, when successful, may be richly rewarded – however, this finding may also be partly attributable to a number of relevant factors (e.g., researcher identity, see Trapido, 2015) for which the authors failed to account or control. Notably, the measure of innovation employed fails to consider recombinant innovation, and is therefore likely to underestimate the novelty of papers which do not introduce new keywords. Consistent with assertions of Cattani et al. (2015), Painter et al. (2021) propose that the concentration of innovative publications in the periphery of the field's conceptual landscape is attributable to the flexibility afforded, and reduced constraint imposed, by a lack of strong connection to other publications within the field, as well as the interdisciplinarity inherent in the field's periphery.

Drawing on McLaughlin's (1998, 2000, 2001) concept of *optimal marginality*, describing a distinctive position "that combines the level of embeddedness in the institutions that shape a given field (R. Collins, 1998) with some distance from intellectual entrenchment" (Cattani et al., 2015, p. 77) and orthodoxies, Cattani et al. (2015) propose an *optimal network structuration strategy* to resolve the core-periphery tension. Through pursuit of an optimal network structuration strategy, Cattani et al. (2015) argue, actors may benefit from the influence and visibility which embeddedness imparts whilst simultaneously carving out a space removed from the normative pressures and "intellectual stagnation", which may "ossify rather than produce creativity" (McLaughlin, 2001, p. 272), associated with the field's core. Recent studies (e.g., Antons et al., 2019; Foster et al., 2015; Safadi et al., 2021; Uzzi et al., 2013) demonstrate the efficacy of such a strategy in practice, indicating that innovative or atypical contributions achieve greatest recognition and impact when grounded in conventional combinations of prior work and aligning with the dominant knowledge canon within a field. Uzzi et al., (2013), investigating the relationship between the balance of novelty and conventionality and impact (i.e., citation count) through analysis of pairwise combinations of references in the bibliography of 17.9 million research articles in the Web of Science (WOS), found that, despite a persistent and prominent tendency for high conventionality throughout papers, highest-impact science, whilst drawing primarily on highly conventional (i.e., appearing more often than expected by chance) combinations of prior work, feature an "intrusion of combinations unlikely to have been joined together before" (p. 471). Uzzi et al. (2013), consistent with Cattani et al.'s (2015) optimal network structuration strategy, suggest that such a pattern may, in part, reflect advantages of "being within the mainstream of a research trajectory, where scientists are currently focused, while being distinctive in one's creativity" (Uzzi et al., 2013, p. 471). Thus, through intentionally relating novel to extant concepts and interposing such concepts into ongoing discussion familiar to members of the community, researchers may translate research content into a more widely consumable or agreeable form, thereby achieving greater impact and enriching research in the field (Antons et al., 2019; Uzzi et al., 2013).

Whilst serving as a crucial mechanism through which scientific knowledge is progressed and potentially yielding substantial recognition and acclaim, evident tensions between innovation and tradition in scientific fields generally render research pursuing innovation strategies a risky endeavour (Foster et al., 2015; Trapido, 2015). Penalisation of novel contributions which are perceived to diverge from, or threaten, established norms and standards and those with vested interests therein thus perpetuates a disposition towards incremental, normal science which reproduces and conserves established conventions and traditions (Cattani et al., 2015; Foster et al., 2015; Siler et al., 2015). Notably, the field of Child-Computer Interaction, exhibiting particular prominence of research concerning novel artefacts and solutions (see Barendregt et al., 2017), may present an exceptional instance wherein innovation provides a productive strategy which (relatively) reliably attains recognition and legitimation. However, research is yet to examine the processes and properties of innovation within the field of Child-Computer Interaction.

Appendix J. Identification of Meaningful Concept Combinations

Spurious pairings – here, chance cooccurrences, and combinations of highly rare terms – were removed through computation of a significance score, based on pointwise mutual information (PMI) for each pairing of concepts (Hofstra et al., 2020; Ramisch et al., 2008). Given a concept link *L = (x, y)*, wherein x and y are concepts which occur in the corpus, PMI is computed as:

$$pmi(L) = \log \frac{p(x,y)}{p(x)p(y)},$$

which compares the probability of observing concept *x* and *y* together (i.e., joint probability), *p(x,y)*, with the probabilities of observing concepts *x*, *p(x)*, and *y*, *p(y)*, independently (i.e., chance). Genuine, or meaningful, concept combinations, are those exhibiting greater probability of occurrence than would be expected by chance (*pmi(L) > 0*). Those (re)combinations failing to demonstrate a meaningful association or relationship (*pmi(L) ≤ 1.5*) were considered spurious and removed from subsequent analysis.

Appendix K. Composition of Dummy 'Core' Document

Terms (stemmed) exhibiting greatest semantic similarity to the geometric median of Child-Computer Interaction semantic space (based on cosine distance) reviewed and subsequently retained to comprise a 'core' document, broadly representing common underlying concerns within the field of Child-Computer Interaction.

Table K.1. *Terms semantically similar to the geometric median of Child-Computer Interaction semantic space reviewed.*

rho tanprorobot fiabot experi design develop chisig explor includ technolog focus flourish nannycap creat interact portion environ addit durabl base children activ set context benefit techpoint minus tommi learn enabl matti contribut facilit form practic illumishar contend technologist wagon handcraft success tool caution paper fascin educ sceneri requir spirit lightweight domino incorpor johnson bildung result reusabl hack sdg game understand approach research mim kahoot particip

Table K.2. *Terms semantically similar to the geometric median of Child-Computer Interaction semantic space comprising a 'core' document.*

experi design develop explor technolog focus flourish creat interact environ base children activ set context benefit learn enabl contribut facilit practic tool caution educ requir incorpor game understand approach particip

Appendix L. Word Intrusion Task Results

Distance ratio (DR) evaluation metric computed through automated word intrusion task, developed based on approaches proposed by Park et al. (2017) and Sun et al. (2016), for word2vec models fitted for a range of dimensions.

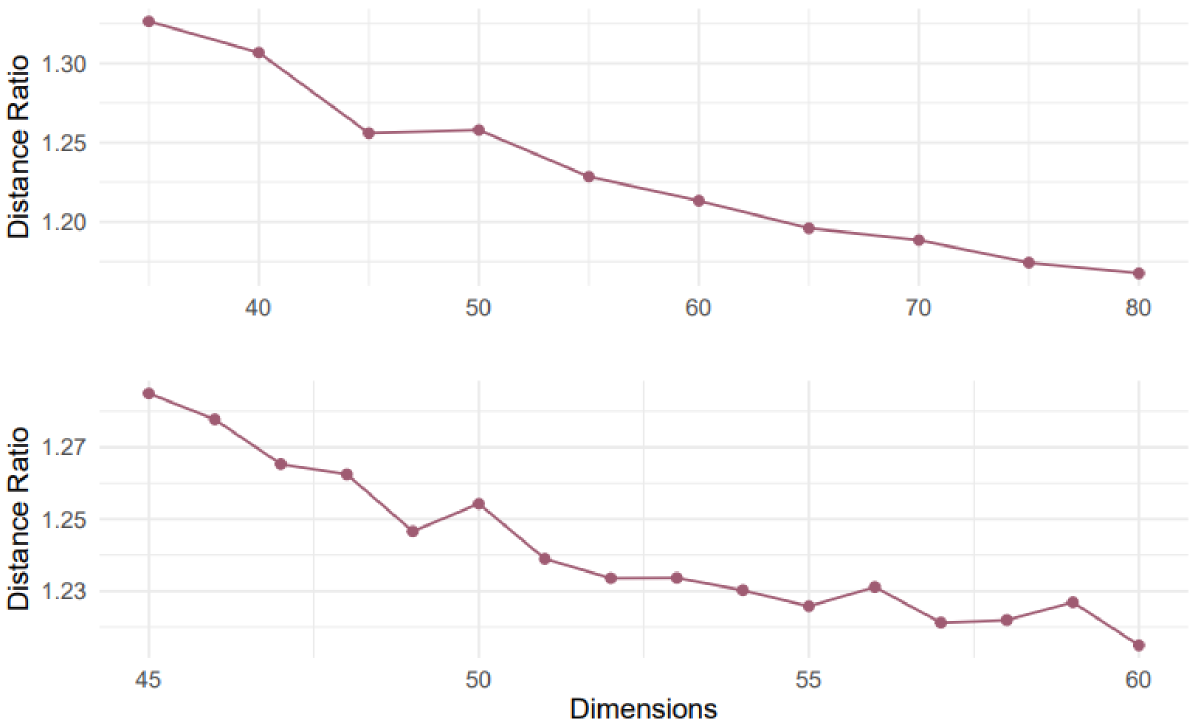


Figure L.1. *Automated word intrusion task distance ratio for word2vec models fitted for a range of dimensions.*

Appendix M. Word2Vec Embedding Interpretability Evaluation

Terms (stemmed) situated nearest (based on cosine distance, or similarity) to a selection of concepts within the semantic space generated through word2vec embedding (with 50 dimensions), evaluated for interpretability.

Table M.1. *Terms semantically similar to concepts based on cosine distance between word2vec embeddings.*

Concept	Nearest Terms
prototyp	iter, describ, fidel, paper, design_process, design_evalu, rapido, pilot, design_implement, initi
educ_game	base_learn, game, edutain, strateg, learn_game, comput_game, educ, sdg, learn, sim
stem	engin, educ, scienc, comput_scienc, extracurricular, steam, maker, educ_set, cs, biodesign
embodi	mix_realiti, embodi_interact, interact_learn, besound, nonsymbol, reflex, interact_design, bodi_interact, enact, metaphor
exhibit	visitor, museum, interact, instal, contrast, engag, dyad, museum_exhibit, multitouch, tabletop
participatori_design	children_design, pd, participatori, design, methodolog, design_technolog, design_method, comicboard, team, technolog_children
tangibl	tangibl_user_interfac, tabletop, tangibl_interact, tangibl_interfac, tool_children, tui, introduc, physic, manipul, design_tangibl
assist	robot, therapi, children, tool, aid, social_robot, teach, therapeut, companion, autonom
cyberbulli	perpetr, cybervictim, victim, bulli, cyberbulli_victim, bystand, adolesc, defend, cyber, bulli_victim
health	well, informat, chronic, obes, mhealth, pediatr, ill, mental_health, unhealthi, healthi
augment_realiti	ar, mix_realiti, fiabot, mobil, mobil_learn, augment, fiduci, base, learn_environ, augment_realiti_technolog
motiv	intrins, engag, enjoy, learn, fun, gamifi, gamif, game, scoliosi, activ
therapi	therapeut, therapist, rehabilit, autism, treatment, assist, impair, neurodevelopment, speech, robot
parent	child, children_parent, parent_children, mediat, phub, dysregul, restrict_mediat, technofer, smartphon, famili
assist	robot, therapi, children, tool, aid, social_robot, teach, therapeut, companion, autonom
robot	social_robot, robot_interact, humanoid, humanoid_robot, human, pleo, assist, nao, robot_children, interact_robot
physic_activ	exergam, obes, exercis, inact, sedentari, pa, promot, health, sleep, encourag
emot	social, facial_express, express, affect, facial, behavior, respons, anger, children_social, emoticon

app	mobil, speechblock, mobil_applic, android, tablet, ipad, bilingu, preschool, english, sb
read	children_read, book, reader, read_comprehens, read_aloud, comprehens, book_read, grapho, storybook, metacomprehens
social	social_interact, interact_social, support, design_social, emot, children_autism, autism_spectrum_disord, behavior, deficit, social_skill
video_game	violent, preadolesc, disengag, aggress, prosoci, exposur, cortisol, tobacco, multiplay, comput_game

Appendix N. R Packages Utilised

R packages facilitating quantitative analyses throughout the current study, including notes on their application.

Table N.1. *R packages utilised.*

Package	Version	Citation	Notes on Use
base	4.2.1	R Core Team (2022)	Base R
broom.mixed	0.2.9.4	Bolker and Robinson (2022)	Miscellaneous functions
circlize	0.4.15	Gu et al. (2014)	Visualisation
coRanking	0.2.3	Kraemer, Reichstein, and Mahecha (2018)	Evaluation of t-SNE dimensionality reduction for clustering
corrplot	0.92	Wei and Simko (2021)	Correlation matrix calculation and plotting using *corrplot* function
countrycode	1.4.0	Arel-Bundock, Enevoldsen, and Yetman (2018)	Converting country names for mapping
data.table	1.14.2	Dowle and Srinivasan (2021)	Miscellaneous functions
dbscan	1.1.11	Hahsler, Piekenbrock, and Doran (2019); Hahsler and Piekenbrock (2022)	HDBSCAN using *hdbscan* function
doParallel	1.0.17	Corporation and Weston (2022)	Facilitates multicore parallel functionality/ computation
effects	4.2.2	Fox (2003); Fox and Hong (2009); Fox and Weisberg (2018); Fox and Weisberg (2019)	Regression model visualisations
entropy	1.3.1	Hausser and Strimmer (2021)	Calculate Shannon entropy using *entropy* function
estimatr	1.0.0	Blair et al. (2022)	Linear model with robust standard errors using *lm_robust* function
flextable	0.8.2	Gohel and Skintzos (2022)	Miscellaneous functions
foreach	1.5.2	Microsoft and Weston (2022)	Miscellaneous functions
ggcorrplot	0.1.4	Kassambara (2022)	Correlation matrix calculation and plotting using *cor* and *cor_pmat* function
ggeffects	1.1.3	Lüdecke (2018)	Computation of marginal effects for regression models using *ggeffect* function
ggmap	3.0.1	Kahle and Wickham (2013)	Mapping visualisation
ggpubr	0.4.0	Kassambara (2020)	Visualisation
ggraph	2.1.0	Pedersen (2022a)	Visualisation
ggsci	2.9	Xiao (2018)	Visualisation
Gmedian	1.2.7	Cardot (2022)	Geometric median calculation using *Weiszfeld* function
grateful	0.1.11	Rodríguez-Sánchez, Jackson, and Hutchins (2022)	R package citation

Package	Version	Citation	Notes on Use
gridExtra	2.3	Auguie (2017)	Visualisation
hhi	1.2.0	Waggoner (2018)	Herfindahl-Hirschman Index calculation using *hhi* function
igraph	1.3.5	Csardi and Nepusz (2006)	Network visualisation
iterators	1.0.14	Analytics and Weston (2022)	Miscellaneous functions
janitor	2.1.0	Firke (2021)	Miscellaneous functions
LambertW	0.6.7.1	Goerg (2011); Goerg (2014); Goerg (2022)	Kurtosis calculation using *kurtosis* function
ldatuning	1.0.2	Nikita (2020)	Estimated natural number of latent topics using the *FindTopicsNumber* function
lsa	0.73.3	Wild (2022)	Cosine distance calculation using *cosine* function
maps	3.4.0	Richard A. Becker, Ray Brownrigg. Enhancements by Thomas P Minka, and Deckmyn. (2021)	Mapping visualisation
marginaleffects	0.7.1	Arel-Bundock (2022)	Computation of marginal effects for regression models using *marginaleffects* function
MASS	7.3.58.1	Venables and Ripley (2002)	Miscellaneous functions including dimensionality reduction and negative binomial regression models using the *glm.nb* function
Matrix	1.5.1	Bates, Maechler, and Jagan (2022)	Miscellaneous functions
modifiedmk	1.6	Patakamuri and O'Brien (2021)	Mann-Kendall trend test using *mkttest* function
networkD3	0.4	Allaire et al. (2017)	Network visualisation
NLP	0.2.1	Hornik (2020)	Extracting n-grams using *ngrams* function
officer	0.4.4	Gohel (2022)	Miscellaneous functions
pals	1.7	Wright (2021)	Visualisation
plyr	1.8.7	Wickham (2011)	Miscellaneous functions
proxy	0.4.27	Meyer and Buchta (2022)	Cosine distance calculation using *dist* function
pscl	1.5.5	Zeileis, Kleiber, and Jackman (2008); Jackman (2020)	Poisson and zero-inflated regression model prediction
psych	2.2.9	Revelle (2022)	Descriptive statistics
quanteda	3.2.3	Benoit et al. (2018)	Preprocessing text and formatting document-feature matrix using *dfm* function
RColorBrewer	1.1.3	Neuwirth (2022)	Visualisation
rcompanion	2.4.18	Mangiafico (2022)	Pseudo R^2 Calculation using *nagelkerke* function
reghelper	1.1.1	Hughes and Beiner (2022)	Simple slopes of interaction calculation using *simple_slopes* function
rjson	0.2.21	Couture-Beil (2022)	Miscellaneous functions
rlist	0.4.6.2	Ren (2021)	Miscellaneous functions

Package	Version	Citation	Notes on Use
rscopus	0.6.6	Muschelli (2019)	Interfacing with Scopus API using *scopus_search* function
Rtsne	0.16	van der Maaten and Hinton (2008); van der Maaten (2014); Krijthe (2015)	t-SNE dimensionality reduction using *Rtsne* function
scales	1.2.1	Wickham and Seidel (2022)	Visualisation
sjPlot	2.8.11	Lüdecke (2022)	Regression model effects plotting and clustered standard error calculation using *tab_model* function
SnowballC	0.7.0	Bouchet-Valat (2020)	Stemming terms using *wordStem* function
stm	1.3.6	Roberts, Stewart, and Tingley (2019)	Correlated Topic Modelling using *stm* function
text2vec	0.6.2	Selivanov, Bickel, and Wang (2022)	Relaxed Word Mover's Distance calculation using *RelaxedWordMoversDistance* function
textmineR	3.0.5	Jones (2021)	Text preprocessing and formatting document term matrix using *CreateDTM* function
tidytext	0.3.4	Silge and Robinson (2016)	Text preprocessing, including token unnesting, stop word removal, and formatting term document matrix using the *cast_tdm* function
tidyverse	1.3.2	Wickham et al. (2019)	Miscellaneous functions
tm	0.7.8	Feinerer, Hornik, and Meyer (2008); Feinerer and Hornik (2020)	Text preprocessing, including punctuation removal, excess whitespace removal, and calculation of tf-idf weighting using *weightTfIdf* function
topicmodels	0.2.12	Grün and Hornik (2011)	Calculation of Latent Dirichlet Allocation models using *LDA* function
tweenr	2.0.2	Pedersen (2022b)	Network visualization
udpipe	0.8.9	Wijffels (2022)	Preprocessing text, editing document term matrices
word2vec	0.3.4	Wijffels (2021)	Constructing word2vec model using *word2vec* function

N.1. Package References

References generated through the grateful R package (Rodríguez-Sánchez et al., 2022).

Allaire, J. J., Christopher Gandrud, Kenton Russell, and CJ Yetman. 2017. networkD3: D3 JavaScript Network Graphs from r. https://CRAN.R-project.org/package=networkD3.

Analytics, Revolution, and Steve Weston. 2022. Iterators: Provides Iterator Construct. https://CRAN.R-project.org/package=iterators.

Arel-Bundock, Vincent. 2022. Marginaleffects: Marginal Effects, Marginal Means, Predictions, and Contrasts. https://CRAN.R-project.org/package=marginaleffects.

Arel-Bundock, Vincent, Nils Enevoldsen, and CJ Yetman. 2018. “Countrycode: An r Package to Convert Country Names and Country Codes.” Journal of Open Source Software 3 (28): 848. https://doi.org/10.21105/joss.00848.

Auguie, Baptiste. 2017. gridExtra: Miscellaneous Functions for "Grid" Graphics. https://CRAN.R-project.org/package=gridExtra.

Bates, Douglas, Martin Maechler, and Mikael Jagan. 2022. Matrix: Sparse and Dense Matrix Classes and Methods. https://CRAN.R-project.org/package=Matrix.

Benoit, Kenneth, Kohei Watanabe, Haiyan Wang, Paul Nulty, Adam Obeng, Stefan Müller, and Akitaka Matsuo. 2018. “Quanteda: An r Package for the Quantitative Analysis of Textual Data.” Journal of Open Source Software 3 (30): 774. https://doi.org/10.21105/joss.00774.

Blair, Graeme, Jasper Cooper, Alexander Coppock, Macartan Humphreys, and Luke Sonnet. 2022. Estimatr: Fast Estimators for Design-Based Inference. https://CRAN.R-project.org/package=estimatr.

Bolker, Ben, and David Robinson. 2022. Broom.mixed: Tidying Methods for Mixed Models. https://CRAN.R-project.org/package=broom.mixed.

Bouchet-Valat, Milan. 2020. SnowballC: Snowball Stemmers Based on the c ’Libstemmer’ UTF-8 Library. https://CRAN.R-project.org/package=SnowballC.

Cardot, Herve. 2022. Gmedian: Geometric Median, k-Medians Clustering and Robust Median PCA. https://CRAN.R-project.org/package=Gmedian.

Corporation, Microsoft, and Steve Weston. 2022. doParallel: Foreach Parallel Adaptor for the ’Parallel’ Package. https://CRAN.R-project.org/package=doParallel.

Couture-Beil, Alex. 2022. Rjson: JSON for r. https://CRAN.R-project.org/package=rjson.

Csardi, Gabor, and Tamas Nepusz. 2006. “The Igraph Software Package for Complex Network Research.” InterJournal Complex Systems: 1695. https://igraph.org.

Dowle, Matt, and Arun Srinivasan. 2021. Data.table: Extension of ‘Data.frame‘. https://CRAN.R-project.org/package=data.table.

Feinerer, Ingo, and Kurt Hornik. 2020. Tm: Text Mining Package. https://CRAN.R-project.org/package=tm.

Feinerer, Ingo, Kurt Hornik, and David Meyer. 2008. “Text Mining Infrastructure in r.” Journal of Statistical Software 25 (5): 1–54. https://www.jstatsoft.org/v25/i05/.

Firke, Sam. 2021. Janitor: Simple Tools for Examining and Cleaning Dirty Data. https://CRAN.R-project.org/package=janitor.

Fox, John. 2003. “Effect Displays in R for Generalised Linear Models.” Journal of Statistical Software 8 (15): 1–27. https://doi.org/10.18637/jss.v008.i15.

Fox, John, and Jangman Hong. 2009. "Effect Displays in R for Multinomial and Proportional-Odds Logit Models: Extensions to the effects Package." Journal of Statistical Software 32 (1): 1–24. https://doi.org/10.18637/jss.v032.i01.

Fox, John, and Sanford Weisberg. 2018. "Visualizing Fit and Lack of Fit in Complex Regression Models with Predictor Effect Plots and Partial Residuals." Journal of Statistical Software 87 (9): 1–27. https://doi.org/10.18637/jss.v087.i09.

———. 2019. An r Companion to Applied Regression. 3rd ed. Thousand Oaks CA: Sage. https://socialsciences.mcmaster.ca/jfox/Books/Companion/index.html.

Goerg, Georg M. 2011. "Lambert w Random Variables - a New Family of Generalized Skewed Distributions with Applications to Risk Estimation." Annals of Applied Statistics 5 (3): 2197–2230.

———. 2014. "The Lambert Way to Gaussianize Heavy-Tailed Data with the Inverse of Tukey's h Transformation as a Special Case." The Scientific World Journal: Special Issue on Probability and Statistics with Applications in Finance and Economics ? (?): ??

———. 2022. LambertW: Probabilistic Models to Analyze and Gaussianize Heavy-Tailed, Skewed Data.

Gohel, David. 2022. Officer: Manipulation of Microsoft Word and PowerPoint Documents. https://CRAN.R-project.org/package=officer.

Gohel, David, and Panagiotis Skintzos. 2022. Flextable: Functions for Tabular Reporting. https://CRAN.R-project.org/package=flextable.

Grün, Bettina, and Kurt Hornik. 2011. "topicmodels: An R Package for Fitting Topic Models." Journal of Statistical Software 40 (13): 1–30. https://doi.org/10.18637/jss.v040.i13.

Gu, Zuguang, Lei Gu, Roland Eils, Matthias Schlesner, and Benedikt Brors. 2014. "Circlize Implements and Enhances Circular Visualization in r." Bioinformatics 30: 2811–12.

Hahsler, Michael, and Matthew Piekenbrock. 2022. Dbscan: Density-Based Spatial Clustering of Applications with Noise (DBSCAN) and Related Algorithms. https://CRAN.R-project.org/package=dbscan.

Hahsler, Michael, Matthew Piekenbrock, and Derek Doran. 2019. "dbscan: Fast Density-Based Clustering with R." Journal of Statistical Software 91 (1): 1–30. https://doi.org/10.18637/jss.v091.i01.

Hausser, Jean, and Korbinian Strimmer. 2021. Entropy: Estimation of Entropy, Mutual Information and Related Quantities. https://CRAN.R-project.org/package=entropy.

Hornik, Kurt. 2020. NLP: Natural Language Processing Infrastructure. https://CRAN.R-project.org/package=NLP.

Hughes, Jeffrey, and David Beiner. 2022. Reghelper: Helper Functions for Regression Analysis. https://CRAN.R-project.org/package=reghelper.

Jackman, Simon. 2020. pscl: Classes and Methods for R Developed in the Political Science Computational Laboratory. Sydney, New South Wales, Australia: United States Studies Centre, University of Sydney. https://github.com/atahk/pscl/.

Jones, Tommy. 2021. textmineR: Functions for Text Mining and Topic Modeling. https://CRAN.R-project.org/package=textmineR.

Kahle, David, and Hadley Wickham. 2013. "Ggmap: Spatial Visualization with Ggplot2." The R Journal 5 (1): 144–61. https://journal.r-project.org/archive/2013-1/kahle-wickham.pdf.

Kassambara, Alboukadel. 2020. Ggpubr: 'Ggplot2' Based Publication Ready Plots. https://CRAN.R-project.org/package=ggpubr.

———. 2022. Ggcorrplot: Visualization of a Correlation Matrix Using 'Ggplot2'. https://CRAN.R-project.org/package=ggcorrplot.

Kraemer, Guido, Markus Reichstein, and Miguel D. Mahecha. 2018. "dimRed and coRanking—Unifying Dimensionality Reduction in r." The R Journal 10 (1): 342–58. https://journal.r-project.org/archive/2018/RJ-2018-039/index.html.

Krijthe, Jesse H. 2015. Rtsne: T-Distributed Stochastic Neighbor Embedding Using Barnes-Hut Implementation. https://github.com/jkrijthe/Rtsne.

Lüdecke, Daniel. 2018. "Ggeffects: Tidy Data Frames of Marginal Effects from Regression Models." Journal of Open Source Software 3 (26): 772. https://doi.org/10.21105/joss.00772.

———. 2022. sjPlot: Data Visualization for Statistics in Social Science. https://CRAN.R-project.org/package=sjPlot.

Mangiafico, Salvatore. 2022. Rcompanion: Functions to Support Extension Education Program Evaluation. https://CRAN.R-project.org/package=rcompanion.

Meyer, David, and Christian Buchta. 2022. Proxy: Distance and Similarity Measures. https://CRAN.R-project.org/package=proxy.

Microsoft, and Steve Weston. 2022. Foreach: Provides Foreach Looping Construct. https://CRAN.R-project.org/package=foreach.

Muschelli, John. 2019. Rscopus: Scopus Database 'API' Interface. https://CRAN.R-project.org/package=rscopus.

Neuwirth, Erich. 2022. RColorBrewer: ColorBrewer Palettes. https://CRAN.R-project.org/package=RColorBrewer.

Nikita, Murzintcev. 2020. Ldatuning: Tuning of the Latent Dirichlet Allocation Models Parameters. https://CRAN.R-project.org/package=ldatuning.

Patakamuri, Sandeep Kumar, and Nicole O’Brien. 2021. Modifiedmk: Modified Versions of Mann Kendall and Spearman’s Rho Trend Tests. https://CRAN.R-project.org/package=modifiedmk.

Pedersen, Thomas Lin. 2022a. Ggraph: An Implementation of Grammar of Graphics for Graphs and Networks. https://CRAN.R-project.org/package=ggraph.

———. 2022b. Tweenr: Interpolate Data for Smooth Animations. https://CRAN.R-project.org/package=tweenr.

R Core Team. 2022. R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Ren, Kun. 2021. Rlist: A Toolbox for Non-Tabular Data Manipulation. https://CRAN.R-project.org/package=rlist.

Revelle, William. 2022. Psych: Procedures for Psychological, Psychometric, and Personality Research. Evanston, Illinois: Northwestern University. https://CRAN.R-project.org/package=psych.

Richard A. Becker, Original S code by, Allan R. Wilks. R version by Ray Brownrigg. Enhancements by Thomas P Minka, and Alex Deckmyn. 2021. Maps: Draw Geographical Maps. https://CRAN.R-project.org/package=maps.

Roberts, Margaret E., Brandon M. Stewart, and Dustin Tingley. 2019. “stm: An R Package for Structural Topic Models.” Journal of Statistical Software 91 (2): 1–40. https://doi.org/10.18637/jss.v091.i02.

Rodríguez-Sánchez, Francisco, Connor P. Jackson, and Shaurita D. Hutchins. 2022. Grateful: Facilitate Citation of r Packages. https://github.com/Pakillo/grateful.

Selivanov, Dmitriy, Manuel Bickel, and Qing Wang. 2022. Text2vec: Modern Text Mining Framework for r. https://CRAN.R-project.org/package=text2vec.

Silge, Julia, and David Robinson. 2016. “Tidytext: Text Mining and Analysis Using Tidy Data Principles in r.” JOSS 1 (3). https://doi.org/10.21105/joss.00037.

van der Maaten, L. J. P. 2014. “Accelerating t-SNE Using Tree-Based Algorithms.” Journal of Machine Learning Research 15: 3221–45.

van der Maaten, L. J. P., and G. E. Hinton. 2008. “Visualizing High-Dimensional Data Using t-SNE.” Journal of Machine Learning Research 9: 2579–2605.

Venables, W. N., and B. D. Ripley. 2002. Modern Applied Statistics with s. Fourth. New York: Springer. https://www.stats.ox.ac.uk/pub/MASS4/.

Waggoner, Philip D. 2018. Hhi: Calculate and Visualize the Herfindahl-Hirschman Index. https://CRAN.R-project.org/package=hhi.

Wei, Taiyun, and Viliam Simko. 2021. R Package ’Corrplot’: Visualization of a Correlation Matrix. https://github.com/taiyun/corrplot.

Wickham, Hadley. 2011. “The Split-Apply-Combine Strategy for Data Analysis.” Journal of Statistical Software 40 (1): 1–29. https://www.jstatsoft.org/v40/i01/.

Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D’Agostino McGowan, Romain François, Garrett Grolemund, et al. 2019. “Welcome to the tidyverse.” Journal of Open Source Software 4 (43): 1686. https://doi.org/10.21105/joss.01686.

Wickham, Hadley, and Dana Seidel. 2022. Scales: Scale Functions for Visualization. https://CRAN.R-project.org/package=scales.

Wijffels, Jan. 2021. Word2vec: Distributed Representations of Words. https://CRAN.R-project.org/package=word2vec.

———. 2022. Udpipe: Tokenization, Parts of Speech Tagging, Lemmatization and Dependency Parsing with the ’UDPipe’ ’NLP’ Toolkit. https://CRAN.R-project.org/package=udpipe.

Wild, Fridolin. 2022. Lsa: Latent Semantic Analysis. https://CRAN.R-project.org/package=lsa.

Wright, Kevin. 2021. Pals: Color Palettes, Colormaps, and Tools to Evaluate Them. https://CRAN.R-project.org/package=pals.

Xiao, Nan. 2018. Ggsci: Scientific Journal and Sci-Fi Themed Color Palettes for ’Ggplot2’. https://CRAN.R-project.org/package=ggsci.

Zeileis, Achim, Christian Kleiber, and Simon Jackman. 2008. “Regression Models for Count Data in R.” Journal of Statistical Software 27 (8). http://www.jstatsoft.org/v27/i08/.

Appendix O. Invitation to Participate

Dear [Invitee],

I am a doctoral student at the University of Oxford investigating and mapping the thematic structure of knowledge within the field of Child-Computer Interaction (CCI) research over the past two decades and examining the processes and practices through which stakeholders in the field act to (re)construct such knowledge. As part of this undertaking, I seek to garner insight from key contributors to the field through virtual workshop discussions. [Having engaged with your work concerning/ Given your work regarding/ Given your expertise in…, your participation in one of these workshops would be greatly valued.]

Workshops will bring together key contributors to the field of CCI research in order to discuss the factors influencing themes of knowledge produced within CCI research, and the processes by which stakeholders actively reproduce and transform CCI knowledge through participation in design processes. Whilst a number of workshops will be hosted to facilitate a broader range of voices, participants are invited to take part in just **one** of these workshops (not all workshops). Workshops will be hosted virtually via Microsoft Teams, will be approximately 1.5 hours in duration. Workshops will be hosted on three dates – Monday 24th January, Wednesday 26th January, and Friday 28th January. If you would like to take part, please indicate your availability for the workshop(s) here (see attached information sheet and consent form for further details).

Your participation in this study would be greatly appreciated and valued. So that you might make an informed decision on whether you would like to take part, please consider the attached participant information sheet and consent form for further details. Should you wish to participate, please complete and return the attached consent form at your earliest convenience, and indicate your availability here.

If you have any questions or concerns, please do not hesitating in contacting me.

Yours Sincerely,

Tiarnach McDermott

Doctoral Student,
Department of Education, University of Oxford
tiarnach.mcdermott@education.ox.ac.uk

Appendix P. Participant Information Sheet

An Exploration of (Re)Construction of Knowledge in the Field of Child-Computer Interaction

Tiarnach McDermott, James Robson, Lars-Erik Malmberg, Niall Winters,

University of Oxford

Purpose of the study: A relatively young field, continuously expanding and evolving through a process of discursive knowledge construction in which various stakeholders engage in ongoing conversation, Child-Computer Interaction (CCI) has, in recent years, matured into a distinct, identifiable area of research, replete with established structures, venues, methodologies, and solutions. This maturation of the field, regarded as having reached a critical juncture in development, has prompted calls - and associated efforts - amongst members of the CCI community to critically reflect upon, and define the identity of, the field, considering the intellectual development hereto (i.e., where we have come from), the current state (i.e., where we are), and the course of the field going forward (i.e., where we want to go).

This study, therefore, seeks to map and investigate the thematic structure of knowledge within the field of Child-Computer Interaction (CCI) research, as constituted by published research, as it has developed over the past two decades (2003-2021) through bibliometric analysis. This study also seeks to investigate the processes through which knowledge in the field is actively reproduced and transformed by stakeholders within research and design contexts (e.g., co-design processes). In so doing, this study intends to elaborate the structure of knowledge within the CCI research field and elucidate processes through which stakeholders act to (re)construct knowledge.

Why are you being asked to participate? As a key contributor to knowledge in the field of CCI over the past two decades, you are well-positioned to reflect upon, and offer perspectives and insight regarding, the development, current state, and future directions of knowledge in the field and the processes through which such knowledge is reproduced and transformed.

What does participation entail? Participants will partake in a virtual discussion workshop involving a number of contributors to the CCI field which seeks to explore participant experiences of, and perspectives on, the structure of knowledge in the field, as well as the (re)construction of knowledge through research and design processes. The workshop will be approximately 1.5 hours in duration and facilitated through Microsoft Teams. The workshop will be recorded for purposes of transcription.

Whilst a number of workshops will be hosted to facilitate a broader range of voices, participants are invited to take part in just **one** of these workshops (not all workshops). Workshops will take on three dates – Monday 24th January, Wednesday 26th January, and Friday 28th January. You are asked to indicate your availability for workshop(s) here. If none of the proposed dates/times are suitable, please contact us and we will explore alternative arrangements.

Indication of informed consent will be required prior to participation (see attached consent form). Please note that you may change or withdraw your consent at any time, without prejudice. Should you withdraw consent prior to data analysis, any data collected from you will be excluded from analysis and any project outcomes (e.g., publication). Should you withdraw consent following the beginning of data analysis, every effort will be made to remove your data from the project.

How will data be safeguarded? Data will be stored on a secure cloud storage platform approved by the University of Oxford's Information Security team and in local, encrypted files. Participant identities and identifiable information will be pseudonymised throughout transcripts. Data will be stored for the duration of the doctorate and post-doctoral publication plans. Identifiable data (including audio-visual recordings) will be safely destroyed thereafter with the assistance of University of Oxford IT. These procedures have received ethical approval from the University of Oxford's Central University Research Ethics Committee (CUREC).

How will this research be used? Data will be utilised in production of a doctoral thesis at the University of Oxford. Data will also contribute to research concerning the structure and construction of knowledge within the field of CCI and research concerning academic knowledge production more broadly through subsequent production and publication of journal articles and conference papers.

Who is conducting this study? This study is being conducted by Tiarnach McDermott, Doctoral Student at the University of Oxford, under the supervision of Dr James Robson, Professor Lars-Erik Malmberg and Professor Niall Winters.

What if there is a problem? If you have any concerns regarding any elements of this project, please contact the principal investigator (tiarnach.mcdermott@education.ox.ac.uk), who will respond to queries. The investigator should acknowledge your concern within 10 working days and give you an indication of how they intend to deal with it. If you remain unhappy or wish to make a formal complaint, please contact the chair of the Research Ethics Committee at the University of Oxford:

Chair, Social Sciences & Humanities Inter-Divisional Research Ethics Committee

Email: ethics@socsci.ox.ac.uk

Address: Research Services
University of Oxford
Wellington Square
Oxford OX1 2JD

The chair will seek to resolve the matter in a reasonably expeditious manner.

To obtain further information: If you have any questions concerning participation in this study, please do not hesitate in contacting the principal investigator (tiarnach.mcdermott@education.ox.ac.uk), who will be happy to discuss the study further and answer any questions you may have.

Appendix Q. Participant Consent Form

An Exploration of (Re)Construction of Knowledge in the Field of Child-Computer Interaction

Tiarnach McDermott, James Robson, Lars-Erik Malmberg, Niall Winters,

University of Oxford

Informed Consent: I have read and understood the details of this study (see information sheet), and have had the opportunity to ask questions, and have received satisfactory answers to questions asked. I understand that the project has received ethics approval through the University of Oxford's ethical approval process for research involving human participants, and understand who will have access to the data, how it will be stored, how data will be de-identified, and what will happen to the data at the end of the study. I understand how to raise a concern or make a complaint.

Changing Consent/ Withdrawal: I understand that participation is voluntary and that I am free to withdraw at any time, without prejudice.

Recording: I agree to the recording (audio-visual) of the virtual workshop discussion in which I participate and to its contents being used for the research purposes indicated (see information sheet).

Availability: Please indicate your availability/ preferred workshop date and time here. If none of the proposed dates/times are suitable, please contact us and we will explore alternative arrangements.

Name: ____

Institutional-/Organisational-Affiliation: ____

Signature: ____

Date: _____________________________ (dd/mm/yyyy)

Appendix R. Discussion Guide/ Questioning Route

Introduction	
Welcome participants	▪ Thanks for taking the time to join, ▪ Greatly appreciate involvement ▪ Value your insight as established contributors to the field ▪ Introduce self
Facilitate introductions	▪ Name, Pronouns, Affiliation, Research Interests, etc.
Share purpose of workshop and connection to broader project	▪ Workshop is part of a broader project seeks to explore the structure of knowledge within CCI and the processes by which knowledge is constructed and actively reconstructed, or reproduced and transformed, in the field ▪ These workshops seek to explore practitioners' experiences of, and perspectives on, the structure and construction of knowledge in CCI and the consequences of the processes of knowledge reproduction and transformation for the continued development of the field, as well as its various stakeholders
Establish (discuss, negotiate) ground rules	▪ Suitable/Unsuitable topics for discussion; respect confidentiality; turn-taking; address each other rather than moderator ▪ Details of recording: stored in encrypted file; audio will be transcribed; transcripts will be pseudonymised; videos will be deleted following transcription; audio retained until conclusion of planned research ▪ Contingencies for technical issues (connectivity, time, home deliveries) ▪ Opportunity to withdraw
Transition Question	
• What topics of study have been prominent in the field of Child-Computer Interaction over the past two decades?	
Key Questions	
What factors or processes have driven trends/ development in topics/themes of research within the field over the past two decades?	▪ What are the consequences of such processes for future directions in CCI research? [i.e., How might the processes/ factors driving trends/ development in topics/ themes of research in the field influence future research in the field?] ▪ What future directions are likely/ foreseeable in the field and why?
What voices contribute to construction of knowledge in CCI?	▪ What factors or practices implicit in, or associated with, the CCI field may impede or prohibit contribution of certain stakeholders/voices? ▪ What are the implications of the lack of certain voices in the field for the construction and cumulation of knowledge? ▪ How may the field better engage/ accommodate contributions from such stakeholders?

How (through what processes and practices) is the structure of the field of CCI knowledge reproduced or changed?	▪ How might CCI researchers act to reproduce established knowledge structures through research/ design processes? ▪ How do these processes and practices influence knowledge (re)construction (i.e., enable or impeded reproduction or transformation) of knowledge?
What external forces and distant actors influence knowledge production (particularly through co-design) in CCI?	▪ How might knowledge generated in/ produced through research/co-design processes be influenced by non-present actors? ▪ What are the implications for such influences for research and design outputs (values embedded in outputs and the (re)construction of knowledge)?
How are tensions between established knowledge within the CCI field and that (re)produced through research negotiated?	▪ What factors influence approaches to negotiation of such tensions? ▪ What are the consequences of such approaches to negotiating, and consequent resolution of, tensions for knowledge (re)construction in CCI? ▪ How may tensions between established knowledge within the field of CCI research and that (re)produced through research practices be best navigated to uphold values of the CCI community?
Concluding Remarks	
Summary/ Overview of Discussion	▪ Today we talked about… ▪ Some prominent themes in discussion…
Next Steps	▪ Results will contribute to ongoing doctoral research project ▪ Hoped to contribute to forthcoming publications concerning…
Any questions	▪ Does anyone have any questions/concerns ▪ Invitation to contact afterwards to address any outstanding issues
Thanks	▪ Thank you for your time and participation

Appendix S. Codebook

Codebook detailing final codes, associated definitions, and illustrative examples.

Table S.1. *Codebook.*

Code	Definition	Example
Impact of Research Concerning Novel Technologies	Participant describes the consequences and contributions of novel technologies designed and developed through CCI research to those within and beyond the field.	"We have seen that millions of kids around the world have been able to access children's books digitally because we created a digital library, the world's largest digital library for kids, using co-design. Okay. So that impact cannot be minimized"
Impact on Industry	Participant describes the potential, and realised, contributions of CCI research to industry practices and products, and the implications of such impact for the field.	"I think there is a deep gap between the industrial and research, like, because, I can tell that most of the research, you know, outcome, there's only stay at lab, and, like we mentioned, when we have the data of a few samples, then we publish that, but it didn't really get much impact"
Impact through Process	Participant identifies the impact of CCI research processes on research participants.	"it doesn't, for me, it doesn't matter, in a sense, what is the outcome, because the outcome is not the thing, but it's more of the process, because in the process children learn"
Impact through Outcome	Participant describes the impact of outputs and (design-) artefacts of CCI research for those within and beyond the field.	"So, I do think there is more responsibility for us to be creating things that is an output because outputs can be scaled"
Shifts in Research Priorities/Interests	Participant identifies developments in research interests and agendas in CCI throughout the past two decades.	"I do think there are fashions and I think fashions sometimes pick up on what people from the outside see to make sense"
Factors Driving Developments in the field	Participant details (internal or external) factors or actors regarded as (previously or currently) influencing developments and trends in research interests and agendas in CCI.	"I think it's a strong, like, kind of driven by technology"
Changes in Funding Availability	Participant describes the perceived influence of changes in funder agendas and funding opportunities throughout the past two decades on research agendas within CCI.	"there wasn't a lot of work done on how much voice is enough voice, how much ownership is enough ownership, until the second decade, really, of work in this area. And, um, you saw a lot of this coming out when people had funding for it"

Technological Developments	Participant describes the consequences of technological developments and advancements during the past two decades on research interests and agendas in CCI.	“I noticed about a shift in the field of tangible interaction design is the, that, almost, probably in the five or past ten years, there is much research about designing some tangible robot or voice-based interaction based on this kind of a robot. This is because the development of the AI”
Effects of Other Fields	Participant describes the effects of developments and advancements in other scientific fields throughout the past two decades on research agendas within CCI.	“I can see the other field’s development also influence the, you know, the research . So ones I notice about is like, uh, development in cognition theories, such as embodied cognition”
Future Directions in Research	Participant identifies emerging and predicted trends in CCI research.	“Access to special populations is difficult . Um, and then, you know, and, but that's the next the next frontier, is thinking about inclusive methods to bring in the voices of many different populations”
Impediments to Development in the field	Participant details challenges, limitations, or tensions within the field of CCI believed to hinder continued maturation of, and advancement of knowledge in, the field.	“We just repeat the experiments and then they die, so there is very little development on this field and that is some things that I think CCI seriously needs”
Technology and Artefact-Centred Research	Participant discusses the prevalence and implications of design-oriented research for development of knowledge in the field of CCI.	“So I would say that in human computer interaction in general, there is this very strong emphasis on novel stuff . You, you have to every year do something novel . And that is kind of visible in child, computer interaction as well… I wouldn't say that our own research has been kind of driven by advancements in technology, but of course you want to do something that people haven't been doing before”
Politicisation of the Field	Participant identifies and describes contested issues in the field of CCI.	“I love working with children, but it's not my methodology. But I would feel quite worried about saying that to some in the community, because it's always presented, like you either want to work with children as equal participants or you don't really respect children. I'm exaggerating for effect, but it can be slightly politicised”

Publishing Norms and Culture	Participant describes the consequences of norms and biases perceived within the field of CCI for development of knowledge.	"originally when we started writing papers to, to child computer interaction there were these struggles and especially our papers, including through multi-disciplinary collaboration, it was difficult to get them accepted and some of them we submitted them so many times… we were then thinking that we were somehow so far away from the mainstream stuff, trying to add some sort of humanistic approaches or something"
Publication Strategies	Participant articulates strategic publication practices utilised in navigating and negotiating tensions within the field of CCI.	"I think there's lots of strategies around like open publishing papers with, like, venues where, like, these things can proceed, such as at CHI, which is more for like, you know, thought provocations"
Aversion to Risk/Innovation	Participant details biases related to novel or unconventional contributions in the field of CCI.	"I think a lot of reviewer has mentioned, this is not a good change because it's encouraged the reviewer to only pass the paper who are safe. So that means maybe now not creative enough, they may not contribute the knowledge too much"
Dominance/Exclusion of Certain Voices	Participant discusses the marginalisation or exclusion of certain researchers within the field of CCI, and consequences for knowledge development thereof.	"I think basically because the committee, right, most of committee member, they are from the UK or US. So basically, because we're not in the committee, so for the [non-Western] researchers, they haven't had enough voices to speak, to help them to speak themselves"
Methodological Standards and Conventions	Participant describes establishment and maintenance of methodological standards and conventions within the field of CCI.	"I think having established practices, it's not always upheld by every research group in our own community"
Ethics in CCI Research	Participant discusses ethical practice and sensitivity apparent in CCI research.	"we still have ethics, but, you know, the standards, I think it's very low, especially when it comes to the vulnerable children"
Methodological Training	Participant discusses limitations in the methodological training of researchers contributing to CCI research.	"I think it also comes from the issue with our methodological training of researchers […] especially for this kind of qualitative interpretation of children's views and interests"
Misconceptions/ Misapplications of Co-Design	Participant describes perceived issues in the conception and practice of co-design methods in CCI research.	"the misconception that people have about co-design … it is not about whose voice is louder. It's not about whether we have to make sure that the kids come up with all the good ideas. It's about the process of elaboration"

Challenges to Equal Participation	Participant identifies factors which impede parity of power between adult and child participants in co-design methods in CCI research.	"it's important that you really hear children and not the adults who build on children's ideas. So, it's a difficult line, but on the other hand, you can never remove the adults totally"
Role/Influence of Adults in Co-Design	Participant describes the role and influence of adult participants within co-design methods in CCI research.	"the kind of messages you receive from children, we recognize a lot of issues with self-reporting from grown-up participants. And there will be naturally even more issue of such from children, especially young children, and then care is not always put in to consideration of all circumstances"
Recruitment/Sampling Challenges	Participant indicates challenges in recruiting participants from special populations in CCI research.	"in the field of participatory design with children, just the fact that you need to recruit children and that they need to have availability, and that usually they need to be accompanied by a parent or that you have to go through schools, means that children from more socio-economically disadvantaged backgrounds are just not as represented – and in general, social class is just not taken into account in most of these papers"
Collaboration (Multidisciplinary, Industry)	Participant discusses the prevalence and consequences of, and impediments to, multidisciplinary and industry collaboration in CCI research.	"It's not like it's happening by itself, actually it requires hard work and that for, for that reason, I'm sure that there are many bad examples, like different disciplines are just listed and all researchers representing different disciplines are doing their own thing and trying to make it look like something was done collaboratively, but in our project regarding children, I've got very positive experiences and researchers who are really devoted to try to understand each other and do something interesting together"

Appendix T. Initial Themes and Associated Codes

Table T.1. *Initial themes and constituent codes.*

Impact of CCI Research *Means by which impact may be achieved through CCI research and perceived areas and extent of impact*	**Funding** *Availability, and effects of, funding related to CCI research*	**Driving Factors** *Factors influencing priorities and trends in themes of study in CCI research*
Areas of Impact Impact through Process Impact through Outcome Lack of Impact	Drivers of Funding Areas Receiving Funding Changes in Funding Availability Effects of Funding Availability	Effects of Technological Developments Effects of Other Fields of Study Effects of Policy and Media Changes in Factors Influencing CCI
Challenges in Research Practices *Factors impeding, constraining, or limiting the efficacy or impact of CCI research*	**Challenges in Knowledge (Re)Construction** *Factors impeding the (re)construction of knowledge within the field of CCI*	**Growth and Development** *Growth and changes in research related to CCI over the past two decades*
Limited scale Lack of Evaluative Measures Methodological Limitations Sample Limitations Influence of Adults on Children's Contributions Misconceptions and Misapplications of Co-Design Tensions and Concerns Related to Intellectual Property and Ownership	Politics within the Field Publication Culture Lack of Cumulative Knowledge Development Aversion to Risk/Innovation Dominance/Exclusion of Certain Voices Problematic Discourses	Development of Intermediate Knowledge Technology and Artefact-Centred Research Multidisciplinary Collaboration Future Directions in Research
Position of Children *Factors influencing the role of children in CCI research*	**Ethics** *related to ethical considerations and practices in CCI research*	**Collaboration** *Collaboration within the field of CCI and its consequences*
to Equal Participation Role of Adults in Co-Design	Ethics in CCI Research Ethics Training	Lack of Meaningful Collaboration Consequences of Lack of Collaboration

Purpose/ Philosophy of Participation		Advantages of Collaboration
Methods *Limitations, challenges, and developments related to methods within CCI research*		
Methodological Limitations Consequences of Methodological Limitations Methodological Challenges Methodological Developments		

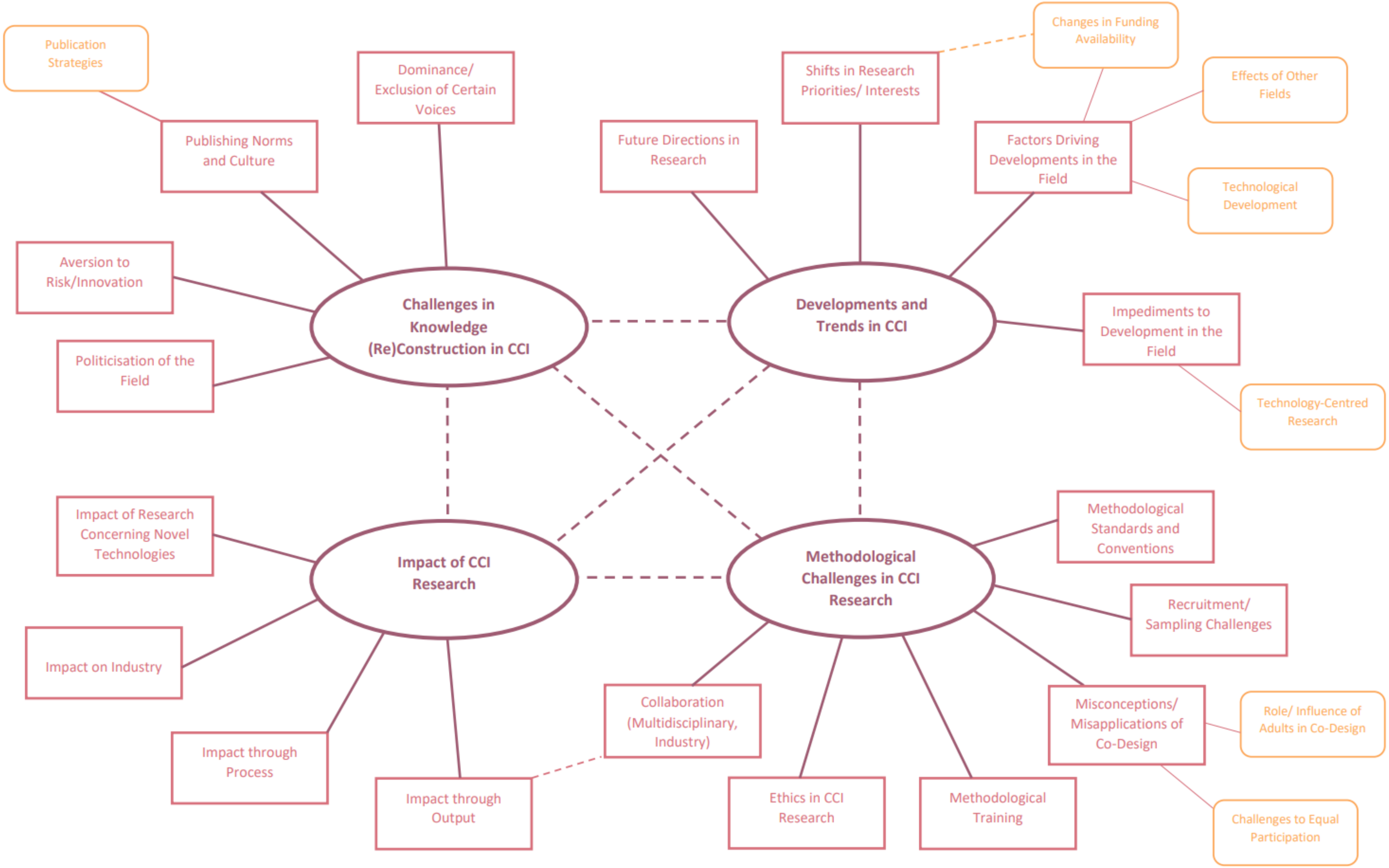
Appendix U. Revised Themes and Associated Codes

Table U.1. *Final themes and constituent codes.*

Impact of CCI Research *Means by which impact may be achieved through CCI research and perceived areas and extent of impact*	**Developments and Trends in CCI** *Growth and changes in research related to CCI over the past two decades, and factors influencing such development*	**Challenges in Knowledge (Re)Construction in CCI** *Factors impeding the (re)construction of knowledge within the field of CCI*
Impact of Research Concerning Novel Technologies Impact on Industry Impact through Process Impact through Outcome	Shifts in Research Priorities/Interests Factors Driving Developments in the field *Changes in Funding Availability* *Technological Developments* *Effects of Other Fields* Future Directions in Research Impediments to Development in the field *Technology and Artefact-Centred Research*	Politicisation of the Field Publishing Norms and Culture *Publication Strategies* Aversion to Risk/Innovation Dominance/Exclusion of Certain Voices
Methodological Challenges in CCI Research *Limitations and challenges related to methods within CCI research and their consequences for knowledge (re)construction*		
Methodological Standards and Conventions Ethics in CCI Research Methodological Training Misconceptions/ Misapplications of Co-Design *Challenges to Equal Participation* *Role/Influence of Adults in Co-Design*		

Recruitment/Sampling Challenges Collaboration (Multidisciplinary, Industry)		

Appendix V. Thematic Map



Appendix W. CUREC Form 1A

The University of Oxford places a high value on the knowledge, expertise, and integrity of its members and their ability to conduct research to high standards of scholarship and ethics. The research ethics clearance procedures have been established to ensure that the University is meeting its obligations as a responsible institution.

They start from the presumption that all members of the University will take their responsibilities and obligations seriously and will ensure that their research involving human participants is conducted according to the established principles and good practice in their fields and in accordance, where appropriate, with legal requirements. Since the requirements of research ethics review will vary from field to field and from project to project, the University accepts that different guidelines and procedures will be appropriate.

- Please check **"Where and how to apply for ethical review"** and the **CUREC flowchart** first to see if you need ethics approval.
- Please complete this form using a word processor and email it, together with your supporting documents, to your **Departmental Research Ethics Committee (DREC)** (**if applicable**). If you don't have a DREC please email this form to **ethics@socsci.ox.ac.uk** using your official **ox.ac.uk email** address. **Only emailed applications will be accepted.**

WHAT THIS CHECKLIST IS DESIGNED FOR
This **CUREC 1A checklist** is designed largely for research that falls within the Divisions of Social Sciences and Humanities where ethical issues are relatively few and straightforward. Interviews, field work and oral history are also included in the CUREC process. The **full CUREC 2 application** is only required where certain project characteristics (e.g. type of participants, or procedures) result in a more complex set of ethical issues. It is expected that only in a limited number of cases will it be necessary for researchers to complete a CUREC 2 application. The checklist below will direct you to a CUREC 2 application if needed.

WHAT THIS CHECKLIST WILL NOT ASSESS
This checklist does not cover research governance, satisfactory methodology, or compliance with the requirements of publishers when administering their tests or questionnaires. As **principal researcher (i.e. principal investigator)**, it is your responsibility to ensure that requirements in these areas are met. CUREC does not review studies classed as **audit** (see Glossary and Decision Flowchart for CUREC on our website). If your study involves **NHS patients, NHS staff / data / facilities, or human tissue**, please check the Decision Flowchart for NHS approval and contact the Clinical Trials and Research Governance (CTRG) team in the first instance. Further information on the University's research ethics procedures is available from the CUREC website.

SECTION A: Filter for CUREC2 application
This section determines whether your study raises more complex issues which require the completion of a full application for ethical review, known as the CUREC 2 application. **(Please mark 'X' in the Yes/No column as appropriate to indicate your response.)**

1.	Are research participants classed as **people whose ability to give free and informed consent is in question**? (This may include those under 18 (though see "competent youths"), prisoners, or adults "at risk".) Your attention is drawn to the University's **Safeguarding Code of Practice** and its implications for researchers involving children or adults at risk, including the need for the work to be risk assessed and for researchers to undertake related training. (**Note**: If any of your participants are aged 16 or under, please answer 'Yes' here **and** also answer question 5 below.)	Yes X	No
2.	By taking part in the research, will participants be at serious risk of criminal prosecution (e.g. by providing information on drug abuse or child abuse)?	Yes	No X
3.	Does the research involve the **deception** of participants?	Yes	No X
4.	Does your research raise issues relevant to the **Counter-Terrorism and Security Act (the Prevent duty)**, which seeks to prevent people from being drawn into terrorism? Please see advice on this on our **Best Practice Guidance web page**.	Yes	No X

If you have answered 'No' to all of the questions above please go to **Section B**. If you have answered 'Yes' to any question above continue to question 5 below.

5.	Is your project covered by a CUREC **approved procedure** (formerly known as "CUREC Protocols")?	Yes X	No
	If yes, please give research procedure number(s): AP25		

If you answered '**Yes'** to **ANY** of questions **1-4**, **and** answered '**No'** to question **5**, **please stop completing this checklist and do not submit it for ethical review**. Instead, please complete the CUREC 2 application form from the CUREC website. Then submit the CUREC 2 form for ethical review.
If you answered 'Yes' to ANY of questions 1-3, **and** answered 'Yes' to question 5, please go on to **Section B**.

SECTION B: Contact details and project description (NB: must be typed not handwritten)

Contact details:

1. **Principal investigator /** supervisor (if student research (title and full name):	Dr. Lars-Erik Malmberg Dr. James Robson
2. Name of student (if student research):	Tiarnach Mc Dermott
3. Degree programme, e.g. DPhil, BA, MPhil, BSc, MSc (if student research):	DPhil in Education
4. Department or Institute name:	Department of Education
5. Address for correspondence (if different from above):	
6. University e-mail (**not** private email) and telephone:	tiarnach.mcdermott@education.ox.ac.uk (+353)867377970
7. Name and status of others taking part in the project, e.g. third year undergraduate; postdoctoral research assistant:	

SECTION B continued

Project description:

8. Title of research project:	There and Back Again: A Study of Children's Transfer of Mathematics Learning and Motivation to Transfer from Touchscreen Tablets
9. List of location(s) where project will be conducted:	Primary schools in Ireland (Counties Dublin and Louth) Primary Schools in the UK (Oxfordshire)
10. If your research involves overseas travel or fieldwork and your department requires a travel risk assessment, will you have completed and returned a risk assessment form beforehand? (This has to be approved by your department before you travel. If you are travelling overseas, you are strongly advised to take out University travel insurance.)	Yes X No Not required in this instance
11. Anticipated duration of research project overall:	months or 3 years (maximum 5)
12. Anticipated start and end dates of the research project involving human participants:	From: (01/05/2019) To: (01/05/2022) Please note that you will need ethics approval **before** you start your research. CUREC 1As may take up to 30 days to process.

13. External organisation funding the research (if applicable):ESRC Grand Union DTP

14. Title and very brief and simple lay description of **research** (about 150 words), plus description (about 200 words) of the nature of participants.

a) Title, brief description of research (150 words) in lay language. When describing the research, please include your methodology, how you are applying professional guidelines, and the use to which results/data will be put. **Please also declare any conflicts of interest here.**

There and Back Again: A Study of Children's Transfer of Mathematics Learning and Motivation to Transfer from Touchscreen Tablets

The proposed experimental study is comprised of two phases.

The design of the intervention, an educational digital app, will be facilitated through a participatory process (Phase 1), involving collaboration with children (7-10 years) in order to identify engaging and effective features of gamefied educational applications. Participants will act to inform the design of an educational, mathematics themed application for younger children and subsequently review this application.
Creative and qualitative approaches will be employed over the course of several (3-5 anticipated) small focus group sessions, during which they will engage in brainstorming and low-tech prototyping.
The intervention study (Phase 2) aims to investigate children's transfer of learning from the digital domain of educational tablet applications to real-world learning tasks.
Participants will be randomly allocated to experimental groups, and will either receive a series of math's lessons (delivered by the researcher) or play a series of educational math's tablet applications (based on phase 1).
Participants motivation, self-efficacy, educational perceptions and engagement will be measured through self-report questionnaires after each learning session (Appendices E & F). Learning sessions will be video recorded for later coding of observed engagement (Appendix G). Participants' working memory and math's achievement will be measured through pre-task measures. Transfer of learning will be measured through near and far transfer learning tasks based on learning from lessons/applications. Parents of participants will complete a short, online media-usage survey (through the use of Qualtrix).

Qualitative data will be coded and analysed with reference to heuristc evaluation frameworks for children's technology. Data will be analysed using ANOVA, ANCOVA, multilevel modelling and structural equation modelling.

Parental opt-in consent and participant assent will be sought in advance of research (Appendices C & D). Parents and children will be fully informed of the proposed research and its aims, and may withdraw at any time.

SECTION B continued

b) Description of participants and **obtaining informed consent** (200 words). When describing participants, please include

- criteria for inclusion/exclusion
- method of recruitment
- processes for consent to participate

Please ensure you attach as separate documents (if applicable, in English translation):

- your recruitment and advertisement material e.g. a poster or brief invitation letter/ email
- information for participants to read (or hear) before they agree to take part e.g. written information sheets or (only if applicable) oral information scripts.
- a document to record informed consent. Templates for written consent forms and/or oral information scripts (in case of an oral consent process) are available from the CUREC website
- a guide to interview questions (this may be a list of questions to be asked, or a preliminary scope of questions), or a sample of other instruments (such as a sample questionnaire)
- (if relevant) debriefing document after participants have taken part

Participants will range from 5 to 10 years old. Participants annonymity will be maintained through assignment of numerical identifiers which will be used in order to match data.

As participants in the study are under 18 years old, CUREC approved procedure 25 will be applicable for this research project. This necessitates that informed parental/ guardian opt-in consent be obtained prior to participation. All typically developing children are elligible for involvement in this study. Parents/ guardians will receive an information pamphlet (Appendices C & D), detailing the intended study, data to be collected, researcher contact details, and rights to withdraw, as well as an opt-in consent form to be signed and returned should they wish their child to participate. This consent will include video recording. Children will be aware of video recording, and children's spoken assent will also be sought prior to participation.

Participants will be entitled to withdraw from the study at any time without need for justification, and will be given the opportunity to withdraw their data which has already been collected.

Data collection will take place in primary schools in Ireland and the UK. Schools will be recruited through convenience sampling, with the intent of obtaining a diverse and representative sample. Formal permission will be acquired from school's principals (head teachers), board of management/govenors and classroom teachers involved. Information pamphlets and consent forms will be distributed to parents in participating schools.

Parents of participants will also complete an online survey. Separate consent will be sought for this (Appendix H).

15. What are the ethical issues connected with your research and what steps have you taken to address them? Please do not answer 'none'. The committee needs to see evidence that you have identified potential ethical issues with respect to your research and have taken steps to address them. These issues could relate to: • your own physical and psychological safety as a researcher (please see the University's and Social Science Division's Safety in Fieldwork guidance • participant burdens and/or risks, and • data protection/ confidentiality (please also see section 18). For more guidance on ethical issues, please see http://researchsupport.admin.ox.ac.uk/governance/ethics/resources
• At risk participants (young children): informed parental opt-in consent will be obtained prior to any data collection as well as participants' spoken assent. • Presence of the researcher in primary schools: the researcher is a trained, registered primary school teacher, has completed child safeguarding training and will be appropriately vetted (Garda Vetting, DBS) before entering schools to conduct research. • Use of touchscreen tablet applications: applications used will be researcher designed, in collaboration with children, inspired by education and technology literature, and designed to align with the maths curriculum. • Electronic data collection: no names or identifying personal information will be collected electronically. Participants will be assigned an individual identification number so as to anonymize data collection and facilitate linking of participant data collected at different time points. • Video recording: video files will be stored securely in encrypted files and will be destroyed appropriately after the completion of doctoral studies. Coded observations will identify participants by pseudonymised identifiers only. • Data storage: Data collected from tablets will be stored on a secure, local SQL database on a password protected laptop. All data files will be encrypted. Any hard documents related to data will be stored in a secure, locked cabinet. • Screen time: the amount of time children spend using screen media during the study will be minimised and will not exceed screen time recommendations of medical professional organisations (e.g. AAP). Tablet learning sessions will last 20 minutes each at most. • Opportunity to experience potential benefits: while some participants will not receive the intervention during the course of the experimental study, the educational applications used will be made freely available to all parents of participants and schools after completion of the study regardless of experimental condition.

Section B continued		
16. Will you obtain informed consent according to CUREC guidelines and good practice in your discipline before participation?	Yes X	No
If you have marked '**No**', please give a brief explanation and justification for this decision here:		
17. Will your research involve discussing sensitive issues? This could be information relating to race or ethnic origin, political opinions, religious beliefs, physical/mental health, trade union membership, sexual life or criminal activities.	Yes X	No

If you have marked '**Yes**', please make sure that you have included some **supporting information** (as directed in question 14 of this section) showing the range of questions covering these issues.

Sample item for ethnicity in Parent Media Use and Attitudes Questionnaire

Which of the following best describes your ethnic group?

- ☐ White (This includes all White backgrounds)
- ☐ White and Black Caribbean
- ☐ White and Black African
- ☐ White and Asian
- ☐ Any other mixed background
- ☐ Chinese
- ☐ Indian
- ☐ Pakistani
- ☐ Bangladeshi
- ☐ Any other Asian background
- ☐ Caribbean
- ☐ African
- ☐ Any other Black Background
- ☐ Prefer not to tell
- ☐ Any Other (please specify)

This question is included as this demographic information is important for later publication and descriptive statistics regarding sample demographics.

18. **Management and handling of personal and other research data**

Your management and handling of personal data and special category data of human participants, either directly or via a third party, will need to comply with the requirements of the General Data Protection Regulation (GDPR) and the new Data Protection Act, as set out in the University's Guidance on Data Protection and Research. In answering the questions below, please also consider the points raised in the Data Protection Checklist. For advice on research data management and security, please consult with the University's Research Data Team (**researchdata@ox.ac.uk)** and/or your local IT department and the University's web pages on research data management.

a) Will your research involve the collection of **records of consent** (e.g. written forms, audio-recorded, or other recorded consent)? **If 'Yes', these will be classed as fully identifiable personal data (directly linked to an individual).**	Yes X	No
b) Will your research involve the collection of **other personal data?** **If 'Yes'**, specify in what form(s) this will be stored:	Yes X	No
• Fully identifiable (directly linked to an individual)	Yes	No X
• Pseudonymised (potentially identifiable as data may be attributed to an individual if linkage information can be accessed elsewhere by researchers)	Yes X	No
• Fully anonymised (i.e. cannot be linked to an individual)	Yes	No X
c) Will any of the personal data you collect classify as **special category** data? **If 'Yes',** in what form(s) will this be stored:	Yes	No X
• Fully identifiable (directly linked to an individual)	Yes	No

• Pseudonymised (potentially identifiable as data may be attributed to an individual if linkage information can be accessed elsewhere by researchers)	Yes	No
• Fully anonymised (i.e. cannot be linked to an individual)	Yes	No

d) How will any personally identifiable data be collected, transferred and backed up? Please describe the arrangements for any physical transfer of personal data (including paper records and data captured electronically via portable media) from where it is collected to local storage.
Data collected on tablets will be anonymised and transferred to a local database on the researcher's laptop (password protected) and will be stored in an encrypted file. Video files will be stored on the researcher's laptop (password protected) and will be stored in an encrypted file. Data from Qualtrix surveys shall be sent to the researcher's university e-mail account, which is securely hosted on the university servers. Data will then be downloaded to the researcher's password protected laptop and stored in an encrypted file. Other data will be stored in encrypted files on the researcher's password-protected laptop. Data will be backed up on both an encrypted hard drive, the University HFS, and supervisors' secure, university computer. Hard records will be stored securely in a locked cabinet.
e) Where, and for how long, will participants' personally identifiable data be stored during and after the study? (Please outline the procedures for ensuring confidentiality, eg security arrangements, anonymisation or pseudonymisation of such data. Please distinguish between records of consent and other forms of personally identifiable data stored)
Identifiable data will be stored in separate, encrypted files to associated anonymised data on the researcher's password-protected laptop. As indicated above, data will be backed up on both an encrypted hard drive, the University HFS, and supervisors' secure, university computer. Data (including video recordings) will be stored for the duration of the doctorate and post-doctoral publication plans; identifiable data, including records of consent, will be destroyed thereafter using digital tools provided by the University IT service. Anonymised digital data will be stored in encrypted files on the researcher's password protected laptop. Hard copies of any identifiable data will be stored in a locked cabinet, and will be destroyed using the department's secure shredding service following completion of the doctorate and post-doctoral publication plans.
f) If storing pseudonymised data, please confirm that identifiers will be held separately from the research data and linked through a unique study number. Specify how and at what point the pseudonymisation will occur, how the linkage information will be stored and state whether or not (and when) the linkage will be destroyed.
Documents linking participants and identifiers will be held in hard copy, locked in a secure cabinet in supervisor's office, and in encrypted files, separate from the data collected. Pseudonymisation will take place after participants have been recruited, prior to data collection. This will occur through randomisation, whereby participants are randomly allocated to experimental conditions and will be assigned a randomised three- or four-digit number.
g) Who will have access to the personally identifiable data? If personally identifiable data is to be shared with another organisation, how will it be transferred/disclosed securely?
My supervisors and I will have access to personally identifiable data. Data will not be shared with other organisations.
h) When and how will personally identifiable data be destroyed? (NB. Personally identifiable data should be destroyed when no longer required.)

Identifiable information will be retained for the duration of the doctorate and post-doctoral publication plans. After this time, hard copies of identifiable data will be destroyed using the department's secure shredding service and electronic data will be destroyed using digital tools provided by the University IT service.
i) How, where and for how long will other research data be stored after the study has finished? For more information about University and research funder retention policies, please see the University's web pages on research data management.
Pseudonymised data will be retained indefinitely, in order to facilitate future publication, in encrypted files on the researcher's password protected laptop and encrypted hard drive.

SECTION C: Methods and procedures to be used	
Method used: Please ensure you have addressed any potential ethical issues related to these methods in Section 14 and in your Participant Information Sheet	**Please mark 'X'**
1. Analysis of existing records	
2. Snowball sampling (recruiting through contacts of existing participants)	
3. Use of casual or local workers e.g. interpreters	
4. Participant observation	X
5. Covert observation	
6. Observation of specific organisational practices	
7. Participant completes questionnaire in hard copy	X
8. Participant completes online questionnaire or other online task	X
9. Using social media	
10. Participant performs paper and pencil task	X
11. Participant performs verbal or aural task (e.g. for linguistic study)	
12. Focus group	X
13. Interview	
14. Audio recording of participant (you will generally need specific consent from participants for this)	
15. Video recording of participant (you will generally need specific consent from participants for this)	X
16. Photography of participant (you will generally need specific consent from participants for this)	
17. Others (please specify):	X
Touchscreen tablet tasks and questionnaires (offline) Near and far learning transfer tasks	

SECTION D: Professional guidelines and training

In this section, please mark 'X' against at least one of the following professional guidelines you aim to adhere to. You should use the principles listed in your chosen guideline(s) in conducting your own research. **Note**: this is not an exhaustive list.

Research specialism/ methodology	Association and guidance document	Please mark 'X'
Anthropology	Association of Social Anthropologists of the UK and Commonwealth	
Criminology	http://www.britsoccrim.org/ethics/	
Education	British Educational Research Association Ethical Guidelines for Educational Research	X
Geography	Association of American Geographers Statement on Professional Ethics	
History	Oral History Society of the UK Ethical Guidelines	
Internet-based Research	British Psychological Society: Conducting Research on the Internet Association of Internet Researchers Ethics Guide Also see our Best Practice Guidance on internet-based research	
Law (Socio-Legal)	Socio-Legal Studies Association: Statement of Principles of Ethical Research	
Management	Academy of Management's Professional Code of Ethics	
Political Science	American Political Science Association (APSA) Guide to Professional Ethics in Political Science	
Politics	Political Studies Association. Guidelines for Good Professional Conduct	
Psychology	British Psychological Society Code of Ethics and Conduct	X
Social Research	Social Research Association: Ethical Guidelines	
Sociology	The British Sociological Association: Statement of Ethical Practice	
Visual Research	ESRC National Centre for Research Methods Review Paper: Visual Ethics: Ethical Issues in Visual Research	
Other professional guidelines. Please specify the other guidelines used here:		

Please indicate what training in research ethics the researchers involved with this study have received, e.g. the title of the course and date completed (online training available at http://researchsupport.admin.ox.ac.uk/support/training/ethics).

If no formal training has been undertaken, please indicate any discussions of research methodology between researchers and supervisors here.

Research Ethics (Foundations in Educational Research), Dr. Liam Gearon, 7/11/18

SECTION E: Signatures (The SSH IDREC Secretariat accepts either option below. If you have a DREC, check which signature option it prefers.) • **Option 1:** 'Electronic signatures', i.e. email confirmations from a University of Oxford email address, can be accepted. Separate emails should come from each of the relevant signatories as outlined below, indicating acceptance of the relevant responsibilities. **Pasted images of signatures <u>cannot</u> be accepted in the sections below.** • **Option 2:** Handwritten (wet-ink) signatures. Please scan them and the rest of the checklist pages to create a single PDF document and email through.	
Please ensure this checklist is signed by:	
For staff research:	**For student research**:
1. **Principal investigator**	1. **Principal investigator (project supervisor)**
2. **Head of Department (or nominee)**	2. **Head of Department (or nominee)**
	3. **Student researcher**

1. **Principal investigator signature/supervisor signature (if student research)**

I understand my responsibilities as **principal investigator** as outlined in the CUREC glossary and guidance on the CUREC website.

I declare that the answers above accurately describe the research as presently designed, and that a new checklist will be submitted should the research design change in a way which would alter any of the above responses so as to require completion of CUREC 2 (involving full scrutiny by an IDREC). I will inform the relevant IDREC if I cease to be the principal investigator on this project and supply the name and contact details of my successor if appropriate.

Signature: ………………………………………………………………………..

Print name (block capitals): ……………………………………………………….   **Date**: ……………………………………...

2. **Departmental endorsement signature**

I have read the research project application named above. On the basis of the information available to me, I:

(i) consider the principal investigator to be aware of her/his ethical responsibilities in regard to this research;
(ii) consider that any ethical issues raised have been satisfactorily resolved or are covered by relevant professional guidelines and/or CUREC approved procedures, and that it is appropriate for the research to proceed (noting the principal investigator's obligation to report should the design of the research change in a way which would alter any of the above responses so as to require completion of a CUREC 2 full application);
(iii) am satisfied that: the proposed project design and scientific methodology is sound; the project has been/will be subject to appropriate **peer review**; and is likely to contribute to existing knowledge and/or to the education and training of the researcher(s) and that it is in the **public interest**.

Signed by Head of Department or nominee *(example nominees for student research include the Director of Graduate Studies/ Director of Undergraduate Studies)*:

Signature: ………………………………………………………………………..

Print name (block capitals): ………………………...   **Date**: ……………………………………...

3. **Student signature (if student research)**

I understand the questions and answers that have been entered above describing the research, and I will ensure that my practice in this research complies with these answers, subject to any modifications made by the principal investigator properly authorised by the CUREC system.

Signed by student: ……………………Tiarnach Mc Dermott………………………………………….

Print name (block capitals): ……Tiarnach Mc Dermott............   **Date**: ………27/03/19…………...

SECTION F: SUBMITTING THE COMPLETED CHECKLIST	Please mark 'X'
1. Check you have completed all sections (A-E)	X
2. Ensure your application is signed by you, your supervisor (if student) and department	X
3. **Please attach all supporting documents (see section B, question 14b for details).** If the appropriate supporting documentation is not included with your application, you will then be asked to provide this separately. **This may well delay the ethical review process, and thus the start of your research.**	X
4. Ensure you have declared conflicts of interest (if any) in Section B, question 14a.	X
5. If your department has a Departmental Research Ethics Committee (DREC), submit this checklist and supporting information to the appropriate departmental officer.	X
6. If your department does not have a DREC, submit the checklist and supporting information to the SSH IDREC (email ethics@socsci.ox.ac.uk).	X
7. Applications must be sent by email from your official ox.ac.uk email account. Please do not send applications by post.	X

Appendix X. Request for Addendum to CUREC Approval

Tiarnach McDermott
Department of Education,
University of Oxford,
15 Norham Gardens,
Oxford,
OX2 6PY

Dr Liam Gearon
Chair, Departmental Research Ethics Committee
Department of Education, University of Oxford

Dear Dr Gearon,

I am writing in submission of an addendum to the existing CUREC approval for my current research (see CUREC no.: ED-C1A-19-184).

I am proposing, further to the research activities approved in the original submission, to undertake: (1) a series of virtual workshops, facilitated via Microsoft Teams, with academic and non-academic contributors to the field of Child-Computer Interaction research, and; (2) an analysis of bibliometric data of published research articles related to the field of Child-Computer Interaction. The proposed workshops are intended to address issues related to knowledge (re-)construction in the field, garnering participant perspectives based on engagement with, and contribution to, the field, whilst the proposed analysis of bibliometric data is intended to infer the thematic structure of knowledge in the field (as represented in published research articles) and identify the stakeholders contributing thereto. Each of the proposed additional activities are further described in turn below.

Virtual Workshops

Participants, all of whom will be over the age of 18, will be identified based on previous contributions to the field (i.e., research publications) and contacted directly (via email) with an invitation to participate. The invitation to participate will include an information sheet which details the intended study, data to be collected (and the means of collection), data storage and access procedures, de-identification of data, intended future use of data, and rights to withdraw. Opt-in consent will be sought via completion and return of a consent form, acknowledging comprehension of the study details and agreement to participate in the study as detailed (including audio-visual recording of virtual workshops). Consent will also be sought regarding the extent of anonymisation applied in reporting participant data – here, whether participants wish to waive their right to individual and/or organisational anonymity (i.e., be listed as a participant, although not having statements or contributions attributed directly in reporting), or remain anonymous (i.e., have identity and all other identifiable information concealed via pseudonymisation).

Workshops will be undertaken, recorded, and transcribed through Microsoft Teams. A "Recording in Teams Request Form" will be submitted to IT Services prior to workshops. The recording of workshops will abide by the University's "Policy on Recording Meetings" (see Record a meeting in Teams). Prior to initiating recording, participants will be reminded of the intent to record and transcribe the workshop, and will be afforded opportunity to indicate dissent and withdraw prior to commencement of, and any time during, recording. Workshops do not intend to address sensitive topics (as per ESRC and GDPR). Workshop procedures will adhere to University best practice guidelines (see Best Practice Guidance 06 version 7.1 and Best Practice Guidance 10_Version 1.0)

Bibliometric Data Analysis

Bibliometric data of published research articles related to the field of Child-Computer Interaction will be retrieved from Elsevier's Scopus database through querying the Scopus application programming interface (API) with a custom search string. Retrieved bibliometric data will include author names (in the form [Last Name] [First (and if relevant middle) Name Initial(s)]), as well as institutional and national affiliations, as reported in published research articles. Retrieval and use of Scopus data will comply with Elsevier's Terms & Conditions and policy for use in academic research.

Retrieved bibliometric data will be analysed through simple frequency counts and collaboration networks. The thematic content of retrieved articles will be inferred through an unsupervised machine learning model (here, using the Correlated Topic Model[15]). Relevant guidance concerning ethical application of machine learning models in research will be heeded (see Association of Internet Researchers' guidelines). Scientific requirements of reproducibility, replicability, and transparency will be pursued through explicit elaboration of the working process in retrieving data and developing and deploying the model, documenting and explaining human choices made therein. Potential biases in data retrieved (e.g., limited scope of search strings, Tower of Babel bias) and model applied (e.g., human judgement in setting number of topics), and associated implications for results, will be explicated.

Data Management Procedures

Data protection by design will be embedded in the research, adhering to the University's data protection by design framework (including completion of relevant screening and assessment forms). Data management procedures will adhere to University best practice guidelines (see Best Practice Guidance 09_Version 4.5) and CESSDA data management guidance (see CESSDA Data Management Expert Guide). Workshop video and audio recordings and transcripts will be stored on OneDrive for Business, as provided by the University and approved by the University's Information Security team. Identifiable and personal information in transcripts will be retained or pseudonymised (based on participant opt-in consent; see above). Copies of transcripts will subsequently be downloaded and stored locally in an encrypted file on the researcher's personal laptop (password-protected). Identifiable data (participant details) will be stored on OneDrive for Business and locally in a separate, encrypted file to transcripts. Bibliometric data retrieved will be stored on OneDrive for Business and locally in an encrypted file. Data (including audio-visual recordings) will be stored for the duration of the doctorate and post-doctoral publication plans; identifiable data (including audio-visual recordings) will be destroyed thereafter using digital tools provided by the University IT service. Data protection screening (DPS) and data protection impact assessment (DPIA) will be completed and submitted for consultation of the University's Data Protection Officer (DPO).

[15] Blei, D.M., & Lafferty, J.D. (2007). A correlated topic model of Science. *The Annals of Applied Statistics, 1*, 17-35.

The research does not address sensitive issues and there are no foreseen harms to participants.

Regards,

Tiarnach McDermott
Doctoral Candidate
[Type the sender company name]
18/11/2021

Appendix Y. Notice of CUREC Approval

Dear Tiarnach

ED-C1A-19-184

Title: There and Back Again: A Study of Children's Transfer of Mathematics Learning and Motivation to Transfer from Touchscreen Tablets

The above application has been considered on behalf of the Departmental Research Ethics Committee (DREC) in accordance with the procedures laid down by the University for ethical approval of all research involving human participants.

I am pleased to inform you that, on the basis of the information provided to DREC, the proposed research has been judged as meeting appropriate ethical standards, and accordingly, approval has been granted.

I have a recommendation that you review your participants' information and consent forms to ensure your supervisor is named on these; and also that you do not give out personal mobile phone details, as this is not recommended.

If your research involves participants whose ability to give free and informed consent is in question (this includes those under 18 and vulnerable adults), then it is advisable to read the following NSPCC professional reporting requirements for cases of suspected abuse

http://www.nspcc.org.uk/globalassets/documents/information-service/factsheet-child-abuse-reporting-requirements-professionals.pdf

Should there be any subsequent changes to the project which raise ethical issues not covered in the original application you should submit details toresearch.office@education.ox.ac.uk for consideration.

Good luck with your study
Best wishes

Nicola

Dr Nicola Warren-Lee

Geography PGCE Curriculum Tutor

DEPARTMENT OF EDUCATION UNIVERSITY OF OXFORD

University of Oxford/Department of Education

15 Norham Gardens, Oxford, OX2 6PY

Tel. 07970803012

Email nicola.warren-lee@education.ox.ac.uk

www.education.ox.ac.uk

@OxfordDeptofEd

Appendix Z. Notice of CUREC Addendum Approval

Dear Tiarnach
Very thorough, thank you. We can note and approve.
Kindest
Liam

Liam Francis Gearon, PhD, FHEA, FRSA, Docent

DEPARTMENT OF EDUCATION
UNIVERSITY OF OXFORD

Senior Research Fellow, Harris Manchester College, University of Oxford
Associate Professor, Department of Education, University of Oxford
Conjoint Full Professor, Newcastle University, Australia
Docent, University of Helsinki, Finland
Extraordinary Professor, North-West University, South Africa
Visiting Professor, Irish Institute for Catholic Studies, MIC, Limerick, Ireland
Honorary Senior Research Fellow, School of Education, University of Birmingham

Appendix AA. Response to Information Compliance Office Recommendations

Responses to Data Protection Impact Assessment (DPIA) Recommendations of Information Compliance Office (ICO)

	ICO Recommendation	Response
I	If visual recordings are not required for the purposes of the study, collecting this data would likely breach the principle of data minimisation. To avoid this issue, I would advise that only audio data should be collected for transcription purposes. Further guidance on this issue can be found here under the section on remote recording in Teams: [Guidance for researchers working remotely with participant data | Research Support (ox.ac.uk)]	Workshops discussion sessions, facilitated via Microsoft Teams, will be recorded (audio-visual) for purposes of subsequent transcription. Video will be recorded in order to support speaker identification and accuracy in transcription. Following transcription, video recordings will be destroyed using tools provided by the University IT service. Audio recordings will be securely retained for the duration of the doctorate and post-doctoral publication plans, and destroyed thereafter.
II	Identification of participants can have an impact on the risks of processing. I would advise clearly outlining why direct identification of participants in the research outputs is necessary to achieve the research goals.	Neither participants nor participant organisational-/institutional-affiliations will be identified in research outputs, with any such identifiable information pseudonymised/ anonymised (as appropriate).
III	I would advise that the reference to informed consent should be clarified. In this instance I would expect that the lawful basis on which the research is based is Article 6(1)(e) UKGDPR, that is carrying out a task in the public interest. In this case that task would be research. The manner in which informed consent is discussed here may lead to misunderstanding, should the DPIA be viewed by anyone external to the University, such as a funding body etc. Whilst it is helpful to outline that you have consent from individuals where you would like to publish their names as this demonstrates transparency, I would advise making it clear that you are not reliant on consent as the lawful basis for the intended processing.	The lawful basis for intended processing of personal data (here, institutional-/organisational-affiliations of published researchers in the field) is that such "processing is necessary for the performance of a task carried out in the public interest", as stipulated in Article 6 (1)(e) of the UK General Data Protection Regulation (UK GDPR; here, the 'task carried out' concerns analysis of the quantity and substantive content of research published by researchers affiliated with institutions/organisations, as well as collaborations between researchers affiliated with institutions/organisations). As noted above (II), neither workshop participant's nor participant organisational-/institutional-affiliations will be identified in research outputs as this is not regarded as 'necessary'.

IV	The DPIA should clarify the following points:	
	• IV.1 Where was this data collected?	Data were collected from Elsevier's Scopus, a curated abstract and citation database consisting of peer-reviewed scientific content submitted, and subsequently selected, for inclusion by editors and publishers of serial content (i.e., journals, conference proceedings, and book series). Data were obtained through interfacing with the Scopus application programming interface (API) using the *rscopus* R package (Muschelli, 2019)
	• IV.2 What privacy information was provided to individuals when this was collected?	Privacy information was not provided to individuals when data were collected due to the disproportionate effort which would be required to inform individuals. Relevant privacy information ought to have been provided to individuals by publishers or editors upon submission or acceptance of manuscripts (Scopus requires all indexed serial content provide clear and publicly available statements of publication ethics; see Elsevier's Content Policy and Selection)
	• IV.3 What purposes were the data collected for?	Data were collected for the purpose of analysis of the thematic structure of knowledge in the field of Child-Computer Interaction (CCI; as represented in relevant published research outputs) and stakeholders contributing thereto (i.e., institutional-/organisational-affiliations of contributing researchers)
	• IV.4 Is there a data sharing agreement in place with Elsevier?	Elsevier provides access to raw data (via the Scopus API), allowing researchers at subscribing institutions (which the University of Oxford is) to text and data mine for non-commercial research purposes (see Elsevier's Text and data mining policy)
V	The use of a search string which is determined by the University, indicates that in this instance, in accordance with regulatory guidance, Oxford University and Elsevier will be joint controllers for the processing required to identify what data is required for the study. This is because:	Data retrieval and processing are undertaken pursuant to Elsevier's Text and data mining policy (see IV.4) and Provisions for Text and Data Mining and Academic Research, and are in accordance with the permissions and conditions stipulated therein to which the researcher agreed upon registration and obtention of API keys.

	• The University participates in the determination of the means and the purposes of processing by engaging Elsevier and also providing them with specific search criteria to obtain the data sample required. And, • Elsevier has decided to process personal data in such a manner to make it available for the purposes of allowing researchers to target individuals. In doing this, Elsevier has made certain decisions regarding the essential means of the processing, such as what personal data it will process and which targeting methods will be offered to researchers. As the University and Elsevier would be considered joint controllers for the purposes of this processing, there should be a clear agreement with Elsevier that reflects this relationship and details exactly what regulatory responsibilities each controller accepts. The University's controller scope should be limited only to that processing required to target specific individuals for the study's purposes and not for any other activities for which Elsevier might use this data. The agreement with Elsevier should be reviewed by a contract specialist within Research Services. Further details on the relevant team can be found here: Research contracts | Research Support (ox.ac.uk)	Data retrieved are publicly available publication details (see XVIII), commonly subject to the bibliometric processing/analysis approach implemented (see, for example, Älgå, Eriksson, & Nordberg, 2020; Asmussen & Møller, 2019; Daenekindt & Huisman, 2020; Ji, Nam, Kim, Lee, & Lee, 2018). Details concerning particular data sought (i.e., search string implemented) and data retrieved (i.e., bibliometric information provided by Elsevier's Scopus in response), as well as data processing, will be reported in a clear and detailed manner.
VI	It is recommended that the DPIA outlines what controls are in place to prevent special category data from being collected? This is especially important in the workshops, given that individuals may choose to discuss topics that are not necessarily anticipate by the researcher– for example it is possible that individuals may disclose health data or similar in a conversational manner, even though this is not the central topic of analysis. The DPIA should detail how the study will	Workshop participants will be requested, prior to commencement of session recording, to refrain from providing special category data as such data is not within the remit of this study. Should any such data be inadvertently shared by participants, relevant portions of session recordings will be removed prior to transcription.

	avoid collecting this type of data - i.e. will a specific request be made before data collection commences to direct participants not to provide special category data?	
VII	Will all data be stored for the same amount of time? I would advise setting exact time limits on retention – i.e. will all data be deleted immediately on doctoral publication? If so, this should be made explicit.	Workshop session recordings and participant details (including links between participants and pseudonymised identifiers) will be destroyed upon doctoral completion. De-identified (i.e., pseudonymised/ anonymised) session transcripts will be retained and stored securely for at least three years following doctoral completion, after which time transcripts may be destroyed should they no longer be of use in research and research publications. A private copy of text corpora retrieved from Elsevier's Scopus will be retained and stored securely for at least three years following doctoral completion for purposes of further analysis and peer review, as permitted by Elsevier, after which time corpora may be destroyed should they no longer be of use.
VIII	It is recommend that you should ensure that data collection from any participants outside of the UK/ EU is conducted in line with the laws within their country of residence. To get clarity on whether there are any legal issues with data collection and processing for non-EU/ UK citizens, you would need to take independent legal advice, as jurisdictions outside of then UK/ EU are beyond the remit on which the ICT can provide advice.	Following review of legal guidance and relevant legislation, data collection from participants outside of the UK/EU complied with laws of participants' countries of residence.
IX	I would advise including details here of how Elsevier obtain the personal data from the individuals.	Personal data, here author name and affiliations, are provided to Elsevier by editors or publishers of publication venues to which authors have willingly provided such details in submitting for publication.
X	How is this information downloaded to the University systems?	Bibliometric data are downloaded (in XML) directly to the researcher's personal device through the interfacing with the Scopus API via the *rscopus* R package

		(Muschelli, 2019) and are subsequently saved to CSV files stored in an encrypted file on the researcher's device. Upload of data to OneDrive for Business will be direct from the researcher's personal device.
XI	How are these individuals recruited? It would help to provide clarity on this within the DPIA.	Prospective participants were contacted directly via email (sent to professional addresses, i.e., personal university or organisation email) with an invitation to participate which included an information sheet detailing the intended study, data to be collected (and means of collection), data storage and access procedures, de-identification of data, intended future use of data, and rights to withdraw.
XII	It should be confirmed with Information Security that this is the most appropriate storage location for this information. You should also ensure that Info Sec approve the access management protocols that are in place for the data. Further information on how to contact Information Security can be found here: Secure my research information | Information Security Team (ox.ac.uk)	Nexus365 OneDrive for Business is certified against internationally recognised information security standards (ISO/IEC 27001:2013) and approved by the University for all data by the Information Security Team. Relevant guidance for secure data storage using OneDrive for Business provided by the University IT Service is followed.
XIII	Who will transcribe this information?	Recordings will be transcribed by the researcher.
XIV	Will the identifiers be destroyed? If identifiers will be retained, then the DPIA should clearly state why this is required for the research purposes. If the identifiers are not required, then the DPIA should confirm that these will be destroyed when the research purposes have been achieved.	See VII
XV	As above, this is vague for a retention time limit and would benefit from further clarification. For clarity, holding the data in an identifiable form should only be done if there is specific reason for doing so, relating to the research purposes. Otherwise moves should be made to remove identifiers from the data or destroy it when it has been used for the purpose for which it was collected.	See VII

XVI	As noted above, the study does not rely on consent as the lawful basis for processing. On this basis, withdrawal of consent does not mean that processing must cease **from a data protection perspective** (although there may be ethical considerations that are relevant here)**.** It is worth clarifying this point to prevent confusion. Although the study does not relay on consent as its lawful basis for processing, individuals do still have a right to object to the processing and/ or request deletion of their personal data. These types of request would be subsumed under the general category of data subject requests. Further details of these types of request and how to deal with them can be found here: Handling an information request | Compliance (ox.ac.uk) The University has a centralised process to deal with requests of this nature and the DPIA should clarify how it will ensure that any received requests are routed to the ICT in line with the agreed process (see referenced guidance). The DPIA should also outline how it will halt processing/ delete data of a particular data subject, if it is deemed that this is required, following consideration of the request by the ICT.	Should a participant withdraw consent, the participant's data will be excluded from processing based on ethical considerations (rather than purposes of data protection). Participant information requests, including erasure and rectification requests will be forwarded via email to the University's Information Compliance Team (ICT), which handles such requests, as advised. Should deletion of data related to a particular subject be required following consideration of a request by the ICT, all such data will be omitted/removed from processing securely destroyed using tools provided by the University IT service.
XVII	A privacy notice should still be made available to individuals on the project website. This should direct individuals to the process by which they can enact their data subject rights (see guidance referenced in the above comment).	There is no project site on which a privacy notice may be published. Workshop participants received privacy details through a participant information sheet provided prior to participation.
XVIII	Was it made clear to them that this would occur at the time which their data was submitted?	In submitting research outputs for publication, authors were aware that the published work (including details such as the authors' names and affiliations) would be publicly accessible, based on publisher or editor submission guidance and publication policy, and may, consequently,

		be subject to review, scrutiny, and criticism.
XIX	Is th research subject to any ethical review? If so, this should be referenced here. Also, you should reference the data protection policy to which you are subject (details of this are available here: Data protection policy | Compliance (ox.ac.uk)) It is recommended you also reference that you are subject to the University's Information Security Policy (Information Security Policy.pdf (ox.ac.uk))	This research was subject to ethical review from the Departmental Research Ethics Committee (DREC) for the Department of Education, on behalf of the Central University Research Ethics Committee (CUREC; CUREC no.: ED-C1A-19-184). This research is also subject to the University's Data Protection Policy and Information Security Policy.
XX	I would advise including some information here on why potential workshop attendees will not be consulted.	Workshop participants were not consulted concerning use of data obtained from Elsevier as workshops and bibliometric analysis were undertaken as independent phases of the research project.
XXI	Although consent may be required from an ethical standpoint, it is not likely to be appropriate here to rely on consent as your lawful basis. I would advise that you are relying on Article 6(1)(e) UK GDPR, that is carrying out a task in the public interest. It is recommended that you remove the reference to consent as a lawful basis and clearly outline that your lawful basis is public task. Suggested wording to include here is provided below: *The University relies on Article 6(1)(e) of the UK General Data Protection Regulation (UK GDPR) to process personal data where processing is necessary for a task carried out in the public interest or in the exercise of official authority vested in the University. In this instance the public interest task is research.* *The principal objects of the University are the advancement of learning by teaching and research and its dissemination by every means. The University has the power to do all things permitted by law which are necessary or desirable to promote its objects. More information about the University's legal status can be found here:*	See III

	https://governance.admin.ox.ac.uk/legislation/statute-i-preliminary	
XXII	Given that you are processing data from individuals from whom data has not been collected directly, you should take steps to provide information publically regarding your intended processing. This is often done through provision of a privacy notice on a public platform such as the project website. This will allow those whose data has been processed for the purposes of your research to identify information on how their personal data has been used by your research. Further details on how to create a privacy notice are available here: Creating privacy notices | Compliance (ox.ac.uk)	
XXIII	See comment above with regards to providing a public privacy notice. In addition, the DPIA should be clear on why it is deemed that it would be disproportionate effort to provide privacy information directly to those individuals for whom personal data is being provided by Elsevier. Relating to this point, it is possible that you may be able to rely on the exemption outlined in Article 14(5)(b) of UK GDPR to justify not providing privacy information directly to participants. However, in order to apply this exemption, it is necessary that certain conditions are met. These conditions include: • The controller shall take appropriate measures to protect the data subject's rights and freedoms and legitimate interests, **including making the information publicly available** – this relates to the above comments regarding a public privacy notice. • Processing should be subject to appropriate technical and organisational measures, in particular in order to ensure respect for the principle of data	Provision of privacy information directly to those individuals for whom personal data is being provided by Elsevier's Scopus is deemed to necessitate disproportionate effort due to the considerable labour involved in identifying contact details for, and subsequently contacting, several thousand individuals as well as the limited anticipated effect use of personal data will have on individuals, with data analysed and reported at aggregate levels (e.g., institution) and not linked to individuals (i.e., individual researchers will not be identified beyond expected academic attribution practice).

	minimisation – these are the measures outlined in the DPIA. • These measures should include the psuedonymisation or anonymisation of the data set, wherever the purposes of processing allow for this – you should be clear on when these will be applied and justify instances where they are not for the Elsevier data. To ensure transparent application of the principles of this exemption, it is recommended that the project clearly documents an assessment of why there is a disproportionate balance between the effort involved to provide individuals with privacy information and the effect that the use of their personal data will have on them. This will allow clear justification for the approach in the event of regulatory scrutiny. Reflection on the three necessary conditions for applying an exemption here should also be made in this section of the DPIA.	
XXIV	Will it be made clear to individuals that you will be accessing their institutional data for these purposes? This information should be included in your privacy informational as you are effectively collecting a second data set from the official University websites	Organisational-/institutional-affiliation will not be checked through organisations'/ institutions' official websites
XXV	See comments above relating to collection of visual data from workshops as this is likely to breach the principle of data minimisation.	Participant name and organisational-/institutional-affiliation are collected but not reported. Affiliation is utilised for identification of country in which researchers' institutions are based, which is subsequently reported for purposes of transparency concerning study sample.
XXVI	See comments above – it is recommended that you consult with the Information Security Team on the suitability of the access controls you have in place for this personal data.	Access to personal data will be restricted to the researcher.
XXVII	As advised above, it should be considered why the publication of participant names is required for research purposes	Participant names will not be published. De-identification will involve pseudonymisation or removal of any

	outlined. Also it should be outlined how pseudonymisation will be achieved – i.e. will this include removal of any personally identifiable information such as identifying comments/ discussion of personal experiences etc. or will this only be the removal of direct identifiers such as names? The DPIA should also identify whether all identifiers that have removed will be saved in a separate location which can provide linkage if required? If so, how will this document be protected and who will have access to it? If linkage data is retained, at what stage will this be destroyed?	information considered personally identifiable, including direct identifiers such as names and locations, as well as highly specific experiences or perspectives (e.g., participants' prior publications, research involving specific organisations). Removed identifiers will be maintained in a separate, encrypted file (accessible only to the researcher) to support linkage should this be required. Identifiers will be destroyed upon completion of the doctorate (see VII).
XXVIII	Will identifiable information be published in your research outputs? If so, have you considered the potential risks to individuals whose data is being published and whether they might object to being identified in this manner?	Individuals will not be identified in publication beyond common academic convention (i.e., citation) where appropriate. Institutions and organisations are not considered at risk from identification in publication, as analysis results detail only the quantity and thematic content of publications in the field of CCI associated therewith and does not seek to make any assertions concerning the quality thereof, and acknowledges limitations in methods which may qualify interpretation of results (that the data analysed are not comprehensive and the analysis subject to researcher judgement).
XXIX	It is recommended that a documented retention schedule is put in place identifying the amount of time that personal data will be retained after publication. This should be related to the research purposes for which the data was collected.	See VII
XXX	If data is retained for other analyses, in addition to the one identified for this research project, then participants should be made aware of this. For clarity, individuals should be informed of any purposes for which their personal data may be used. If data is retained for purposes, other than that of the study that is being conducted, these should be	Data will be analysed only for those purposes stated for this research project. The manner in which project outcomes will be published (i.e., publication venue, content of publications) has not yet been determined, but will be based on the analyses identified for this research project.

	made transparent. Also you will need to consider whether the appropriate compliance requirements have been met for any additonal uses of the data.	
XXXI	It is advised that you have a process document in place that clearly identifies exactly how and when data will be destroyed as well as who within the University is responsible for ensuring that this is completed.	See VII Data will be destroyed by the researcher using digital tools provided by the University IT service, following University and Department procedures (see CUREC Best Practice Guidance for Management and Protection of Data Collected for Research Purposes and ICO Data Protection Policy).
XXXII	Are you using any software programs to analyse, store or transfer your data? If so, these should be included under the section on data processors. Also, are you using any transcription service for the transcription of workshop data? If so, these should be included. If you are not using any third party software or external services to process any of the personal data, this should be confirmed within the DPIA.	Nexus365 OneDrive for Business will be utilised for cloud storage of data (here, de-identified transcripts) and text corpus. OneDrive for Business will be used for secure storage purposes (i.e., data back-up).
XXXIII	It appears the Elsevier are sharing personal data with us for the purpose of our analysis. It is also apparent that they may be considered joint data controllers with us for this processing. Elsevier should be added to the table below and you should document what controls are in place to manage this relationship. For clarity, there should be a formal agreement in place with Elsevier detailing the respective data protection responsibilities for each party. There should also be a data sharing agreement in place (possibly as part of the joint controllership agreement) detailing the terms of data sharing that have been accepted by both parties. This should be reviewed by a contract specialist in Research Services to ensure that it is aligned with the University's legal requirements.	See V
XXXIV	If you are using any software programs for analysing the personal data you	Data analysis is to be undertaken using R (and Rstudio) on the researcher's personal

	should confirm whether these services may require data to be transferred to cloud storage outside of the UK/EU. If there is any suggestion that a software provider or other third party service may transfer data outside of the UK, the section below should be filled in for that provider.	device, and as such will not be transferred to other services. Nexus365 OneDrive for Business does not transfer data outside of the UK (see, for example, University's IT Services)
XXXV	This should be assessed as "probable", given this will definitely happen - the study has confirmed that personal data will be collected where individuals have no knowledge of this and will not receive any privacy information This should be assessed as "significant", given that those individuals who do not know their data is being processed will not be able to exercise their data protection rights. Given the suggested likelihood and severity assessments, this should be assessed as "high".	Inability to be given information about processing presents probable likelihood of harm to individuals, a significant impact, and present high overall risk
XXXVI	Publishing a public privacy notice will assist in mitigating this risk.	There is no project site on which a privacy notice may be published.
XXXVII	This only applies up to the point of publication. Once published, it will not be possible for individuals to remove their personal data from the study outputs. This is particularly relevant with regards to the publication of an individual's name. Irrespective of whether an individual has initially provided permission for their name to be published, should they change their mind following publication, it will not be possible to recall their personal data from the public sphere. Therefore, control will be lost at this point. This is worth reflecting in the risk assessment.	Participant names will not be published.
XXXVIII	The researcher should consider whether there may be possible impacts from this form of re-identification and document these considerations within the DPIA.	Re-identification of participants may cause disagreements within the research field concerning the participant's perspectives, impact the participant's standing within the field, and potential result in

		ostracization of participants from the research community and reduced professional opportunities (e.g., research collaboration, funding).
XXXIX	This should be assessed as "probable", given this will definitely happen - the study has confirmed that personal data will be collected where individuals have no knowledge of this and will not receive any privacy information This should be assessed as "significant", given that those individuals who do not know their data is being processed will not be able to exercise their data protection rights. Given the suggested likelihood and severity assessments, this should be assessed as "high".	The likelihood of harm due to obtention of personal data not directly from individuals and without informing them of processing due to disproportionate effort is probable, may have a significant impact, and presents a high risk.
XL	Please see comments above regarding the possible retention of the data for purposes outside of the identified research project. These should be considered with regards to this assessment.	See XXX
XLI	See comment above, regarding the possible retention of the data for purposes outside of the research project	See XXX
XLII	The steps taken to mitigate this risk include those discussed above with regards to the exemption that can be applied to this requirement. Ensuring that you comply with the requirements of the exemption will be the main mitigations here. To re-iterate, the requirements of applying the exemption are as follows: *• The controller shall take appropriate measures to protect the data subject's rights and freedoms and legitimate interests,* ***including making the information publicly available****.* *• Processing should be subject to appropriate technical and organisational measures, in particular in order to ensure respect for the principle of data.*	See XXIII

	• *These measures should include the psuedonymisation or anonymisation of the data set, wherever the purposes of processing allow for.* Ensuring that the processing is aligned with these controls will mean that an exemption under 14(5)(b) of UK GDPR would likely be justified. However, the DPIA should clearly commit to adhering to these mitigations to successfully reduce the risk that has been identified.	

Appendix BB. Paper Latent Topic Structure Descriptive Statistics

Descriptive statistics for paper topic structure variables (based on topic loadings derived through Correlated Topic Modelling)

Table BB.1. *Descriptive statistics of Child-Computer Interaction research paper latent topic structure variables.*

	Mean	Standard Deviation	Minimum	Median	Maximum	Skewness	Kurtosis	Missing
Design Methods and Techniques	0.030	0.080	0	0	0.689	3.29	13.19	0
Child-Robot Interaction	0.016	0.073	0	0	0.758	5.17	29.54	0
Programming	0.012	0.060	0	0	0.814	6.26	46.37	0
Social Media	0.005	0.034	0	0	0.725	9.14	111.50	0
Educational Game Design and Development	0.026	0.072	0	0	0.504	3.01	9.24	0
Cyberbullying and Cybervictimization	0.015	0.082	0	0	0.954	6.90	52.93	0
Addiction and Problematic Usage	0.014	0.077	0	0	0.882	6.67	49.59	0
Design Evaluation	0.010	0.055	0	0	0.917	7.80	75.36	0
Mobile Devices and Applications	0.009	0.046	0	0	0.629	6.38	50.33	0
Reading and eBooks	0.010	0.060	0	0	0.903	7.71	71.10	0
Assessment and Feedback	0.015	0.061	0	0	0.676	5.23	32.86	0
Visually Impaired Children	0.007	0.044	0	0	0.600	7.59	67.20	0
Video Game and Screen Media Exposure	0.007	0.050	0	0	0.820	9.48	105.13	0
e-Learning Environments	0.018	0.058	0	0	0.530	3.53	13.65	0
Making and Makerspaces	0.018	0.064	0	0	0.599	4.48	23.88	0
Internet Competencies	0.007	0.046	0	0	0.640	8.08	75.47	0
Children on the Autism Spectrum	0.017	0.075	0	0	0.661	4.74	23.24	0
Primary Education (Schools, Students, Teachers)	0.024	0.075	0	0	0.836	3.92	19.62	0
Play and Toys	0.009	0.048	0	0	0.527	6.35	46.20	0
Touchscreen Gestures	0.008	0.056	0	0	0.874	8.95	95.12	0

User Characteristics, Preferences, and Perceptions	0.011	0.049	0	0	0.719	6.25	51.55	0
Virtual Reality	0.007	0.042	0	0	0.572	6.77	52.87	0
Everyday Technology Experiences	0.016	0.059	0	0	0.670	4.48	24.14	0
Tangible User Interfaces	0.015	0.062	0	0	0.565	4.69	23.95	0
Augmentative and Alternative Communication Systems	0.009	0.045	0	0	0.575	6.15	44.90	0
User Experience	0.005	0.039	0	0	0.829	10.45	139.79	0
Mental Health	0.007	0.041	0	0	0.652	7.97	75.20	0
Digital Libraries	0.005	0.031	0	0	0.520	7.92	75.52	0
Physical Activity	0.005	0.033	0	0	0.554	9.19	99.65	0
Parent-Child Interaction and Communication	0.015	0.063	0	0	0.885	5.13	32.63	0
Music and Movement	0.005	0.039	0	0	0.752	9.63	110.16	0
Augmented and Mixed Reality	0.007	0.041	0	0	0.730	7.34	65.46	0
Tutoring and Scaffolding Systems	0.007	0.049	0	0	0.928	10.31	134.86	0
Therapeutic and Rehabilitative Technologies	0.014	0.060	0	0	0.799	5.47	37.01	0
Computational Thinking	0.009	0.044	0	0	0.520	5.80	37.52	0
Supports for Mothers/ Caregivers	0.004	0.026	0	0	0.566	9.15	109.51	0
Storytelling	0.013	0.056	0	0	0.559	4.88	26.79	0
Embodied Interaction	0.015	0.056	0	0	0.822	4.85	31.34	0
Participatory Design	0.017	0.077	0	0	0.831	5.77	38.69	0
STEM Education	0.018	0.069	0	0	0.747	4.62	24.83	0
Healthcare	0.006	0.044	0	0	0.714	9.69	111.67	0
Preschool Children	0.008	0.044	0	0	0.772	7.25	68.71	0
Emotion (Recognition and Expression)	0.009	0.048	0	0	0.819	6.94	60.09	0
Collaborative Interaction and Learning	0.008	0.045	0	0	0.730	6.99	59.47	0

Social Networking and Peer Relationships	0.007	0.047	0	0	0.803	8.42	86.27	0
Data Collection Methods and Tools	0.008	0.042	0	0	0.723	6.80	59.96	0
Assistive and Inclusive Technologies	0.009	0.047	0	0	0.741	6.40	52.07	0
Critical and Ethical Research and Design	0.003	0.034	0	0	0.702	13.75	220.57	0

Appendix CC. Innovative Paper Latent Topic Structure Descriptive Statistics

Descriptive statistics for topic structure variables (based on topic loadings derived through Correlated Topic Modelling) associated with papers introducing innovations

Table CC.1. *Descriptive statistics of Child-Computer Interaction research papers introducing innovations latent topic structure variables.*

	Mean	Standard Deviation	Minimum	Median	Maximum	Skewness	Kurtosis	Missing
Design Methods and Techniques	0.034	0.089	0	0	0.675	3.23	12.30	0
Child-Robot Interaction	0.009	0.050	0	0	0.552	5.58	31.62	0
Programming	0.010	0.055	0	0	0.564	5.96	37.45	0
Social Media	0.002	0.019	0	0	0.389	8.88	89.61	0
Educational Game Design and Development	0.033	0.082	0	0	0.498	2.56	6.02	0
Cyberbullying and Cybervictimization	0.008	0.056	0	0	0.936	8.18	77.04	0
Addiction and Problematic Usage	0.012	0.072	0	0	0.882	7.05	54.31	0
Design Evaluation	0.012	0.053	0	0	0.917	6.43	59.77	0
Mobile Devices and Applications	0.009	0.053	0	0	0.629	7.84	71.52	0
Reading and eBooks	0.010	0.063	0	0	0.903	8.91	94.56	0
Assessment and Feedback	0.015	0.057	0	0	0.672	4.56	24.18	0
Visually Impaired Children	0.006	0.037	0	0	0.591	8.03	79.33	0
Video Game and Screen Media Exposure	0.003	0.025	0	0	0.567	11.83	179.75	0
e-Learning Environments	0.027	0.069	0	0	0.478	2.77	7.56	0
Making and Makerspaces	0.015	0.054	0	0	0.597	4.41	26.22	0
Internet Competencies	0.007	0.044	0	0	0.561	7.55	67.40	0
Children on the Autism Spectrum	0.010	0.059	0	0	0.642	6.97	52.41	0
Primary Education (Schools, Students, Teachers)	0.028	0.073	0	0	0.836	3.10	12.95	0
Play and Toys	0.007	0.041	0	0	0.527	6.58	46.95	0

Touchscreen Gestures	0.004	0.029	0	0	0.537	9.44	103.34	0
User Characteristics, Preferences, and Perceptions	0.008	0.042	0	0	0.515	6.58	50.39	0
Virtual Reality	0.011	0.050	0	0	0.494	4.99	27.89	0
Everyday Technology Experiences	0.013	0.053	0	0	0.670	5.87	45.18	0
Tangible User Interfaces	0.024	0.076	0	0	0.511	3.41	11.87	0
Augmentative and Alternative Communication Systems	0.010	0.045	0	0	0.575	5.49	34.05	0
User Experience	0.005	0.035	0	0	0.829	7.93	82.89	0
Mental Health	0.003	0.028	0	0	0.531	11.29	148.40	0
Digital Libraries	0.008	0.052	0	0	0.520	7.33	55.97	0
Physical Activity	0.003	0.025	0	0	0.513	11.40	165.53	0
Parent-Child Interaction and Communication	0.007	0.042	0	0	0.656	7.48	67.56	0
Music and Movement	0.006	0.038	0	0	0.552	7.91	75.47	0
Augmented and Mixed Reality	0.005	0.032	0	0	0.358	7.71	61.76	0
Tutoring and Scaffolding Systems	0.009	0.055	0	0	0.928	9.05	103.77	0
Therapeutic and Rehabilitative Technologies	0.010	0.045	0	0	0.799	5.07	32.19	0
Computational Thinking	0.008	0.036	0	0	0.303	4.49	19.32	0
Supports for Mothers/ Caregivers	0.002	0.019	0	0	0.264	9.17	86.61	0
Storytelling	0.016	0.053	0	0	0.559	3.79	16.88	0
Embodied Interaction	0.013	0.049	0	0	0.484	4.16	18.77	0
Participatory Design	0.009	0.049	0	0	0.756	6.86	55.43	0
STEM Education	0.015	0.066	0	0	0.517	4.84	24.71	0
Healthcare	0.003	0.027	0	0	0.657	12.52	197.73	0
Preschool Children	0.005	0.031	0	0	0.572	8.33	84.56	0
Emotion (Recognition and Expression)	0.008	0.042	0	0	0.532	5.39	30.99	0

Collaborative Interaction and Learning	0.009	0.042	0	0	0.425	5.54	33.56	0
Social Networking and Peer Relationships	0.009	0.050	0	0	0.636	6.90	52.39	0
Data Collection Methods and Tools	0.007	0.042	0	0	0.481	6.61	48.79	0
Assistive and Inclusive Technologies	0.006	0.038	0	0	0.443	6.30	42.03	0
Critical and Ethical Research and Design	0.002	0.022	0	0	0.661	11.70	179.80	0

Appendix DD. Model 1 Residual Plots

Plot 1 (Residuals vs Fitted), illustrating the relationship between residuals and fitted value, indicates a relatively linear relationship between predictors and the outcome. Plot 2 (Normal Q-Q), a QQ plot of residuals, exhibits approximate normality of residuals, with indication of "heavy tails", implying a greater number of observations towards the extremes of the distribution than would be anticipated in a normal distribution. Plot 3 (Scale-Locations), presenting the spread of residuals along the range of predictor values, indicates non-constant variance in residual errors (i.e., heteroscedasticity). Plot 4 (Residuals vs Leverage), illustrating potential outliers and high leverage points, indicates a number of possible outlier observations (i.e., observations whose standardized residuals exceed 3 in absolute value; James et al., 2013) for further scrutiny, although these observations fail to exhibit high influence (i.e., does not exceed Cook's distance; Bruce et al., 2020).

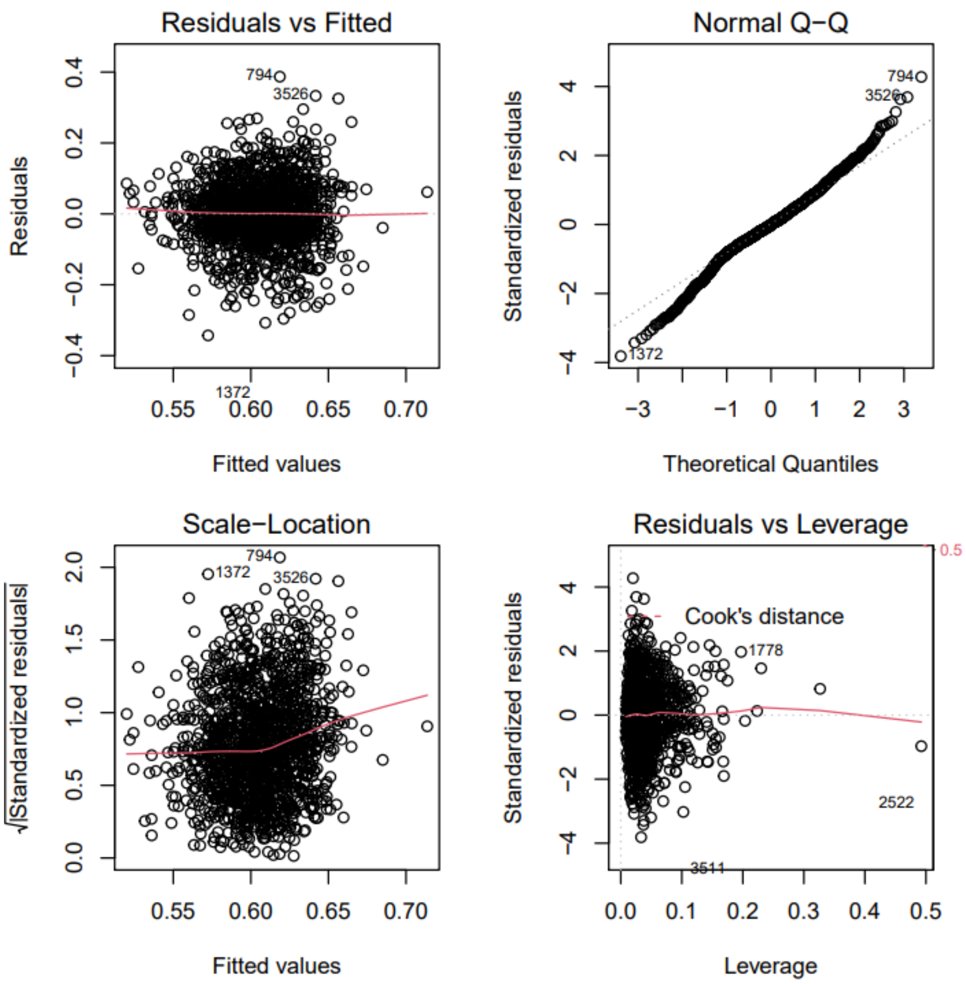


Figure DD.1. *Model 1 residual plots. Potential outliers are labelled.*

Appendix EE. Model 2 Regression Model Comparison

Distribution of regression model (ordinary least squares, negative binomial, and Poisson) predictions (Model 2) and observed values of scientific novelty.

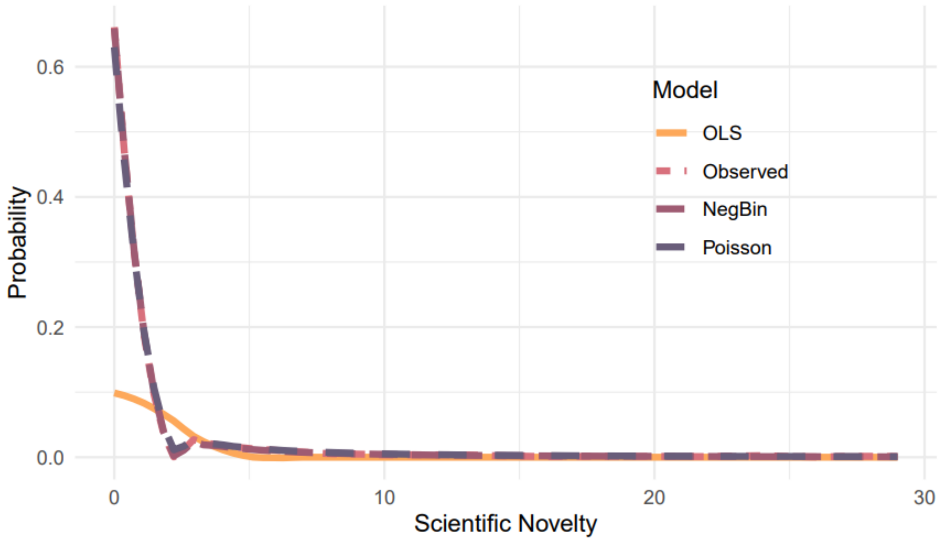


Figure EE.1. *Distribution of regression model predictions and observed values of scientific novelty (Model 2)*

Appendix FF. Model 1 Latent Topic Structure Coefficient Estimates

Coefficient estimates for latent topic structure variables from ordinary least squares (with robust standard errors) regression investigating the relationship between paper distal novelty and publication venue (Model 1).

Table FF.1. *Ordinary least squares (with robust standard errors) estimates for latent topic structure variables (Model 1).*

Level of Analysis:	Paper		
Dependent Variable:	Distal Novelty		
Model/Estimation:	Model 1 Robust Standard Errors (HC3)		
	β (SE)	β (SE)	β (SE)
Intercept			.672*** (.015)
Topic Structure			
Design Methods and Techniques			-.088** (.031)
Child-Robot Interaction			-.034 (.047)
Programming			-.066* (.029)
Social Media			-.030 (.041)
Educational Game Design and Development			-.023 (.030)
Cyberbullying and Cybervictimization			-.128** (.040)
Addiction and Problematic Usage			-.164*** (.038)
Design Evaluation			-.063* (.028)
Mobile Devices and Application			-.061** (.021)
Reading and eBooks			-.081* (.032)
Assessment and Feedback			-.033 (.029)
Visually Impaired Children			-.082** (.026)
Video Game and Screen Media Exposure			-.086 (.048)
e-Learning Environments			-.057* (.027)
Making and Makerspaces			-.097** (.037)
Internet Competencies			-.004 (.027)
Children on the Autism Spectrum			-.115*** (.034)
Primary Education (Schools, Students, Teachers)			-.068 (.040)
Play and Toys			-.026 (.030)
Touchscreen Gestures			-.076* (.037)
User Characteristics, Preferences, and Perceptions			.002 (.028)
Virtual Reality			-.052* (.023)

Everyday Technology Experiences	-.046	(.028)
Tangible User Interfaces	-.087**	(.027)
Augmentative and Alternative Communication Systems	-.016	(.023)
User Experience	.008	(.023)
Mental Health	-.063	(.045)
Digital Libraries	-.031	(.020)
Physical Activity	-.025	(.024)
Parent-Child Interaction and Communication	-.047	(.034)
Music and Movement	-.016	(.023)
Augmented and Mixed Reality	-.065	(.035)
Tutoring and Scaffolding Systems	-.035	(.030)
Therapeutic and Rehabilitative Technologies	-.086**	(.032)
Computational Thinking	-.078*	(.038)
Supports for Mothers/Caregivers	-.036	(.028)
Storytelling	-.069**	(.025)
Embodied Interaction	-.063*	(.030)
Participatory Design	-.096*	(.041)
STEM Education	-.049	(.038)
Healthcare	-.034	(.041)
Preschool Children	-.102***	(.029)
Emotion (Recognition and Expression)	-.024	(.029)
Collaborative Interaction and Learning	-.044	(.023)
Social Networking and Peer Relationships	-.069*	(.029)
Data Collection Methods and Tools	-.013	(.032)
Assistive and Inclusive Technologies	-.057*	(.029)
Critical and Ethical Research and Design	-.073	(.048)

Note: All variables are standardised – here, converted to z-scores with a mean of 0 and standard deviation of 1 – in order to support interpretability. As the original sale for these variables demonstrates a range of less than 1, interpretation of (unstandardised) coefficient estimates associated with a 1 unit change in the predictor is rendered challenging and potentially misleading. Coefficient estimates for standardised variables thus represents the change in the outcome associated with a 1 standard deviation change in the predictor.

* *p* <.05; ** *p* <.01; ****p*<.001.

Appendix GG. Model 1 Coefficient Estimates Plot

Figure GG.1. *Coefficient estimates (unstandardised betas) for Model 1, predicting paper distal novelty. Bars represent 95 percent confidence intervals (calculated based on robust standard errors). Coefficients for which 95% CIs which do not overlap zero (dotted) may be considered statistically significant.*

Appendix HH. Model 2 Latent Topic Structure Coefficient Estimates

Coefficient estimates for latent topic structure variables from negative binomial regression investigating the relationship between paper scientific novelty and publication venue (Model 2).

Table HH.1. *Negative binomial estimates for latent topic structure variables (Model 2).*

Level of Analysis:	Paper		
Dependent Variable:	Scientific Novelty		
Model/Estimation:	Model 2 Negative Binomial		
	IRR (SE)	IRR (SE)	IRR (SE)
Intercept			.016*** (.002)
Topic Structure			
Design Methods and Techniques			.858*** (.023)
Child-Robot Interaction			1.029 (.034)
Programming			.938* (.026)
Social Media			.998 (.031)
Educational Game Design and Development			.990 (.025)
Cyberbullying and Cybervictimization			1.053 (.034)
Addiction and Problematic Usage			1.025 (.029)
Design Evaluation			.864*** (.022)
Mobile Devices and Application			.946* (.021)
Reading and eBooks			.982 (.024)
Assessment and Feedback			.908*** (.024)
Visually Impaired Children			.975 (.025)
Video Game and Screen Media Exposure			.971 (.031)
e-Learning Environments			.985 (.023)
Making and Makerspaces			.941* (.027)
Internet Competencies			.957 (.023)
Children on the Autism Spectrum			1.071* (.031)
Primary Education (Schools, Students, Teachers)			.940* (.026)
Play and Toys			.882*** (.023)
Touchscreen Gestures			.919* (.031)
User Characteristics, Preferences, and Perceptions			.922** (.025)
Virtual Reality			.995 (.024)
Everyday Technology Experiences			.912*** (.024)
Tangible User Interfaces			.903*** (.022)

Augmentative and Alternative Communication Systems	.924***	(.021)
User Experience	.976	(.025)
Mental Health	1.015	(.029)
Digital Libraries	.974	(.019)
Physical Activity	.991	(.025)
Parent-Child Interaction and Communication	.921**	(.028)
Music and Movement	.977	(.024)
Augmented and Mixed Reality	1.036	(.032)
Tutoring and Scaffolding Systems	.977	(.023)
Therapeutic and Rehabilitative Technologies	1.034	(.032)
Computational Thinking	.939	(.031)
Supports for Mothers/Caregivers	.978	(.024)
Storytelling	.982	(.025)
Embodied Interaction	.872***	(.023)
Participatory Design	.958	(.032)
STEM Education	.918**	(.026)
Healthcare	1.049	(.028)
Preschool Children	1.051	(.028)
Emotion (Recognition and Expression)	.992	(.025)
Collaborative Interaction and Learning	.897***	(.023)
Social Networking and Peer Relationships	1.032	(.022)
Data Collection Methods and Tools	.938**	(.023)
Assistive and Inclusive Technologies	.975	(.025)
Critical and Ethical Research and Design	1.019	(.039)

Note: All variables are standardised – here, converted to z-scores with a mean of 0 and standard deviation of 1 – in order to support interpretability. As the original sale for these variables demonstrates a range of less than 1, interpretation of (unstandardised) coefficient estimates associated with a 1 unit change in the predictor is rendered challenging and potentially misleading. Coefficient estimates for standardised variables thus represents the change in the outcome associated with a 1 standard deviation change in the predictor.

* *p* <.05; ** *p* <.01; ****p*<.001.

Appendix II. Model 2 Coefficient Estimates Plot

Figure II.1. *Coefficient estimates (incidence rate ratio) for Model 2, predicting paper scientific novelty. Bars represent 95 percent confidence intervals. Coefficients for which 95% CIs which do not overlap one (dotted) may be considered statistically significant.*

Appendix JJ. Model 3 Regression Model Comparison

Distribution of regression model (ordinary least squares, negative binomial, and Poisson) predictions (Model 3) and observed values of innovation uptake.

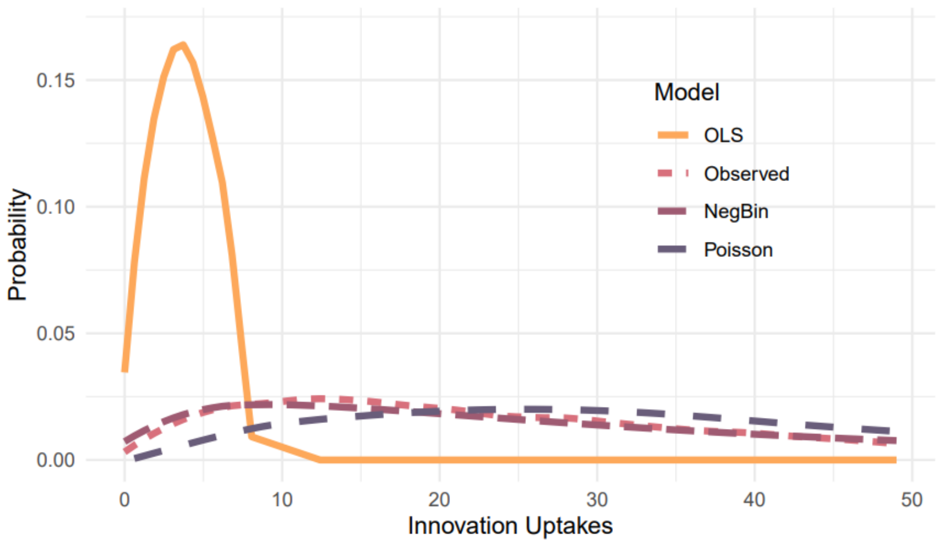


Figure JJ.1. *Distribution of regression model predictions and observed values of scientific novelty (Model 3)*

Appendix KK. Model 3 Coefficient Estimates Plot

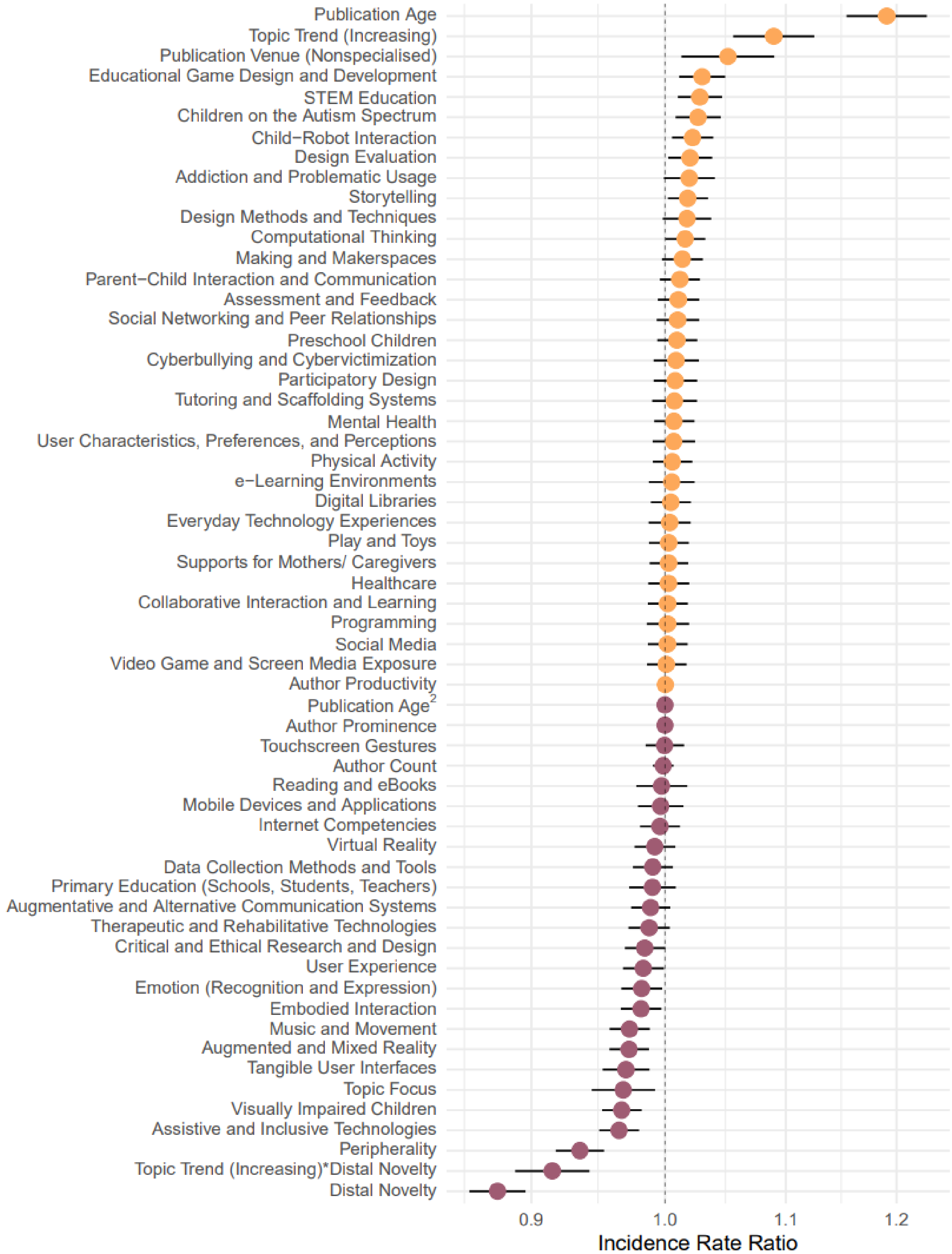


Figure KK.1. *Coefficient estimates (incidence rate ratio) for Model 3, predicting innovation uptakes. Bars represent 95 percent confidence intervals (calculated based on cluster-robust standard errors). Coefficients for which 95% CIs which do not overlap one (dotted) may be considered statistically significant.*

Appendix LL. Model 3 Latent Topic Structure Coefficient Estimates

Coefficient estimates for latent topic structure variables from negative binomial regression (with cluster-robust standard errors) investigating the relationship between paper (un)conventionality (i.e., peripherality) and innovation uptakes (Model 3).

Table LL.1. *Negative binomial (with cluster-robust standard errors) estimates for latent topic structure variables (Model 3).*

Level of Analysis:	Innovation		
Dependent Variable:	Innovation Uptakes		
Model/Estimation:	Model 3 Negative Binomial (Cluster-Robust [Paper, HC3] Standard Errors)		
	IRR (SE)	IRR (SE)	IRR (SE)
Intercept		2.330*** (.214)	2.356*** (.214)
Topic Structure			
Design Methods and Techniques		1.033** (.012)	1.017 (.011)
Child-Robot Interaction		1.020* (.010)	1.022* (.009)
Programming		1.005 (.010)	1.002 (.009)
Social Media		1.000 (.007)	1.002 (.007)
Educational Game Design and Development		1.037*** (.011)	1.030** (.011)
Cyberbullying and Cybervictimization		1.007 (.009)	1.008 (.009)
Addiction and Problematic Usage		1.015 (.012)	1.019 (.012)
Design Evaluation		1.019 (.011)	1.020 (.010)
Mobile Devices and Application		.989 (.010)	.997 (.010)
Reading and eBooks		.991 (.011)	.997 (.011)
Assessment and Feedback		1.008 (.011)	1.011 (.010)
Visually Impaired Children		.961*** (.008)	.966*** (.008)
Video Game and Screen Media Exposure		.999 (.007)	1.001 (.006)
e-Learning Environments		1.017 (.010)	1.005 (.010)
Making and Makerspaces		1.012 (.010)	1.014 (.010)
Internet Competencies		.990 (.008)	.996 (.008)
Children on the Autism Spectrum		1.024** (.009)	1.026** (.009)
Primary Education (Schools, Students, Teachers)		.985 (.010)	.990 (.010)
Play and Toys		1.002 (.010)	1.003 (.009)
Touchscreen Gestures		.998 (.009)	1.000 (.009)
User Characteristics, Preferences, and Perceptions		.995 (.009)	1.007 (.009)
Virtual Reality		1.005 (.009)	.992 (.009)

Everyday Technology Experiences	1.006	(.011)	1.004	(.010)
Tangible User Interfaces	.968**	(.010)	.970**	(.010)
Augmentative and Alternative Communication Systems	.983	(.009)	.989	(.009)
User Experience	.981*	(.009)	.983	(.009)
Mental Health	1.005	(.007)	1.007	(.007)
Digital Libraries	1.006	(.013)	1.004	(.007)
Physical Activity	1.005	(.008)	1.006	(.008)
Parent-Child Interaction and Communication	1.006	(.008)	1.012	(.008)
Music and Movement	.967***	(.007)	.972***	(.008)
Augmented and Mixed Reality	.972***	(.008)	.972***	(.007)
Tutoring and Scaffolding Systems	1.006	(.011)	1.007	(.010)
Therapeutic and Rehabilitative Technologies	.978**	(.008)	.988	(.008)
Computational Thinking	1.017	(.011)	1.016	(.010)
Supports for Mothers/Caregivers	1.009	(.007)	1.003	(.007)
Storytelling	1.028*	(.011)	1.018	(.007)
Embodied Interaction	.984	(.009)	.981*	(.008)
Participatory Design	1.007	(.009)	1.008	(.009)
STEM Education	1.014	(.010)	1.028**	(.011)
Healthcare	.999	(.008)	1.003	(.008)
Preschool Children	1.007	(.010)	1.009	(.011)
Emotion (Recognition and Expression)	.977**	(.009)	.982*	(.009)
Collaborative Interaction and Learning	.998	(.009)	1.002	(.008)
Social Networking and Peer Relationships	1.017	(.011)	1.010	(.011)
Data Collection Methods and Tools	.986	(.009)	.990	(.009)
Assistive and Inclusive Technologies	.969***	(.008)	.965***	(.007)
Critical and Ethical Research and Design	.982	(.010)	.984	(.009)

Note: All variables are standardised – here, converted to z-scores with a mean of 0 and standard deviation of 1 – in order to support interpretability. As the original sale for these variables demonstrates a range of less than 1, interpretation of (unstandardised) coefficient estimates associated with a 1 unit change in the predictor is rendered challenging and potentially misleading. Coefficient estimates for standardised variables thus represents the change in the outcome associated with a 1 standard deviation change in the predictor.

* *p* <.05; ** *p* <.01; ****p*<.001.

Appendix MM. Model 4 Regression Model Comparison

Distribution of regression model (ordinary least squares, negative binomial, and Poisson) predictions (Model 4) and observed values of citation count.

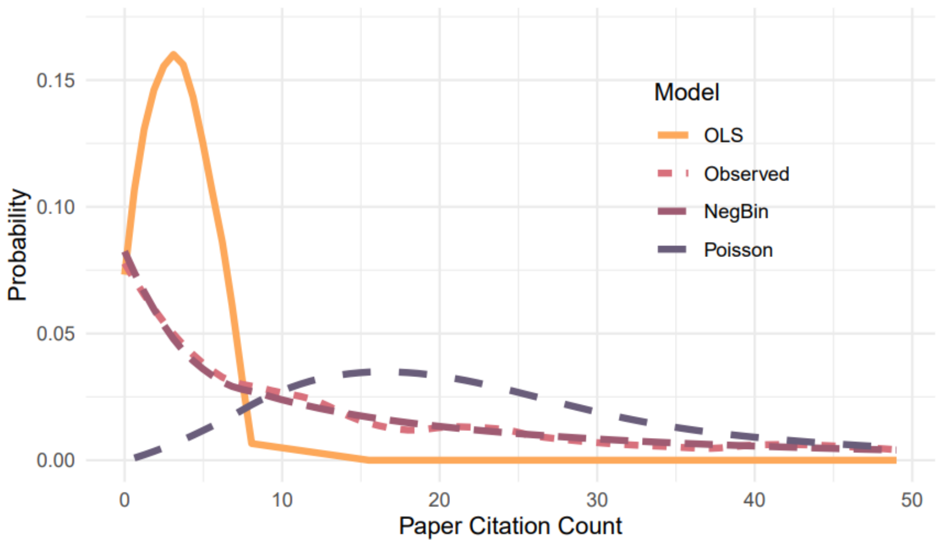


Figure MM.1. *Distribution of regression model predictions and observed values of scientific novelty (Model 4)*

Appendix NN. Model 4 Latent Topic Structure Coefficient Estimates

Coefficient estimates for latent topic structure variables from negative binomial regression investigating the relationship between paper scientific impact and novelty (Model 4).

Table NN.1. *Negative binomial estimates for latent topic structure variables (Model 4).*

Level of Analysis:	Paper			
Dependent Variable:	Scientific Impact (Citation Count)			
Model/Estimation:	Model 4 Negative Binomial			
	IRR (SE)	IRR (SE)	IRR (SE)	IRR (SE)
Intercept		.800*** (.058)	.723*** (.058)	2.277*** (.494)
Topic Structure				
Design Methods and Techniques		1.011 (.023)	1.034 (.023)	1.013 (.037)
Child-Robot Interaction		1.149*** (.026)	1.171*** (.026)	1.206*** (.054)
Programming		1.069** (.023)	1.073*** (.023)	1.079* (.004)
Social Media		1.048* (.020)	1.062** (.021)	1.061 (.044)
Educational Game Design and Development		.991 (.022)	1.012 (.022)	1.024 (.036)
Cyberbullying and Cybervictimization		1.155*** (.028)	1.191*** (.029)	1.177*** (.053)
Addiction and Problematic Usage		1.170*** (.027)	1.210*** (.028)	1.177*** (.047)
Design Evaluation		1.013 (.022)	1.049* (.023)	1.044 (.034)
Mobile Devices and Application		1.001 (.020)	1.015 (.020)	.941* (.028)
Reading and eBooks		1.093*** (.023)	1.109*** (.023)	1.072* (.037)
Assessment and Feedback		1.068** (.022)	1.100*** (.023)	1.010 (.038)
Visually Impaired Children		1.028 (.021)	1.031 (.020)	.970 (.034)
Video Game and Screen Media Exposure		1.061** (.022)	1.082*** (.022)	1.141** (.051)
e-Learning Environments		1.173*** (.024)	1.168*** (.024)	1.120*** (.037)
Making and Makerspaces		1.001 (.022)	1.009 (.022)	1.023 (.040)
Internet Competencies		1.043* (.021)	1.080*** (.022)	1.017 (.035)
Children on the Autism Spectrum		1.078*** (.024)	1.089*** (.025)	1.057 (.042)
Primary Education (Schools, Students, Teachers)		1.092*** (.024)	1.112*** (.024)	1.090* (.041)
Play and Toys		1.013 (.021)	1.025 (.021)	1.000 (.034)
Touchscreen Gestures		1.039 (.022)	1.059** (.022)	1.050 (.053)
User Characteristics, Preferences, and Perceptions		1.146*** (.023)	1.172*** (.023)	1.140*** (.044)
Virtual Reality		1.078*** (.021)	1.092*** (.021)	1.049 (.035)
Everyday Technology Experiences		1.043* (.022)	1.049* (.022)	1.039 (.037)

Tangible User Interfaces	.984	(.021)	.996	(.021)	1.015	(.034)
Augmentative and Alternative Communication Systems	.974	(.020)	.990	(.020)	.985	(.031)
User Experience	1.011	(.020)	1.019	(.020)	1.038	(.034)
Mental Health	1.054**	(.021)	1.062**	(.021)	1.021	(.040)
Digital Libraries	.995	(.020)	1.011	(.020)	.940*	(.028)
Physical Activity	.994	(.020)	1.003	(.020)	.995	(.030)
Parent-Child Interaction and Communication	1.158***	(.024)	1.182***	(.025)	1.128**	(.047)
Music and Movement	1.002	(.020)	1.008	(.020)	1.046	(.035)
Augmented and Mixed Reality	1.092***	(.022)	1.095***	(.022)	1.247***	(.022)
Tutoring and Scaffolding Systems	1.028	(.021)	1.038	(.021)	.971	(.035)
Therapeutic and Rehabilitative Technologies	1.002	(.022)	1.017	(.022)	1.001	(.045)
Computational Thinking	1.144***	(.023)	1.152***	(.023)	1.064	(.049)
Supports for Mothers/Caregivers	1.040*	(.020)	1.050**	(.021)	1.048	(.038)
Storytelling	.992	(.021)	1.005	(.020)	1.024	(.035)
Embodied Interaction	.963	(.020)	.980	(.020)	.971	(.035)
Participatory Design	1.092***	(.025)	1.095***	(.025)	1.114*	(.048)
STEM Education	1.031	(.023)	1.039	(.023)	.918*	(.038)
Healthcare	.992	(.021)	1.000	(.021)	.961	(.036)
Preschool Children	1.067**	(.022)	1.074***	(.022)	1.042	(.041)
Emotion (Recognition and Expression)	1.085***	(.022)	1.102***	(.022)	1.029	(.036)
Collaborative Interaction and Learning	1.028	(.021)	1.039	(.021)	1.055	(.038)
Social Networking and Peer Relationships	1.073***	(.021)	1.096***	(.022)	1.043	(.032)
Data Collection Methods and Tools	.990	(.020)	1.006	(.020)	1.020	(.035)
Assistive and Inclusive Technologies	1.003	(.020)	1.016	(.021)	1.009	(.039)
Critical and Ethical Research and Design	1.048*	(.021)	1.052*	(.021)	.983	(.044)

Note: All variables are standardised – here, converted to z-scores with a mean of 0 and standard deviation of 1 – in order to support interpretability. As the original sale for these variables demonstrates a range of less than 1, interpretation of (unstandardised) coefficient estimates associated with a 1 unit change in the predictor is rendered challenging and potentially misleading. Coefficient estimates for standardised variables thus represents the change in the outcome associated with a 1 standard deviation change in the predictor.

* *p* <.05; ** *p* <.01; ****p*<.001.

Appendix OO. Model 4 Coefficient Estimates Plot

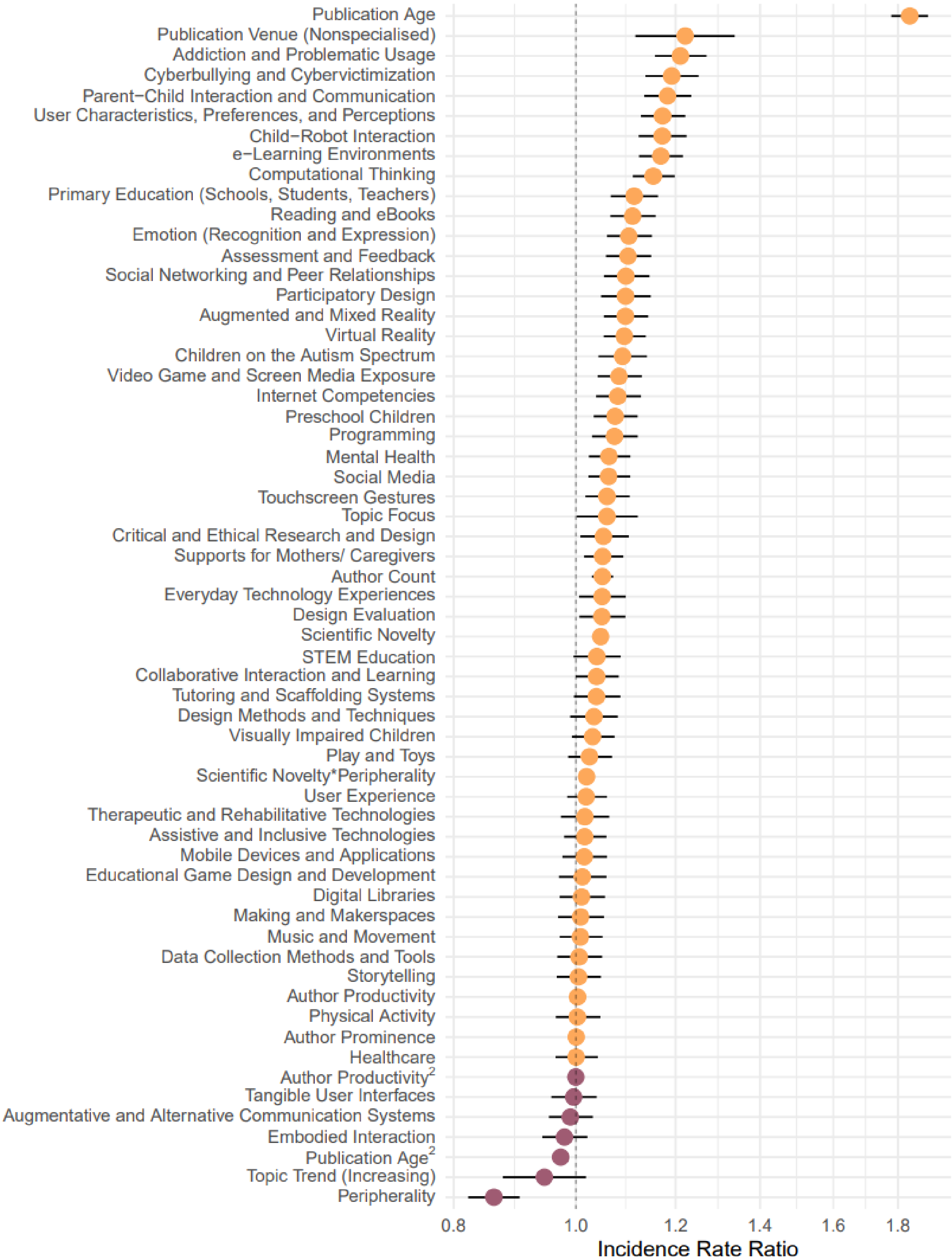


Figure OO.1. *Coefficient estimates (incidence rate ratio) for Model 4, predicting paper scientific impact. Bars represent 95 percent confidence intervals. Coefficients for which 95% CIs which do not overlap one (dotted) may be considered statistically significant.*