Executive function, social-emotional skills, and academic competence in three preschool programmes: pathways to school readiness

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Abstract

Research findings indicate that executive function (EF), social-emotional skills, and pre-academic competence significantly promote children's school readiness and later success. School readiness broadly refers to a combination of skills necessary to function successfully in school and lack thereof may increase the risk of children's school problems. Therefore, it is essential for school systems to provide appropriate and timely support to the development of these fundamental skills. The present study focused on three particular preschool programmes: Montessori, Reggio Emilia, and the traditional play-based (British Columbia Early Learning Framework: BCEFL) programmes in Western Canada. Although they are popular, there is little empirical research that examines and compares the benefits of these programmes to the development of school readiness skills. As such, the present study aimed to 1) determine the effectiveness of these three preschool programmes in Western Canada on the development of children's school readiness; and 2) examine other sources of influences in the child, family and school in relation to the development of school readiness skills.

Overall, 119 preschool children (48 Montessori, 42 Reggio Emilia, 29 BCELF) participated in the study. Observation was conducted once in the autumn of 2015 for each classroom using the CLASS observation tool. Teachers and parents of participating children filled in a series of questionnaires regarding the quality of their relationship with their child and their perceptions of daily EF and social-emotional skills of their child. The researcher also assessed individual children's fluid intelligence, EF, and pre-academic competence.

The results showed that 1) although Montessori education appeared to be the most effective in facilitating numeracy skills, no curriculum stood out as notably more effective than any of the others at improving other areas of school readiness skills; 2) well-run classrooms where teachers were effective in time, behavioural, and attention management were most effective in promoting children's numeracy skills; 3) EF, social-emotional skills, and pre-academic competence exhibited an overlapping developmental process over time; 4) relational quality in both home and school environments significantly affected the development of school readiness skills, especially social-emotional skills; and 5) adults' perceptions of children's EF and social-emotional skills had a significant consequence for how teachers and parents formed their relationships with their children.

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ABBREVIATIONS

ADHD: Attention Deficit Hyperactivity Disorder

AMI: Association Montessori Internationale

ANCOVA: Analysis of Covariance

ANOVA: Analysis of Variance

BAS: British Ability Scale

BC: British Columbia

BCELF: British Columbia Early Learning Framework

BRIEF-P: Behavioural Rating Inventory of Executive Function – Preschool Version

CBCL: Child Behaviour Checklist

CF: Cognitive Flexibility

CLASS: Classroom Assessment Scoring System

CPRS: Child Parent Relationship Scale

DCCS: Dimensional Card Change Sorting

DSB: Digit Span backwards

ECE: Early Childhood Education

HTKS: Head-Toes-Knees-Shoulders

IC: Inhibitory Control

NAREA: North American Reggio Emilia Alliance

SEARS: Social-Emotional Assets and Resiliency Scale

SEM: Structural Equation Modeling

SSRS: Social Skills Rating Scale

STRS: Student Teacher Relationship Scale

ToM: Theory of Mind

WM: Working memory

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Chapter 1: Introduction

1.1 Problem statement

Young children's readiness for schooling has received substantial attention in an effort to improve the school performance of all children. The establishment of full-day state pre-kindergarten (pre-K) programmes across Canada and the US indicates increased awareness about the importance of early learning and school readiness. There is general agreement amongst scholars that school readiness is a multifaceted construct and not limited to isolated academic skills; instead, it suggests that numerous domains including physical well-being, language, communication, emotional maturity, and general knowledge are necessary to succeed in the academic and behavioural demands of school (Duncan et al., 2007; Romano, Babchishin, Pagani, & Kohen, 2010; Welsh, Nix, Blair, Bierman, & Nelson, 2010). Each year, over 35,000 children in British Colombia (BC), Canada transition from preschool to kindergarten, and student enrolment is increasing (BC Ministry of Education, 2012). Cognitive and behavioural demands in kindergarten are different from preschool or home (Rimm-Kaufman & Pianta, 2000) such that this transition can be challenging for children who may not have the adequate skills needed to adapt in a new school environment and partake in learning, and these children are at greater risk for experiencing difficulty in later academic, behavioural and social outcomes (McClelland, Cameron, Wanless, & Murray, 2007; Romano et al., 2010).

There is substantial evidence that *school readiness skills* including executive function (EF), social-emotional skills, and academic competence are important for a successful school transition and later academic and social functioning. Most obviously, pre-academic skills provide a foundation for learning and are one of the strongest predictors of later achievement (e.g., Duncan et al., 2007; La Paro & Pianta, 2000). Another critical area of school readiness is children's EF and social-emotional skills (e.g., Cerda, Im, & Hughes, 2014; McClelland, Acock, & Morrison, 2006; Ready, LoGerfo, Burkam, & Lee, 2005). EF generally refers to higher-order cognitive processes such as inhibitory control, working memory, and attention flexibility in the service of goal-oriented behaviours (e.g., Anderson, 2002; McClelland et al., 2014). Social-emotional skills include "behaviours, attitudes and understanding that support the development of good relationships and enable children and adults to be successful in tasks involving other" (Edmunds & Stewart-Brown, 2003, p. 14).

Both EF and social-emotional skills are fundamental sets of skills that allow children to control, plan, direct, empathise, and communicate, all of which are necessary to successfully partake in academic learning and social interactions in classrooms (McClelland et al., 2007). However, there are increasing concerns amongst educators regarding children's lack of these school readiness skills when they enter formal schooling. Rimm-Kaufam, Pianta, and Cox (2000) found that one-third of kindergarten teachers in the US reported that more than half of children entering kindergarten exhibited social-emotional and executive functioning problems including difficulties in following directions, working in a group, and interacting with peers. Deficits in these skills can be detrimental not only for school transition but also for overall school success, as they are linked to a higher rate of school expulsion (Gilliam, 2004). For example, preschool children in the US and Canada are being removed or suspended from schools at a significantly high rate due to their problematic behaviours (Gilliam, 2004; US Department of Education Office for Civil Right, 2014; Toronto District School Board, 2012, 2016). Preschoolers in the US get expelled at three times the rate that found in primary, middle, and high schools (Gilliam, 2004). The Caring and Safety reports from the Toronto District School Board (2012, 2016) also suggest that preschool-age children in Canada are facing a similar situation; the number of Canadian preschool children suspended has increased more than six times in the last four years.

The National Longitudinal Survey of Children and Youth (Bushnik, 2006) indicates that 54% of parents in Canada enrol their children aged four and under in early childhood and childcare services; of these parents, 64% use either daycare centres or home daycares. As demand for early childhood education programmes continues to grow, the value of establishing and evaluating effective preschool programmes has gained increased attention. The apparent rise in challenging behaviours amongst young children during preschool years and upon formal school entry also suggests an important role that early childhood programmes can play in facilitating children's readiness for school thus mitigating the risk of children's subsequent school problems. As children enter school with varying levels of skills, support for early social and academic learning that is sensitive to individual differences is crucial for effectively promoting school readiness (Blair & Raver, 2015). While a wealth of empirical evidence indicates that attendance at high-quality early childhood settings can have a range of short-term and long-term benefits (e.g., Bierman et al., 2008; Gormley, Gayer, Phillips, &

Dawson, 2005; Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2004; Weiland & Yoshikawa, 2013), other research suggests that the effects of different school curricula on children's school outcomes, especially EF and social-emotional skills largely varies and may even be limited (e.g., Darrow, 2013; Farran & Wilson, 2014; Preschool Evaluation Research Consortium, 2008). Despite the mixed research results, many school systems are making important decisions to implement particular programmes based on their pedagogical preferences (Farran & Wilson, 2014). For example, three preschool programmes including Montessori, Reggio Emilia, and traditional play-based programmes are particularly popular in Canada. Traditional play-based programmes that are not affiliated with either Montessori or the Reggio Emilia approaches have been the dominant form of Western-European early childhood education (Rogers, 2001). The play-based programmes in British Columbia (BC) emphasise the power of child-led play and generally adhere to the British Columbia Early Learning Framework (BCELF; Government of British Columbia, 2008), which identifies visions, principles, and key areas of play-based learning for young children. As such, these generic play-based curricula in BC are referred to as the BCEFL programmes or the BCEFL interchangeably in the current study. On the other hand, both Montessori education and the Reggio Emilia approach are progressive in a way that maintains a delicate balance between children's autonomy and teachers' active roles in children's learning (Tzuo, 2007) and provide strong alternatives to traditional play-based curricula such as the BCELF programmes (Edwards, 2003). While these three programmes are highly regarded respectively, there is little research that has compared the effectiveness of these approaches on young children's school readiness, especially in the Canadian context.

In addition to curriculum quality, it is important to identify other sources within child, family, and school that may have a substantial impact on the development of school readiness skills. According to bioecological-contextual models (e.g., Bronfenbrenner, 1977; Pianta & Walsh, 1996), child development occurs over time within interconnected systems, and this process is influenced by interactions of factors in each of the system. As such, focusing on single factor in one system without consideration of influences of other factors in the other systems cannot provide holistic solutions to improve the lives of children (Bronfenbrenner, 1977; Pianta & Walsh, 1996). Research indicates that the relational capacity such as teacher-child or parent-child relationship is particularly important for children who might be at risk of school problems (Pianta, Hamre, & Allen, 2012; Liew, 2012). Conversely, a child's ability to engage in prosocial conduct and manage his/her behaviour is also essential in establishing healthy relationships in the school environment and beyond. Positive relationships with parents and teachers have been shown to be powerful influential factors beyond other variables such as gender, ethnicity, behavioural problems, and IQ (Hamre & Pianta, 2001; O'Connor & McCartney, 2007; Pianta, Nimetz, & Bennett, 1997). In contrast, children who experience more conflictual relationships with parents and teachers are likely to display lower academic achievement, decreased motivation, and more negative interactions with peers (Hamre & Pianta, 2005; Pianta et al., 1997). Therefore, it is likely that a high-quality preschool curriculum along with positive relationships in both home and school environments may promote school readiness skills and thereby prepare children for a more successful transition to formal schooling and subsequent social and academic outcomes.

As such, the present study was set to 1) determine the effectiveness of these preschool curricula (Montessori, Reggio Emilia, and BCEFL programme) in Western Canada on the development of children's school readiness including EF, social-emotional skills, and pre-academic competence; and 2) examine other sources of influences in the child, family and school in relation to the development of these school readiness skills. In doing so, this research will also be an important step forward in understanding the broader dimensions of the factors that have an impact on child development and in ultimately designing better-equipped classroom environments that will prepare children cognitively, socially and emotionally for a successful transition and later school achievement.

1.2 Research questions

In order to determine the effectiveness of three preschool programmes on the development of children's school readiness skills including EF, social-emotional skills, and pre-academic competence, this study investigated two main research questions:

1) Are there any differences in classroom process quality (Emotional Support, Classroom Organisation, and Instructional Support) by preschool types (Montessori, Reggio Emilia, and BCEFL programmes) in Western Canada?
2) Is enrolment in different preschool programmes associated with changes in school readiness skills including EF, social-emotional skills, and pre-academic competence over one school year?

In order to better understand the development of school readiness skills at more comprehensive levels, it is critical to include other components within the context of children's lives and their interactions with one another. Therefore, the current study also investigated five sub-research questions to examine other sources of influences in the child, family, and school in relation to the development of school readiness skills.

3) Is any aspect of classroom process quality measured by the CLASS associated with changes in EF, social-emotional skills, and pre-academic competence?
4) What are the associations between EF and pre-academic competence over time?
5) What are the associations between social-emotional skills and pre-academic competence over time?
6) What are the associations between EF and social-emotional skills over time?
7) What are the associations between teacher-child/parent-child relationship quality and school readiness skills over time?

1.3 Contents of each chapter

The dissertation includes six chapters: 1) an introduction; 2) a literature review; 3) early childhood education curriculum; 4) methodology; 5) results; and 6) a discussion.

1. *Chapter 1* is the introduction aiming to explore the potential role of EF, social-emotional skills, and the quality of teacher-child relationships in contributing to children's school readiness and subsequent school outcomes. An overview of the research questions and the research rationale is also presented.
2. *Chapter 2* presents a literature review pertaining to the following topics:
    a) *The theoretical framework*

       This section illustrates the Bioecological theory (Bronfenbrenner & Morris, 1998) and the Contextual Systems Models (CSM; Pianta & Walsh, 1996) employed in the current study and discusses various factors in both home and school environments such as relational capacity, child and family characteristics, and classroom quality that have an impact on the development of school readiness skills.

b) School readiness skills

This section focuses on school readiness and proposes certain skills including academic competence, EF, and social-emotional skills that may be required for a successful school transition and subsequent achievement.

c) The definition and roles of EF

This section discusses the proposed constructs of EF (e.g., inhibitory control, working memory, and cognitive flexibility) and how EF is contributing to school outcomes including academic achievement and social functioning. The limitations of research on EF are also discussed.

d) The definition and roles of social-emotional skills

This section defines what constitutes social-emotional skills (e.g., social awareness, responsible decision-making, and relationship skills) and how each component of these skills is contributing to school outcomes including academic achievement and social functioning. The limitations of research on social-emotional skills are also discussed.

e) Relations between EF and social-emotional skills

This section discusses the directionality between EF and social-emotional skills highlighting three varying views: 1) social-emotional skills are fundamental for the development of EF; 2) EF is antecedent to the development of social-emotional skills; and 3) EF and social-emotional skills reciprocally influence each other.

f) Contextual factors influencing school readiness and outcomes

This section outlines various factors in both family and school systems that have a significant influence on the development of school readiness skills and subsequent school outcomes. These factors include parent-teacher relationships, teacher-child relationships, and classroom process quality.

3. *Chapter 3* presents a curriculum framework and different teaching practices to explore three curriculum types included in the current study and reviews existing research on the effectiveness of these programmes on children's school outcomes including aspects of school readiness skills.

a) Early childhood curriculum

This section outlines the definition of curriculum and what constitutes curriculum using the Tyler curriculum model. Two contrasting teaching practices including teacher-centred and child-centred approaches and associated benefits and problems are also discussed. Based on challenges and dissatisfaction around both approaches, the definition of progressive practices is determined.

b) The three preschool programmes included in the current study

This section illustrates characteristics of three different preschool curricula including Montessori, Reggio Emilia, and BCELF programmes. Four components of each curriculum (educational values and objectives, learning areas, methods, and evaluation) are scrutinised using the framework of the Tyler curriculum model.

c) Research on three preschool types

This section reviews research on each preschool approach in relation to the development of school readiness skills including EF, social-emotional skills, and pre-academic competence. Methodological limitations are also discussed to explain the limited availability of research on these approaches and how interpretations of existing studies require caution.

d) Gap in the literature

This last section of the literature review identifies gaps in the existing literature: 1) the general lack of empirical evidence on the effectiveness of Montessori, Reggio Emilia, and traditional play-based approaches; and 2) limited research that has focused on the effects of multiple factors in both home and school systems on the development of school readiness skills, thus providing rationales for conducting the current study.

4. *Chapter 4* describes the methodology employed in the current study. The research design, participants, assessment challenges, procedures, data collection instruments, structural validity, analytical plan, and ethical considerations are presented.
5. *Chapter 5* presents the results from the quantitative data analyses based on classroom observation, direct assessments of EF and academic achievement, and teacher-and-parent questionnaires for EF and social-emotional skills.
6. *Chapter 6* provides possible explanations for the key findings and discuss how they may be related to other existing studies. This is followed by the strengths of the study, limitations and future directions of the study, educational implications, and finally a conclusion.

Chapter 2: Literature review

This chapter has three goals aimed at describing the role of school readiness skills (including EF, social-emotional skills, and pre-academic competence) in children's academic achievement and social functioning and identifies the sources of influences in the skill development. First, the theoretical framework deriving from both Bronfenbrenner's bioecological theory and the Contextual Systems Model and its application to the current study are reviewed. Second, characteristics of school readiness skills and how these skills are reciprocally related to each other is discussed. Third, contextual factors such as preschool curricula, classroom process quality, and relational capacity in both home and school environments that may influence the development of these school readiness skills are examined. Searchers of ERIC, SOLO, and ProQuest were conducted in order to identify other studies that included keywords such as school readiness, school effectiveness, EF, social-emotional skills, teacher-child relationships, parent-child relationships, and classroom process quality.

2.1 Theoretical framework

In order to better understand various factors associated with child development, the bioecological theory (Bronfenbrenner & Morris, 1998) and the Contextual Systems Model (CSM; Pianta & Walsh, 1996) were employed in the current study. The bioecological theory outlines that development is a result of bidirectional interactions between a child and his/her proximal and distal environments over time (Rosa & Tudge, 2013), whilst the CSM posits that a child's developmental process occurs over time within these interactive and nested systems and that the quality of relational dynamics plays a central role in assisting this process (Mashburn & Pianta, 2006; O'Connor & McCartney, 2007). The theoretical frameworks are discussed in the following section.

The bioecological theory (Bronfenbrenner & Morris, 1998), initially termed as the ecological theory, informs the current study. With self-criticism for overlooking the significant role an individual plays in his/her own development and for focusing excessively on the impact of context in his earlier theorising (Bronfenbrenner, 1989; Rosa & Tudge, 2013), the bioecological theory includes the Process-Person-Context-Time (PPCT) model which suggests four components of development to include in research (Bronfenbrenner, 2005). The first concept is *process*. The mature bioecological theory considers reciprocal interactions between an individual person and context (e.g., environments, culture, or social class) as the most fundamental driving force of development (Bronfenbrenner & Morris, 2006; Tudge, Mokrova, & Hatfield, & Karnik, 2009). This means that these interactions are always initiated by a varying degree of reciprocal exchange and have an impact in both directions (Bronfebrenner & Morris, 2006). Proximal processes involve not only social interactions but also interactions with objects and symbols in the immediate environment.

The second concept in the PPCT model is *person*. Bronfenbrenner and Morris (2006) identified three types of person characteristics that positively or adversely influence the course of future development: demand, resource, and force characteristics. First, demand characteristics involve visible features of a person such as age, gender, ethnicity, and physical appearance that can provoke positive or negative reactions from the social environment. Second, resource characteristics refer to ability, knowledge, skills, and experience that activate or limit development (Rosa & Tudge, 2013). Last, generative force characteristics involve active orientation such as motivation, persistence, and temperament that sustain proximal processes, whilst disruptive force characteristics include impulsiveness and distractibility that can interfere with the processes (Bronfenbrenner & Morris, 2006).

The third concept in the PPCT model is *context*. Context generally refers to environment and involves four interrelated systems (Bronfenbrenner, 1979) (Figure 2.1): the microsystem, mesosystem, exosystem, and macrosystem. The child is situated at the heart of interrelated and reciprocally interactive systems. Each system has rules, roles, and norms that have a powerful influence in shaping a child's development. The microsystem refers to the immediate environment such as home, school, or childcare where the individual spends a vast majority of time in engaging in activity and has the most direct interactions with social agents (Tudge et al., 2009). The people who are in close contact with children on a daily basis such as teachers, parents, or peers have the most immediate and powerful effect on children's development (Bronfenbrenner, 1994). The mesosystem refers to the connections between members of the microsystem. For example, this could include interactions between parents and teachers at school. These interactions have a second order influence on the child's behaviour in school, and the child's behaviour reciprocally affects the relationship between

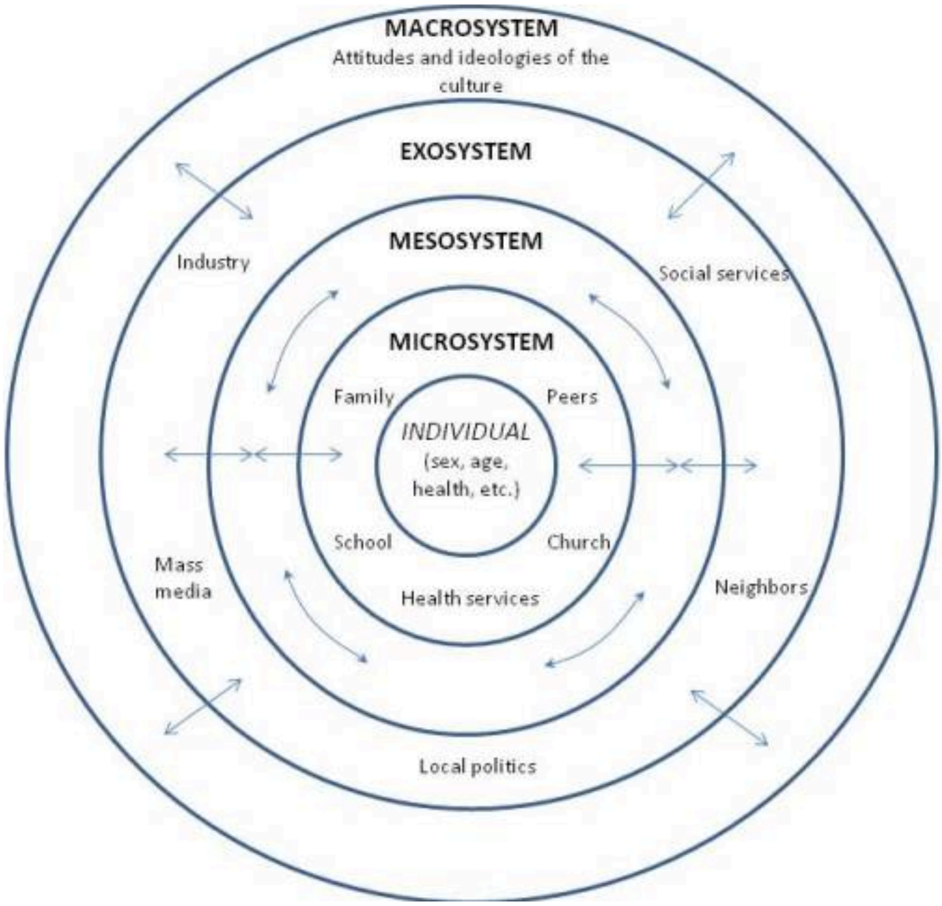

Figure 2.1. Bronfenbrenner's ecological model (1979)

parents and teachers. The exosystem refers to larger social structures such as school district, local and federal governments, and social networks that have an indirect impact on the individual. For example, if parents were made redundant at their workplaces in the exosystem, this would affect their child directly through financial strain or increased parental stress, although the child spends no time there. The macrosystem refers to social-cultural values and beliefs that permeate all other ecological systems (Tudge et al., 2009). As such, the macrosystem holds information and ideology about life styles, social interchange, and life course options that provide particular meaning to social groups, activities, and their interrelations (Bronfenbrenner, 1993).

The final concept in the PPCT model is *time*, which was termed as the chronosystem in earlier theorising (Bronfenbrenner, 1989). The concept of time was extended to encompass chronological age, duration, and nature of periodicity as the developmental change takes some time, and both the individuals and the environment are largely shaped by experiences and events in the historical time in which these individuals live (Rosa & Tudge, 2013). As time or history has a significant impact on subsequent development, present circumstances alone cannot explain current outcomes. For effective development, reciprocal interactions between a person and context must occur on a daily basis for a long period of time with increased complexity (Bronfenbrenner & Morris, 2006). Although it is often impractical to include each and every aspect of the PPCT model into a single study due to scale and cost, a study should prioritise proximal processes and focus on how these processes are influenced by both a person's characteristics, their environment and by their reciprocal interactions across time (Tudge et al., 2009).

While the bioecological theory was the first to suggest that children are nested within systems which function independently as well as interactively to support or interfere with child development, it does not specify how children relate to contexts, particularly concerning the quality of relationships within the family and classroom. The bioecological theory is also limited to only describing the negative effects of adversity and travesty on the developmental trajectory (Christensen, 2016), and it does not specify potential preventative factors to support children who are at risk. On the other hand, the Contextual Systems Model (CSM: Pianta & Walsh 1996) specifically focuses on experiences in school that can function as a protective mechanism for high-risk children and explores how teachers and children have a reciprocal impact on each other within these multi-layered microsystems. Relational quality is central to these systems in which the parent-child relationship is situated at the heart of the family system, and a teacher-child relationship is situated at the heart of the school system (O'Connor & McCartney, 2007).

Similar to Bronfenbrenner's bioecological theory, the CSM proposes that the child develops over time, particularly within the family and school systems that are interdependently affecting one another (Figure 2.2). Like Bronfenbrenner and Morris (2006), Pianta and Walsh (1996) maintain that the single-factor approach to analysing early schooling is too simplistic in which a direct causal relation between a single factor and student outcomes is assumed in isolation without integrating multiple bi-directional factors and influences. A child cannot be explained or evaluated by extracting only one aspect such as cognition, and thus an assessment should focus on wider indicators reflecting behavioural organisation in accordance with situational demands (Pianta & Walsh, 1996). Accordingly, the model assumes that 1) any outcome is a by-product of multiple interactive factors within and

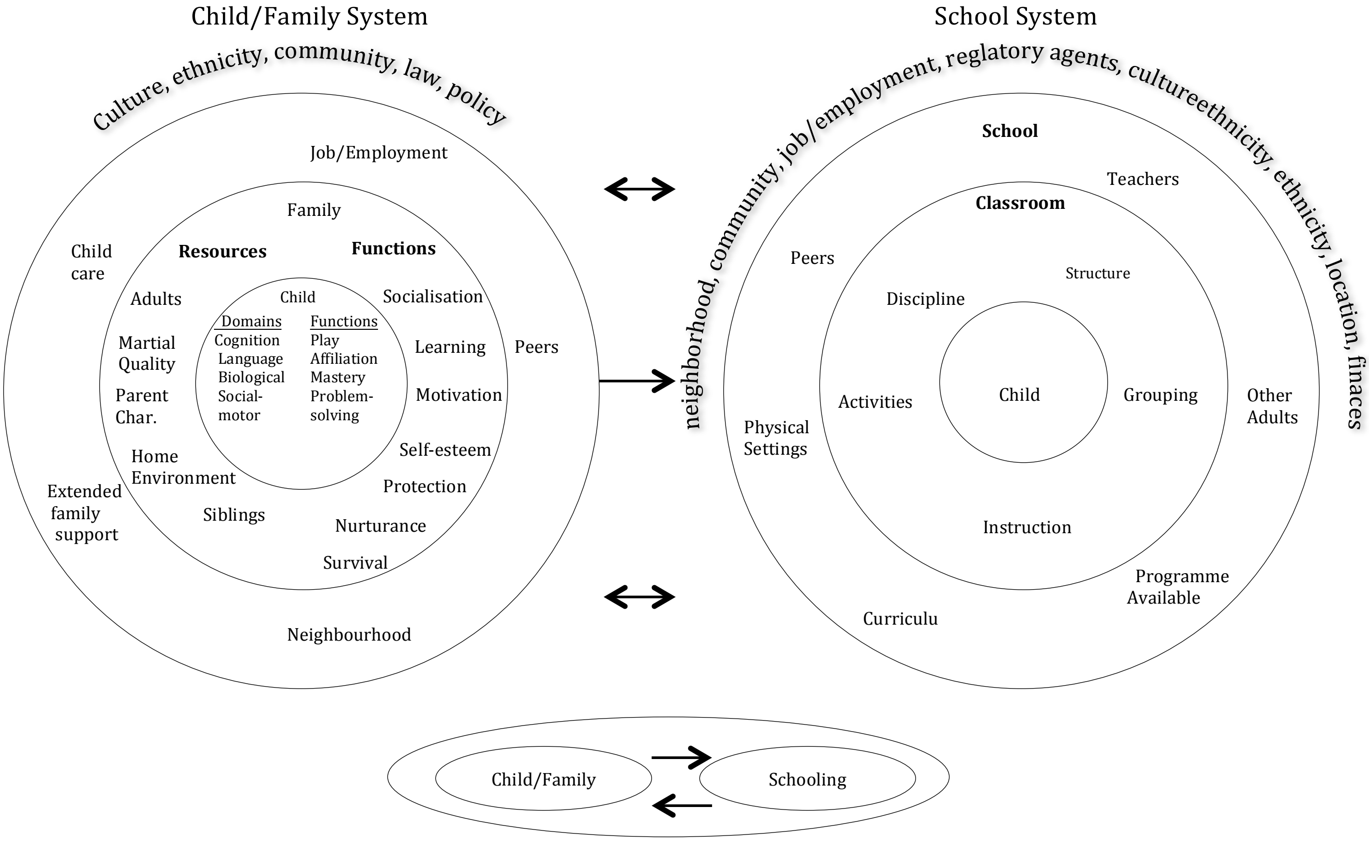

Figure 2.2. The Contextual Systems Model (Pianta & Walsh, p. 64)

between systems over time; and 2) the development process is not a simple reflection of linear relations between two or three factors (Pianta & Walsh, 1996). Like the bioecological theory, the CSM consists of sequences of nested systems that affect child development: the individual child, family, and school systems. A *system* in the model is also "an organised set of interrelated components each of which serves a function in relation to the activity of the whole system" (Pianta & Walsh, 1996, p. 65) and each system subordinates within a larger system. As such, the effects of a factor in one system have some degree of influence over a factor in another system (O'Connor & McCartney, 2007). While Bronfenbrenner's bioecological model primarily lacks specificity of the individual influential factors in relation to schooling, the CSM discusses explicit factors within school and family systems that help determine children's school outcomes.

Similar to the Bronfenbrenner's view, the CSM treats the family system as an institution in which factors such as parental social-class and employment have significant influences on child rearing. The family system includes a number of key components such as family resources and functions that are relevant to schooling. Family resources include family's socio-economic status, the quality of home environment (e.g., availability of books, parental provision of support), and parent characteristics (e.g., educational level, personality features). These aspects of family resources have an impact on the parent-child relationship, and consequently influence the child's functions such as socialisation, learning, motivation, self-esteem and so forth (O'Connor, 2010; Pianta & Walsh, 1996). For example, children from lower income families and whose parents have lower educational attainment are at greater risk of attaining lower levels of achievement (Dearing, McCartney & Taylor, 2006), and these children are more likely to experience more negative relationships with teachers at school compared to children with more privileged backgrounds (Ladd, Birch, & Buhs, 1999). On the other hand, improving parent-child relationships and the home learning environment is likely to increase children's school performance academically and behaviourally (e.g., Parker, Boak, Griffin, Ripple, & Peay, 1999). As such, these factors are interconnected and the family system cannot be viewed in isolation from the school system (Pianta & Walsh, 1996).

The school system includes the school and the classroom. The school system is characterised by influences such as collective child characteristics (e.g., percentage of poor children) and people involved in a school (e.g., peers, teachers) as well as school characteristics (e.g., resources, building, curriculum) (Pianta & Walsh, 1996). The influence of these factors regulates the behaviours of teachers and children, and consequently affects the quality of relationships between children and teachers at school (O'Connor, 2010). For example, teachers tend to engage in less sensitive and positive interactions with children in schools where there are higher concentrations of children living in poverty (Pianta et al., 2005). The classroom system encompasses interactions between teachers and children (e.g., instructional and emotional support) and structural features (e.g., ratio, schedule, grouping) (Pianta & Walsh, 1996). For example, teachers tend to have less negative relationships with children when they incorporate developmentally appropriate practices in classrooms (Mantzicopoulos, 2005).

The CSM acknowledges the important role that biological (e.g., gender, physiology), behavioural (e.g., interactive skills), and cognitive (e.g., language ability) characteristics of the individual child play in building a relationship and shaping development (O'Connor &

McCartney, 2007). For example, children with higher levels of behavioural problems are more likely to experience negative interactions with their teachers (e.g., Murray & Murray, 2004). Children with better language skills are also more likely to have higher quality interactions with their teachers as they are better equipped to communicate their ideas and needs efficiently, possibly inviting more positive and sensitive reactions from teachers (Rudasill, Rimm-Kaufman, Justice, & Pence, 2006).

In the CSM, the quality of relationships within and between family and school systems plays a central role in a number of areas of development. Areas of development encompass cognition (e.g., academic skills), learning processes (e.g., EF), language, and social behaviours, all of which assist various developmental outcomes such as problem solving, motivation, communication skills, and so on (Pianta & Walsh, 1996). According to the CSM, teacher-child relationships develop within the school environment, yet their quality is the results of various influences in both the family and school systems that are interacting over time (Hamre, Pianta, Downer, & Mashburn, 2008). As previously mentioned, the parent-child relationship at home may affect the nature of teacher-child interactions in classrooms, and in turn, these classroom interactions may alter child's communications with parents. As such, these two major systems are co-active, fluid, and interactive such that "the effect of a factor within the school environment on a child's development may be dependent on a factor within the family environment and vice versa" (O'Connor, 2010, p. 189). As such, risk factors do not independently exist in the child, family or school, but instead they are distributed across systems and in the patterns of interactions between these systems (Pianta & Walsh, 1996). Accordingly, the passage of time in relation to changes in the relationship quality is also key to understanding the CSM. Relationships take time to develop, and expectations based on previous experiences or history may influence how the relational quality changes in the present moment as well as subsequent developmental outcomes of the child (Pianta & Walsh, 1996).

The CSM might be viewed as reductionist because it primarily focuses on aspects of schooling and does not address the complexity of contemporary reality. Consequently, other factors that affect child development (e.g., municipal involvement) might not be considered. Although the CSM provides a useful framework that simplifies schooling without narrowly focusing on only one aspect or domain of child development, it is not enough to understand the comprehensive activity of broader systems in relation to the outcomes of early schooling

(Pianta & Walsh, 1996). Therefore, the bioecological theory complements the CSM by providing more detailed explanations of interactive influences of these multiple systems on children's learning and development at several levels.

2.1.1 Application of theory to this study

Both Bronfenbrenner's bioecological theory and the CSM suggest that children develop within nested systems that are interrelated. Additionally, the CSM provides a schooling framework that focuses more on the microsystem and highlights not only factors within the child, family, classroom and school, but also the impact of relational quality within and between school and family systems on promoting school success for children. It is a fundamental premise of the bioecological-contextual model that development is a complex function of various factors within nested systems and from the associations amongst these systems such that a single study cannot possibly capture all factors and their relations in the systems (Bronfenbrenner, 1999). Nonetheless, Tudge et al. (2009) maintain that it is important for research to include each concept of the PPCT model to represent the contents and propositions of the theory, thus providing appropriate directions in supporting the needs of children. For example, to understand the development of school readiness skills, inclusion of child characteristics such as age or intelligence would be the minimum requirement, and evaluating quality of different microsystems such as home and school environments and how these systems affect the development of school readiness in a mutual manner would be desirable. To incorporate the concept of time, a longitudinal study with data collected at a minimum of two time points is more desirable so that it can take into account the change of the developmental outcomes across time (Tudge et al., 2009). Following the bioecological-contextual framework provided by both the bioecological theory and the CSM, the current study focuses on the child factors (e.g., EF, social-emotional skills, and academic competence), the school-level factor (e.g., preschool curricula), and the classroom-level factors (e.g., teacher-child relationship, classroom quality) along with the family-level factors (e.g., parent characteristics, parent-child relationship) and examines how a set of these interrelated factors within school and family systems affect the development of school readiness skills in preschool settings over time.

2.2 School readiness skills

As children undergo rapid growth during early years, the importance of this period in order to form the foundations for school readiness and later achievement has attracted increased attention (Mann, Hund, Hesson-McInnis, & Roman, 2017). School readiness broadly refers to a combination of skills necessary to function successfully in school (Carlton & Winsler, 1999; Snow, 2006). Historically, pre-academic skills have been viewed as important criteria for determining fitness to enter school; however, the recent conceptualisation of school readiness has included a broader set of competencies such as executive function (EF) and social-emotional skills as critical as academic ability for assisting a successful and smooth transition to formal schooling and later achievement (Denham, Bassett, Thayer, Mincic, Sirotkin, & Zinsser, 2012; McClelland et al., 2007). Accumulating research findings suggest a significant contribution of EF and social-emotional skills to children's various school outcomes including higher levels of social functioning and academic achievement (e.g., Blair & Diamond, 2008; Fantuzzo, Bulotsky-Shearer, Fusco, & McWayne, 2005). Indeed, kindergarten teachers reportedly value both EF and social-emotional skills as the most critical skills for easing the transition into kindergarten and facilitating children's school success (Rimm-Kaufman et al., 2000). In spite of the growing interest in these skills, there is substantial variability in the definition and conceptualisation of EF and social-emotional skills (Campbell et al., 2016, Pintrich, 2000), posing a challenge to identify what constitutes these skills and how they are related to children's social and academic development. Therefore, the goal of the next four sections is to clarify the definition of both EF and social-emotional skills and their specific relations to children's school outcomes.

2.2.1 Definition of executive function

The first area of skills essential to school readiness and early school success is executive function (EF). EF refers to cognitive regulatory capacities in accordance with purposeful use of attention and goal-directed behaviours (Best, Miller & Jones, 2009; Miller & Cohen, 2001). As such, EF is a critical control system that allows individuals to plan, problem-solve, and monitor actions for goal attainment (Carlson, 2005; Liew, 2012; Riggs, Blair, & Greenberg, 2004). EF, however, is an umbrella term that encompasses a wide range of cognitive operations (Anderson, 2002; Duncan, 2001). This conceptual ambiguity makes it difficult to determine what the exact underlying processes of EF are. Consequently, there are ongoing debates on a conceptual framework, particularly whether EF is a unitary or componential construct (Garon, Bryson, & Smith, 2008).

A unitary view considers EF as a central executive or self-regulatory system necessary for various cognitive operations such as intentional use of attention (Baddeley, 1996). This unitary account suggests that general control processes are concentrated within certain prefrontal regions (Miller & Cohen, 2001), thus EF shares a common executive control component (Blair, 2006). In contrast, a componential view considers EF as a multidimensional construct with dissociable but inter-related components (e.g., Diamond, 2001; Miyake et al., 2000). The three-factor model proposed by Miyake et al. (2000) has been hugely influential for the componential account (Brydges, Reid, Fox, & Anderson, 2012). Miyake et al. (2000) conducted confirmatory factor analysis (CFA) to identify the latent structure of EF. CFA, a latent variable approach, is a powerful statistical tool to extract common variance from multiple tasks of supposedly the same EF component thus determining whether a unidimensional model of EF can fit the data better than a multidimensional model or vice versa (Wiebe, Espy, & Charak, 2008). Using CFA, Miyake et al. (2000) found three putative elements of EF: inhibitory control (IC), working memory (WM), and cognitive flexibility (CF). IC is the ability to consciously inhibit dominant habits or distractions and avoid non-goal oriented behaviour (Diamond, Barnett, Thomas, & Munro, 2007; Dawson & Guare, 2010). WM is the ability to maintain information and actively manipulate relevant information (Miyake et al., 2000). CF is the ability to adjust to changes and modify behaviour according to particular situations when necessary (Diamond et al., 2007). This three-factor model has been widely accepted in both adult and school age children (e.g., Brocki & Bohlin, 2004; Friedman et al., 2006; Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003; Wu, Chan, Leung, Liu, Leung, & Ng, 2011).

The dimensionality of EF amongst preschool children is less conclusive, with some CFA studies showing a unitary or two-factor construct of EF for this age group (Hughes, Ensor, Wilson, & Graham, 2009; Wiebe et al., 2008; Willoughby, Blair, Wirth, & Greenburg, 2010). However, the unitary models in particular may be too simplistic to explain such complex cognitive processes (Anderson & Reidy, 2012). Firstly, lesion studies with adults (e.g., Bechara, 2004) and preschool children (e.g., Tsuchida & Fellows, 2013) support a functional heterogeneity of executive processes by demonstrating that different EF tasks trigger activation in different areas of the prefrontal regions. Secondly, different components of EF exhibit different developmental trajectories over time (Anderson, 2002; Best & Miller, 2010; Diamond, 2001). For example, while IC generally grows rapidly during the preschool years and slows down through adolescence (Hughes, 1998; Garon et al., 2008), WM and CF grow more gradually in a linear manner throughout development (Gathercole, Pickering, Ambridge, & Wearing, 2004; Luciana & Nelson, 1998). For these reasons, the current study employed the componential view of EF and treated three factors, namely IC, WM, and CF, as separate yet inter-related elements of EF. The next section will present unique contributions of each EF component to children's school outcomes including academic achievement and social functioning.

2.2.2 EF and school outcomes

EF is linked in multiple ways to children's development of academic skills and social functioning, and thereby affects children's overall school experiences. A number of studies have provided compelling evidence for the distinct role of EF in both mathematics and reading amongst preschool children. For example, in a study with 66 preschool children, Espy et al. (2004) demonstrated that both IC and WM predicted early emergent mathematical abilities (e.g., counting, mathematical operations, applied problem-solving) ($\beta = .24$, $p < .05$, $\beta = .46$, $p < .0001$, respectively). CF was not associated with any aspects of emergent mathematics skills. After controlling for age, maternal education, and vocabulary, however, IC was the only variable that predicted mathematical achievement ($\beta = .44$, $p < .01$), explaining 12% of the unique variance. In contrast, Monette, Bigras, and Guay (2011) demonstrated that only WM at kindergarten entry was the significant predictor of standardised mathematics test scores at the end of grade one ($\beta = .32$, $p < .05$) and that IC or CF did not show an effect on mathematics achievement while controlling for general academic abilities, gender, age, and family characteristics. Although the adequate statistical power is in question for both studies due to their small sample sizes (N = 66, N = 85, respectively), these findings indicate a powerful relation between EF, particularly IC and WM, and mathematical achievement. None of these studies reported a contribution of CF to mathematic performance.

A similar pattern of specific associations between EF and literacy skills has been documented in other studies. For example, Monette et al. (2011) indicated that WM and IC at kindergarten entry were moderately correlated with achievement in literacy skills including reading and writing at the end of grade one (*rs* = .51, *rs* = .46, respectively, $p < .01$), although only WM showed a significant total effect on reading/writing ($\beta = .31$, $p < .01$) in the mediation analyses after controlling for general academic abilities, gender, age, and family characteristics. In a study with older children age 11-12, St Clair-Thompson and Gathercole (2006) tested three aspects of EF (including IC, WM, and CF) and also found similar associations between EF and English skills (e.g., reading, writing, spelling). Exploratory factor analysis (EFA) identified two executive factors: a working memory factor and an inhibition factor. As CF tasks did not load on a single separate factor, they were excluded from the analysis. The results showed that both the WM and IC executive factors were significantly correlated with attainment in standardised English scores ($r = .62$, $p < .01$, $r = .31$, $p < .05$, respectively), although WM was a stronger predictor. Some studies demonstrate that CF is associated with academic outcomes including reasoning and reading (e.g., van der Sluis, de John, & van der Lei, 2007) and that children with poor mathematical ability are more likely to have poorer CF (Bull & Scerif, 2001); however, WM and IC in particular seem to be more strongly correlated with emergent mathematics and literacy skills.

The effect of EF on academic achievement has been also shown to last through early primary school years. For example, Bull, Espy, and Wiebe (2008) conducted a longitudinal study in which they examined associations between EF and academic achievement from 4 to 7 years of age. A sample of 124 children who attended local nursery schools in the UK were tested three times for the first three years of school regarding their EF (e.g., WM, IC, and CF) and academic achievement (e.g., mathematics and reading). The results showed that all aspects of EF were significantly correlated with both the mathematics and reading outcomes three years later. Growth curve analyses also revealed that children with a higher level of short-term WM and IC at school entry maintained their advantages and demonstrated better mathematics and reading achievement at the end of their third year of school, highlighting that better EF abilities can provide children with a long-lasting academic support.

Together, it is evident that the different facets of EF play a significant role in children's concurrent and longitudinal academic achievement. Common classroom learning activities are ever demanding for children, requiring close attention to be paid to a given task, reasoning, simultaneous processing, and mentally retaining information while dismissing the irrelevant (Passounghi & Siegel, 2001; St Clair-Thompson & Gathercole, 2006). As such, high levels of EF entailing high cognitive control are essential for facilitating effective learning (Agostino, Johnson, & Pascual-Leone, 2010).

In addition to academic achievement, the role of EF is also seen in its relation to social functioning. To understand the joint or unique contribution of different aspects of EF to children's social functioning, Raaijimaker et al. (2008) assessed the WM, IC, and CF of 82 Dutch preschool children and examined the relation between these aspects of EF and aggressive behaviour. Preschool children who showed high levels of aggressive behaviour as indicated by scores above the 93rd percentile on the Child Behaviour Checklist (CBCL; Achenbach & Rescorla, 2000) were included in the study. Direct assessments using a range of EF tasks were conducted individually in their home environment. One-way ANCOVAs suggested that 1) IC was the only robust EF factor that was associated with children's aggressive behaviour (F (1,181) = 9.90, $p < .01$); and 2) aggressive children exhibited deficits in IC even after controlling for their attentional problems (F (1,181) = 5.27, $p < .05$). One primary limitation of the study is that the sample comprised well-educated families such that generalisability to children whose parents are less educated is limited. Another limitation is that the study included children with extreme cases of aggressive behaviour. Coupled with a small sample size, the findings may be limited to this specific context.

Other studies also demonstrate the critical role of IC in the development of children's social behaviour. For example, Rhoades, Greenberg, and Domitrovich (2009) examined the concurrent associations between IC and teacher-rated social skills amongst 146 preschoolers ages 4-5 from low-income, ethnically diverse backgrounds. Direct assessment was conducted to measure IC skills. Teachers rated children's social behaviour (e.g., cooperation, social interaction) and both internalising (e.g., anxiety, social withdrawal) and externalising (e.g., self-centred, aggressive) behaviour problems using the Preschool and Kindergarten Behaviour Scales (PKBS; Merrell, 1996). The results showed that better IC was significantly associated with higher levels of teacher-rated social skills (b = .005, $p < .05$) and lower levels of internalising behaviour (b = -.006, $p < .001$) beyond other covariates including maternal education, child gender, ethnicity, receptive vocabulary, and emotion knowledge. The study did not assess other aspects of EF such that it is impossible to compare the effects of WM and CF. However, the findings indicate the importance of supporting the development of inhibitory control amongst young children who may be otherwise at risk of developing maladaptive behaviour and resultant school challenge. The results are consistent with a series of studies by Hugh et al. (1998, 2000) in which negative associations between IC and anti-social behaviours during peer interactions were found. This also suggests that the interpersonal problems of young children may be attributed to impairments in EF abilities, particularly IC.

Similarly, IC appears to be more strongly associated with social functioning. A meta-analysis conducted by Shoemaker, Mulder, and Deković (2013) confirms this particular association. The researchers examined 22 studies that investigated the associations between impairments in EF and externalising behaviour problems such as aggression, unmanageable behaviours, oppositional defiant disorder (ODD), and conduct disorder (CD) amongst preschool children. Their findings indicated a stronger effect size for IC ($r = .24$, $p < .001$) compared to WM ($r = .17$, $p < .001$) and CF ($r = .13$, $p < .001$). The results also revealed a stronger association between EF and externalising behaviour problems for older preschoolers (ages 4.6-6) ($r = .28$, $p < .001$) compared to younger preschoolers (ages 3-4.5) ($r = .12$, $p < .001$). These results highlight that impairments in EF are significantly associated with problematic behaviours in preschool years at an increasing rate and support a notion of a specific facet of EF, especially IC, exhibiting a stronger correlation with behavioural problems. A number of studies clearly indicate that the inhibitory aspect of EF is central to social functioning of young children. Children with weak inhibition are more likely to engage in anti-social and aggressive behaviours and are viewed negatively by their peers and teachers, which in turn interferes with establishing a positive relationship (Riggs, Jahromi, Razza, Dillworth-Bart, & Mueller, 2006). As a relational context is a critical source of support and security during school years (Ladd et al., 1999), impairments in relational skills due to poor IC skills may put children at risk of negative future outcomes with considerable regularity (Jahromi, Bryce, & Swanson, 2013; Rhoades et al., 2009).

In summary, EF studies highlight empirical evidence that 1) different aspects of EF are significantly linked to children's social and academic outcomes; and 2) developing EF is beneficial for those with or without disadvantaged social and economic diverse backgrounds. The limitations of research on EF, however, should be addressed. As previously mentioned, there is a substantial variation in conceptual definitions of EF across different studies, which in turn has produced inconclusive findings within empirical literature (e.g., Blair & Razza, 2007; McClelland & Cameron, 2011; Williford, Whittaker, Vitiello, & Downer, 2013). As a result of the same underlying construct being labelled and defined differently, the resultant methodological approaches also largely vary (Dent, 2013). The lack of consensus in conceptual definitions as well as the existing measurement concerns makes it difficult to identify a common conceptual ground between studies and require a careful interpretation of findings (Dent, 2013; Schmitt, Pratt, & McClelland, 2014) (See *4.8 Assessment challenges*).

2.2.3 Bidirectionality between EF and academic achievement

Although a number of studies have demonstrated the significant role of EF in facilitating school outcomes, the opposite directionality, with academic competence influencing EF, is also possible. Scholars have argued that language ability impacts EF development (e.g., Fuhs & Day, 2011; Baddeley & Hitch, 1974). According to Vygotsky (1986), language ability serves as a mental tool that allows one to reflect on behaviour and navigate situations more efficiently towards self-regulated action. For example, Wolfe and Bell (2007) found that language skills including receptive vocabulary and verbal comprehension were significantly associated with WM amongst children ages 3-4 ($\beta = .52$, $p < .001$) and that this association increased in strength with age.

However, these two disparate bodies of literature examining only one direction of influence limit conclusions regarding the possible developmental interplay between EF and academic competence. As the bioecological-contextual model emphasises the co-active nature of skill development over time (Bronfenbrenner & Morris, 2006), assessing directionality is an important step towards capturing the potential interactive process of growth in both EF and academic competence. Initial support for the bidirectional association between these skills is emerging. For example, Slot and von Suchodoletz (2018) assessed the bidirectionality between EF and language skills in 227 preschoolers ages 3-4. Children's language skills including vocabulary, verbal comprehension, and grammatical knowledge and three core aspects of EF were directly assessed twice a year during preschool years. Findings from an autoregressive cross-lagged model indicated that there were simultaneous development and bidirectional associations between EF and language skills, with language skills predicting gains in EF more strongly than EF predicting gains in language skills ($\beta = .45$, $p < .001$, $\beta = .17$, $p < .01$, respectively). In a longitudinal study with more measurement waves, Bohlmann, Maier, and Palacios (2015) also found bidirectional associations between EF and vocabulary, with vocabulary being a stronger predictor of EF development ($\beta = 53$, $p = .001$) than vice versa ($\beta = .12$, $p = .01$) during preschool years. However, the directionality differed depending on children's age; there was only a unidirectional association between EF and vocabulary when children were younger, with only EF influencing vocabulary from wave 1 to wave 2 ($\beta = .12$, $p = .01$). This finding postulates that early EF capacity during preschool years might be particularly important for developing subsequent vocabulary. Although this study was useful in highlighting the important long-term role of EF, the assessment of overall EF was based on a single measure that is often considered to tap into IC (Diamond & Taylor, 1996) such that the reported association might be limited to the inhibitory aspect of EF.

Other studies that have extended analyses across multiple academic areas through kindergarten also illustrate that early EF is a persistently stable predictor of academic gains and that there is a more domain-specific association between these skills. For example, Welsh et al. (2010) assessed the longitudinal associations between EF and both mathematics and literacy skills in 164 economically disadvantaged children across three time points from the beginning of pre-K through the end of kindergarten. Findings indicated that initial levels of EF predicted gains in both mathematics ($\beta = .20$, $p < .05$) and literacy skills ($\beta = .29$, $p < .05$) during the pre-K year. In addition, growth in EF during the pre-K year made significant contributions to kindergarten numeracy skills ($\beta = .35$, $p < .05$) and literacy achievement ($\beta = .36$, $p < .05$). Bidirectional associations were also found between numeracy skills and EF during the pre-K year; pre-K mathematical skills at school entry predicted EF development, as well as the reverse, but the same pattern of effects was not detected for literacy skills. Because the study employed a composite view of EF, specific associations between individual components of EF and academic achievement were unknown.

In contrast to the study by Welsh et al. (2010) that did not show an effect for language skill development, Fuhs, Nesbitt, Farran, and Dong (2014) found longitudinal reciprocal associations between EF and both mathematics (e.g., EF T1→ Applied Problems T2: $\beta = .34$, $p < .05$; Applied Problems T1 → EF T2: $\beta = .21$, $p < .05$) and oral comprehension skills (e.g., EF T1→ Oral Comprehension T2: $\beta = .20$, $p < .05$; Oral Comprehension T1 → EF T2: $\beta = .13$, $p < .05$) during pre-K, but not during kindergarten, although the relations between EF and mathematics were stronger than those for language skills. These findings indicate the importance of facilitating both early EF and academic competence, especially emergent numeracy skills, in promoting school readiness. Thus, children with higher initial EF skills at preschool entry were more likely to be academically equipped for kindergarten. Reciprocally, children with higher initial academic competence at preschool entry tended to exhibit higher EF skills for kindergarten. Consistent with previous studies, EF skills also continued to predict performance gains in academic content areas throughout kindergarten, suggesting that EF skills may allow children to respond to classroom demands more efficiently and to acquire different skill sets beyond preschool years.

In summary, although the bidirectional effect between EF and academic competence remains inconclusive, emerging evidence illustrates that EF skills consistently appear to make a significant contribution to academic gains during preschool years and beyond and that there may be a dynamic interplay between these domains. Overall, findings indicate the importance of improving early EF during preschool years with the aim of facilitating growth in academic achievement thereby promoting school readiness. Conversely, reported reciprocal associations especially in the preschool years also suggest that it might be beneficial for preschoolers to participate in early mathematical and literacy activities that tax higher cognitive functions before formal schooling for enhancing EF and subsequent academic achievement.

2.2.4 Definition of social-emotional skills

Parallel to EF, social-emotional skills seem to be an important contributor to children's school readiness and subsequent outcomes including positive attitudes toward school, smoother adjustment in the classroom, and better academic achievement (Denham, 2006; Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Nix, Bierman, Domitrovich & Gill, 2013). Conversely, a lack thereof is linked with persistent internalising and externalising behaviour problems, peer rejection, and poor academic performance throughout school years (Denham et al., 2003; Schultz, Izard, Ackerman & Youngstorm, 2001).

According to Zins, Bloodworth, Weissberg, and Walberg (2007), social-emotional skills include the ability to "recognise and manage their emotions, establish healthy relationships, set positive goals, meet personal and social needs, and make responsible and ethical decisions" (p. 194). Social-emotional skills involve multi-faceted domains (e.g., social and emotional domains) comprising a set of delineated skills including identifying emotions, understanding other people's perspectives, cooperating, and resolving conflict (Campbell et al., 2016). One of the most influential and widely-accepted constructs is suggested by the Collaborative for Academic, Social, and Emotional Learning (CASEL), a leading group of researchers and policy analysts who are at the forefront in global efforts to promote the importance of social-emotional skills (e.g., Denham & Brown, 2010; Elias, Zins, Graczyk, & Weissberg, 2003; Merrell, 2010; Merrell, Juskelis, Tran, & Buchanan, 2008; Schonert-Reichl & Hymel, 2007; Zins et al., 2007). The CASEL has identified five core areas of social-emotional skill: self-awareness, social awareness, self-management, responsible decision-making, and relationship skills (CASEL, 2003), all of which are essential for optimising learning and social functioning (Zins et al., 2007). Self-awareness encompasses the ability to identify one's emotions and feelings. Social-awareness includes the ability to recognise others' emotions and perceive the perspective of others. Self-management is defined as the ability to control impulses and effectively regulate emotions and behaviours in order to achieve a desired goal. Responsible decision-making includes the ability to identify a problem, analyse a situation, and exercise personal, moral, and ethical responsibility. Relationship skills are the ability to communicate, cooperate, and manage conflicts that can lead to building and maintaining a healthy relationship with others.

Denham (2005) proposed a delineation of relational/prosocial skills and emotional competence skills, emphasising the importance of differentiating social competence from emotional competence (Figure 2.2.4-1). According to Denham (2005), social competence, categorised as relational/prosocial skills, includes responsible decision-making and relationships skills whilst emotional competence involves self-awareness, social-awareness, and self-management. While emotional competence involves the ability to express and understand emotions of self and others, social competence includes the ability to respond to social cues appropriately (Denham, Wyatt, Bassett, Echeverria, & Knox, 2009). In order to be appropriate and effective in social interactions, a child must be equipped with skills of emotional competence such as understanding others' emotions (Campbell et al., 2016). As such, it is the behaviour that manifests in the context of social interactions, and thus social competence largely results from one's level of emotional competence (Denham et al., 2009). Conversely, even if a child possesses skills of emotional competence such as empathy, if he/she fails to act on this awareness due to a lack of social competence, it does not necessarily lead to effective social interactions. Therefore, both social and emotional factors

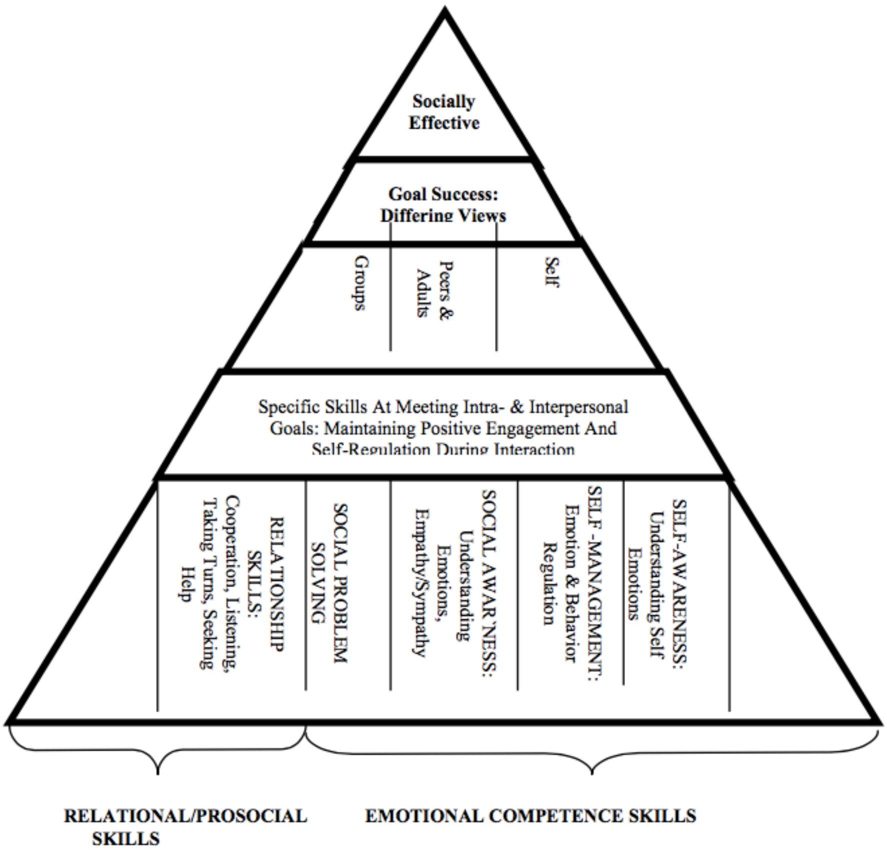

Figure 2.2.4-1. Social-emotional learning model (Denham & Brown, 2010, p. 655)

are essential for positive social functioning and are reciprocally influential. Cultural expectations also play a role in conceptualising social-emotional skills. Societal beliefs and norms fall under the cultural macrosystem (Bronfenbrenner, 1994), and such cultural expectations serve as a barometer to determine the acceptability of certain social-emotional skills and behaviour (Rubin, 1998). In fact, cultural differences have been shown to exist in parental expectations of social competence (Masataka, 2002; Rothbaum & Weisz, 1989) and emotional arousal level (Lim, 2016). For example, American parents tend to have greater appreciation toward wilfulness and assertiveness such that children are encouraged to negotiate and communicate their needs (Rothbaum & Weisz, 1989). By contrast, Japanese parents place more importance on empathy, compliance, and accommodating others' needs such that children are discouraged from explicitly expressing their own opinions or wishes (Masataka, 2002). These persistent cultural differences may also be attributed to differences in emotional arousal. For example, Western culture is associated with high arousal emotions (e.g., stimulated, excited, angry) to promote self-agency, whereas Eastern or collective culture is associated with low arousal emotions (e.g., calm, relaxed, helpless) in order to adjust to others or eliminate conflict (Lim, 2016; Tsai, 2007). It is clear that particular social-emotional constructs are influenced by cultural differences such that a conceptualisation of social-emotional skills must carefully respond to varying cultural perspectives of sub-groups to which children may belong. Taken together, the present study focused on both the social and emotional competencies that tap into age-appropriate attributes within a North American culture with a particular focus on social interactions: social-awareness, responsible decision-making, and relationships skills. The next section will illustrate specific contributions of each construct of the targeted social-emotional skills to school outcomes including social functioning and academic achievement.

2.2.5 Social-emotional skills and school outcomes

Social-awareness. Empathy is the ability to distinguish one's own emotions from those of others (Bronson, 2000) and to respond to others' emotional states. In other words, it is the "emotional matching and the vicarious experiencing of a range of emotions consistent with those of others" (Eisenberg & Miller, 1987, p. 91). Children's maturity helps to increase their competence in understanding others' emotions (Bronson, 2000; Schonert-Reichl, 2011), thus becoming more aware of the impact of their own behaviours on others' emotions with increasing age (Shonkoff & Phillips, 2000). While this increased empathetic understanding has been shown to be a major correlate of greater prosocial behaviour (Eisenberg & Miller, 1987; Findlay, Girardi, & Coplan, 2006), the inability to apply empathetic understanding to emotionally-driven situations is likely to lead to difficulties in peer interactions. For example, Warden and Mackinnon (2003) examined associations between social behaviour, empathy and sociometric status of 131 primary school children age 9-10. The peer nominated social status and social behaviour (e.g., 'thrown things at someone in his/her class', 'comforted another child who was hurt or upset') divided children into three categories: prosocial, bullies, and victims of bulling. The results revealed that prosocial children showed higher emphatic awareness than bullies (p = .016) and that these prosocial children were also significantly more likely to be liked by their peers compared to bullies and bully-victims. Therefore, establishing positive peer relations require advanced empathetic understanding and associated prosocial behaviour, and failing to understand how another child feels and to apply that knowledge to social interactions may put children at greater risk of social rejections at school. Research also suggests that such prosocial behaviours, in turn, show strong and positive associations with academic achievement. Specifically, early prosocialness is a powerful contributor to subsequent academic achievement even after controlling for early academic functioning (Caprara, Barbaranelli, Pastorelli, Bandura, & Zimbardo, 2000; Malecki & Elliott, 2002; Nix et al., 2013).

Responsible decision-making. Responsible decision-making is a critical aspect of social competence and refers to the ability to accept personal responsibility and behave conscientiously in accordance with "social rules and role expectations" (Wentzel, 1991b, p.2). As children enter formal schooling, social interactions increase in frequency and complexity involving teachers and peers. Responsible decision-making clearly goes hand in hand with other emotional skills such as understanding emotional arousal and social demands in an everyday interaction, which in turn enables children to select appropriate approaches to problem-solving in the case of interpersonal conflict (Denham, 2006). In a study that examined the role of such social problem-solving skills, Warden and Mackinnon (2003) found that prosocial children were more likely to be engaged in socially responsible and constructive solutions to problematic social situations, whilst aggressive children were more prone to propose forceful solutions to the social problems. This is in line with Wentzel study (1991a) in which rejected children displayed higher levels of irresponsible social behaviour including lack of problem-solving skills and lower levels of interpersonal trust compared to popular children. The ability to make responsible choices also appears to benefit academic achievement. For example, the Wentzel study (1991b) of sixth and seventh graders showed a significant association between peer and teacher ratings of social responsibility and academic achievement (GPAs) ($r = .70$, $p < .001$). The correlation was still significant after adjusting for IQ, social background, and school absence. Sylva (1994) argues that social responsibility enhances academic learning in two ways: 1) responsible behaviour helps children establish a constructive and cooperative relationship with peers and teachers, thus providing a positive learning environment; and 2) behaving responsibly complements the process of pursuing learning goals. Although the Wentzel study is fairly old and requires updated research with younger children, it is clear that a failure to recognise social situations and take responsibility for their actions can undermine broader personal conduct.

Relationship skills. Relationship skills are another aspect of social competence. Deducing the basic emotions of others, applying empathetic understanding to a social interaction, and acting conscientiously allow children to successfully establish a healthy relationship with others (Denham et al., 2012) and promote social inclusion (Ladd, 2003). In addition to interpersonal sensitivity, various underlying skills are required for a successful social exchange with others including initiating and maintaining conversations, taking turns, helping, and cooperating. For example, Hazen and Black (1989) examined the associations between a sample of 54 preschool children's peer-nominated sociometric status and their peer communication skills during free play. They found that well-liked children were more likely to initiate interactions, respond to the initiations of other children effectively, and modify their communication styles compared to less liked children. Results also showed that disliked children displayed lower levels of communication skills than low-impact children. However, the observation codes used in the study were not standardised and their psychometric property was not tested such that coding reliability was in question. Nevertheless, the study proposes that well-liked children tend to show more socially adept behaviour. In fact, children's positive relationship with their peers is critical with increasing age, as peer rejection is associated with significantly greater risk for later classroom maladjustment, school dropout, and even psychiatric problems (Lopez & Dubois, 2005; Malecki & Elliott, 2002). A better relationship skill such as cooperation is also linked to better academic skills. For example, Doctoroff, Greer, and Arnold (2006) assessed the social behaviours of 123 preschool children with socioeconomically disadvantaged backgrounds and their relations to emergent literacy skills. Classroom observation was conducted to assess social behaviours such as aggression (e.g., hostile) and prosocial behaviour (e.g., cooperative). Direct assessments were conducted to measure children's literacy skills including expressive vocabulary and receptive language skills. Regression analyses showed that although boys and girls performed similarly in literacy tasks, higher levels of prosocial behaviour predicted literacy skills more strongly for boys than girls ($\beta = .41$, $p < .05$). Poorer relationship skills measured by displays of aggressive behaviour were also significantly associated with lower emergent literacy skills ($\beta = -.31$, $p < .05$). One main limitation is that prosocial behaviour was measured only within the peer context as opposed to within both teacher and peer interactions. As the CSM points out, relational quality with teachers has a significant influence on children's social and academic learning. Further consideration for a dynamic network of relationships is necessary to understand the mechanism behind the association between prosocial behaviour and emergent literacy skills.

Social-emotional skills refer to children's abilities to recognise their own feelings and others' emotions appropriately; respond to the feelings of others with empathetic understanding; act conscientiously for the collective benefits and engage in ethical behaviours; and build a healthy and positive relationship with peers and teachers. In particular upon school entry, children with higher levels of social-emotional skills can engage in a more effective social interaction by making and sustaining new friendships, cooperating, and building a positive relationship with teachers. Subsequently, these children are more likely to develop positive feelings toward school, actively participate in learning and school activities, and achieve more academically (Denham, 2006). When children's intellectual development is highly influenced by social relations (Bandura, 1997), it is clear that the extent to which children develop adequate social-emotional skills largely affects their overall school experience.

Caution should be exercised, however, in interpreting these findings due to conceptual and methodological challenges. Firstly, there is a lack of consensus in conceptualising social-emotional skills. As previously mentioned, some studies identify behavioural skills such as compliance (Webster-Stratton & Reid, 2004; Briggs-Gowan & Carter, 1998; Wentzel, 1991a; Landry, Smith, & Swank, 2006) and independence (Cooper & Farran, 1988; McClelland & Morrison, 2003) as socially competent behaviours, whereas others place more importance on emotional aspects such as empathy and emotion knowledge (Eisenberg & Miller, 1987; Bridges, Denham, & Ganiban, 2004). Cultural expectations in the macrosystem also pose challenges in conceptualising social-emotional skills. Depending on the values and belief of the host culture and society, an endorsement to certain social-emotional skills and associated behaviour varies significantly (Edmunds & Stewart-Brown, 2003; Rubin, 1998). Edmunds and Stewart-Brown (2003) emphasise that it is important to separate core social-emotional skills from socially desirable behaviour. This is because socially desirable behaviour might include attributes that often target behavioural outcomes that are favourable to adults rather than children, and these attributes might not be valued in other cultures (Edmunds & Stewart-Brown, 2003; Weare, 2002). Consequently, the definition with the same term may be understood differently in different conceptual and cultural contexts. Secondly, there are methodological variations, thus affecting the results depending on responders and/or assessors (Caprara et al., 2000). In addition to the conceptual inconsistencies, instrumental alterations may also reduce the generalisability and inflate the findings across different studies (See *4.8 Assessment challenges*).

2.2.6 Bidirectionality between social-emotional skills and academic achievement

In contrast to evidence illustrating that social-emotional skills contribute to academic outcomes, other studies provide support for the opposite path in which deficits in academic ability influence social behaviour. For example, St Clair, Pickles, Durkin, and Conti-Ramsden (2011) examined a relation between language ability and behavioural difficulties in children from childhood to adolescence. Results showed that lower reading and expressive language ability was significantly associated with more behavioural problems later ($\beta = -.03$, $p < .005$; $\beta = -.02$, $p < .05$, respectively) and that this relationship remained persistent throughout the developmental period examined. This is consistent with a meta-analysis of 19 studies that also suggests that children who have early language impairments are more likely to experience increases in severity of emotional and behavioural problems than children with typical language abilities (Yew & O'Kearney, 2013). These findings provide support for academic skills leading to social competence.

Although there is an established relationship between social-emotional skills and academic competence, most studies have tested nondirectional associations lending support to only a unidirectional relation between these two domains. In terms of possible reciprocal relations, findings of previous studies are inconclusive. For example, Petersen et al. (2013) examined the direction of effect between language ability and behaviour problems amongst children from ages 7 to 13 years old. Children's language ability including language mechanics and expression was measured annually using a standardised achievement test. Parents and teachers also reported children's externalising behaviour such as aggression and delinquency annually. Results showed that language ability was significantly associated with later parent and teacher ratings of behavioural problems even after controlling for individuals' trajectories and prior levels of behavioural problems, but the inverse path was not significant.

On the other hand, a longitudinal study by Welsh, Parke, Widaman, and O'Neil (2001) provided partial support for social and academic competence influencing each other reciprocally over time. The study involved 163 children from first through third grades. Both teacher and peer ratings were collected annually to measure children's social acceptance and prosocial and aggressive behaviour, and annual language and mathematics report cards were used to measure academic competence. A latent cross-lagged path model showed that academic achievement consistently had a significant influence on social competence from both first grade to second grade (β = .22, *SE* = .04) and second grade to third grade (β = .25, *SE* = .10); although social competence at first grade did not directly influence academic competence at second grade, the cross-lagged pathway from social competence at second grade to academic competence at third grade was significant (β = .47, *SE* = .14). Academic competence was also consistently associated with negative social competence from both first grade to second grade (β = -.24, *SE* = .09) and second grade to third grade (β = -.20, *SE* = .09), but the inverse paths were not significant. These findings suggest that the impact of academic achievement at school entry on social performance is persistent over time with a reciprocal association emerging between social competence and academic ability from second to third grade. Although the continued developmental interplay of these domains could not be determined as data from the fourth grade were not available, Welsh et al. (2001) indicated that academic interventions might be more useful for increasing both academic and social competence in young children.

An experimental study supports this by demonstrating the effectiveness of academic skills training over social skills training. Coie and Krehbiel (1984) conducted intervention research to explore the effects of social and academic training on the social status of 40 socially rejected, low-achieving African American children. The third graders were randomly assigned to one of four intervention conditions: academic skills training, social skills training, a combination, or control. The academic skills training consisted of tutoring in the areas of reading and mathematics twice a week; the social skills training predominantly consisted of paired play once a week to coach children in positive types of behaviour such as participation, cooperation, communication, and support. Both trainings occurred over a six-month period. The results indicated that academic skills training was the most effective in improving reading, mathematics, and sociometric scores compared to other conditions. Conversely, social skills training only contributed to significant progress in reading comprehension and was not as effective as academic skills training in improving academic achievement and social competence with peers. Coie and Krehbiel (1984) suugested that improved academic skills helped enhance children’s on-task behaviour, positive teacher attention, and self-esteem, which in turn led to improvements in social behaviour. Limitations should be noted. Firstly, the programme fidelity of social skills training itself was questionable, as children in this training group did not show significant improvements in the targeted social skills compared to their counterparts in academic skills training. Secondly, academic skills training was implemented more frequently than social skills training such that frequency of interventions might have caused differences in the skills acquisition. Despite these limitations, this study was useful for highlighting that academic competence leads to social skills.

In summary, although the possible reciprocal associations between social and academic competence remain inconclusive, the existing studies lend more support for academic competence being a stronger and more stable predictor of social competence development than vice versa, especially when children are younger. As the experimental study also points out, early academic interventions might be most effective for younger children with the goal of increasing both academic and social competence. However, given that both academic and social competence appears to mutually influence each other in the later years, the importance of targeting these two domains simultaneously cannot be ignored.

2.2.7 Relations between executive function and social-emotional competence

Converging research has supported the importance of both EF and social-emotional skills in facilitating positive social functioning and academic success; however, the directionality of the association between EF and social-emotional skills remains unclear with varying views (Austin, Groppe, & Elsner, 2014; Razza & Blair, 2009). One position is that social-emotional skills underpin the development of EF. Perner (1998) suggests that EF requires certain social-emotional competence such as the ability to make inferences about the mental states of oneself and others, e.g., theory of mind (Frith & Frith, 1999). Therefore, according to Perner, it is only when a child develops perspective-taking skills and has general social insights that s/he is able to successfully engage in EF. To support this view, for example, McAlister and Peterson (2013) conducted a longitudinal study examining the link between EF (e.g., IC) and theory of mind (ToM) involving 157 preschool and kindergarten children ages 3-6. IC and ToM were individually measured at time 1 in preschool and at time 2 in kindergarten with an average 12-month-interval. Hierarchical multiple regression analyses showed that early ToM at time 1 predicted later EF at time 2 at a significant level ($t(151) = 2.51$, $p < .05$) even after controlling for initial EF, age, language ability, and number of siblings. On the contrary, early EF at time 1 did not significantly predict later ToM at time 2 after controlling for initial ToM, age, language ability, and number of siblings. The study, however, included a broad age range of children from age 3-6, and ceiling and other floor effects were observed with some tasks. Since EF and ToM undergo a rapid growth during early years (Diamond, 2013; Hughes & Ensor, 2007), utilising measures with good age norms or alternatively narrowing the age range is important for accurate interpretations of the findings (Anderson & Reidy, 2012). Nonetheless, the study supports the mental representational account that children's EF development is contingent upon the prior level of affective perspective taking. Therefore, promoting the development of social-emotional competence may result in helping to facilitate EF (Blair & Diamond, 2009).

On the other hand, the second position claims the opposite directionality in which EF is fundamental for the development of social-emotional skills (e.g., Russell, 1996). This view has been largely supported by research on social competence of children with Attention Deficit Hyperactivity Disorder (ADHD). ADHD is a developmental disorder characterised by inattention, impulsivity, and hyperactivity (Clark, Prior & Kinsella, 2002). These symptoms of ADHD are considered to be primarily a result of deficits in EF (Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005; Pennington & Ozonoff, 1996; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005), and children with ADHD suffer impairment in a variety of social-emotional skills including taking turns, communication, reciprocity, and listening (Biederman et al., 2004; Clark et al., 2002). Other studies also support that EF is primary, and social-emotional skills may depend on the development of EF. For example, Flynn, O'Malley, and Wood (2004) tested whether EF was a precursor to ToM or vice versa. The study found that the majority of three-year-old children were able to perform well on IC tasks even when they did not demonstrate a good grasp of ToM, indicating that the development of EF skills preceded the improvement in mental representation skills. However, the sample size was small (N = 26) and a few children (N = 2) in the sample actually showed the opposite sequence of development in which they performed well on ToM tasks before reaching the threshold for good performance on EF tasks. In a larger scale longitudinal study, Hughes and Ensor (2007) tested the predictive relations between the inhibitory aspect of EF and ToM amongst 122 children ages 2, 3, and 4. Hierarchical regression analyses showed that EF at time 1 (age 2) predicted ToM at both time 2 (age 3) ($\beta = .19$, $p < .05$) and time 3 (age 4) ($\beta = .19$, $p < .05$) at a significant level, controlling for initial ToM, gender, age, and verbal ability, but EF at time 2 did not predict ToM at time 3 ($\beta = .16$). On the contrary, ToM at time 1 only predicted EF at time 3 ($\beta = .22$, $p < .05$), controlling for initial EF, gender, age, and verbal ability, but not EF at time 2. Conversely, ToM at time 2 did not predict EF at time 3 ($\beta = .01$) either. These results provide fractional support for the account that ToM is an antecedent to higher EF, but stronger evidence for the assumption that EF is a building block for social-emotional competence.

These findings from studies with two opposite views are rather inconclusive. The nature of mostly correlational studies contributes to considerable disagreement and does not provide conclusive evidence for the directionality between EF and social-emotional skills. This suggests a third position that there is a bidirectional relationship between EF and social-emotional competence. This account claims that while facilitating EF has a significant impact on the social-emotional skills of young children, social-emotional skills also influence the development of EF (Hala, Pexman, Climie, Rostad, & Glenwright, 2010). For example, Kloo and Perner (2003) conducted a pre-and post-training study as opposed to a correlational study and examined a reciprocal relationship between ToM and CF amongst preschool-aged children. ToM was measured by false-belief tasks, and CF was measured by the dimensional change card sort task (DCCS; Zelazo, 2006). Preschool children ($N = 44$) ages 3-4 were randomly assigned to one of three different training groups: false-belief training, cognitive flexibility training, and control training. Training with explicit feedback on children's performance was conducted once a week over two weeks. The pretest was conducted about a week before the training in which no significant group differences were found, and the post-test followed about 11 days after the final training session. One-tailed paired t-tests showed that children in both the cognitive flexibility and false-belief training made significant improvements in the DCCS tasks ($t\,(13) = 5.26$, $p < .01$; $t\,(14) = 3.07$, $p < .05$, respectively) compared to the control training, whereas the cognitive flexibility training made a significant improvement on the false-belief task ($t\,(13) = 2.46$, $p < .05$). This transfer of training effect in both directions indicates a functional dependency between EF and ToM. The findings should be interpreted with caution, however. Firstly, although the false-belief training improved subsequent performance on the trained task, the difference between the pre-test and post-test was not statistically significant. This may be explained by the difficulty in training ToM. The development of ToM might take time as shown in earlier training research in which no immediate training effect on the false-belief task was found (e.g., Taylor & Hort, 1990). Limited frequency and a short period of training in the study might have been insufficient to show the training effect on the target skills, particularly ToM in this case. Moreover, the nature of a short-term study posed a question about the longitudinal interactive association between EF and ToM. Secondly, the final sample size was small to provide sufficient statistical power. Finally, children were predominately Caucasian with middle-class backgrounds such that generalisability was questionable. Despite these limitations, this was the first training study to clarify the causal directionality between EF and ToM and to provide evidence for their mutual functional dependence.

In summary, these studies clearly show that EF and social-emotional skills are interrelated, although their reciprocal relationship is underdetermined and highly complex (Hala et al., 2010). Despite the debatable directionality, EF and social-emotional skills are essential for school readiness and subsequent school outcomes both academically and socially (Berhenke, Miller, Brown, Seifer, & Dickstein 2011; McClelland et al., 2006; McClelland et al., 2007). Consequently, understanding these skills is evidently crucial as a way to effectively apply educational strategies and thus help children become ready for further schooling (McClelland et al., 2007). The bioecological-contextual model suggests that child development is a result of co-active interactions between a child and multiple factors within the family and school systems (Bronfenbrenner & Morris, 2006). There are several factors identified to have a significant influence on the development of the school readiness skills (including EF, social-emotional skills, and academic competence) and resultant school outcomes. Following the bioecological-contextual framework, the next section will specify these influential factors in both the family and school systems and how they are connected to school readiness and outcomes.

2.3 Contextual factors influencing school readiness skills

2.3.1 School factors

2.3.1.1 Preschool programme

The global increase in early childhood education programmes suggests a growing interest and commitment to improving school readiness and long-term success amongst young children (Miller & Cameron, 2004; OECD, 2017). The benefits of attending high-quality early childhood education programmes are well documented. For example, the Effective Preschool and Primary Education (EPPE) project in the UK (Sammons et al., 2008; Sylva et al., 2008), a large-scale longitudinal study that examined the impact of preschool provision on children’s developmental outcomes, indicated that children who attended high-quality early years programmes, regardless of programme types, were more likely to have better cognitive and social skills by the time they started formal schooling and even at age 11. Findings also showed that children who attended low quality preschools performed similarly in academic and behavioural domains to those who had no preschool experience at age 11, indicating that quality of preschool is critical in not only preparing children for formal schooling but also sustaining the long-term effects of early education (Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2011). While high-quality preschool programmes can improve children's school readiness and subsequent school success, whether different types of curricula actually produce significantly different effects remains inconclusive.

The Perry Preschool study (Schweinhart & Weikart, 1997) is one of the first longitudinal studies that examined the effects of a comprehensive preschool programme called the High/Scope curriculum (Hohmann, Weikart, & Epstein, 1995) on children living in poverty. The study employed an experimental design by randomly assigning 123 children to either a half-day Perry preschool programme at age 3 and 4 or another group that received no preschool programme. Researchers followed these children annually from age 3 through age 11 and again periodically through age 40 and measured a wide range of outcomes including education attainment, economic performance, crimes, relationship status, and health (Schweinhart et al., 2005). The High/Scope curriculum is strongly influenced by Piagetian theories and emphasises the importance of active learning, interpersonal skills, self-control, and independence (Hohmann, Weikart, & Epstein, 1995; Wood, 2013). At the age 40 follow-up, the Perry programme made a significant short-term and long-term contribution to cognitive and behavioural development in childhood and subsequent school success, higher employment status and earnings, and lower incarceration rates in adulthood. Because the sample size was relatively small, it diminishes the generalisability of the findings. However, the Perry Preschool study was useful for highlighting impacts of a high-quality preschool curriculum on disadvantaged children's readiness for school and subsequent educational and economic success even many years later.

Several studies have examined whether targeted curricula are more effective in improving children's school readiness than general curricula (e.g., Barnett et al., 2008; Farran & Wilson, 2014; Schindler et al., 2015). For example, Schindler et al. (2015) conducted a meta-analysis of 31 studies that examined the overall effect of early childhood education (ECE) programmes on children's social behaviour. ECE programmes were categorised into three levels: level 1 (no clear focus on social and emotional development), level 2 (clear but broad focus on social and emotional development), and level 3 (clear and intensive focus on social and emotional development). Findings showed that level 2 programmes were significantly more effective in reducing externalising behavioural problems ($ES = -.23$, $p < .01$) compared to level 1, although the effects of level 2 programmes were small when compared to control groups ($ES = -.10$, $p < .05$). Compared to level 2 programmes, level 3 programmes were significantly more effective in reducing externalising behavioural problems ($ES = -.26$, $p < .05$). The study only focused on externalising behaviour such that the effects of programmes on other areas of development were unknown. Yet, findings indicate that ECE programmes are most effective in reducing aggressive behaviour when they have a clear goal of improving children's social skills and actively supporting them in this domain.

The Tools of the Mind (Tools; Bodrova & Leong, 1996) is a curriculum that specifically targets the development of EF through a variety of play activities. In spite of a clear-cut goal of facilitating the growth of EF, previous research on the Tools has shown mixed results on the programme effects. For example, Barnett et al. (2008) found that the Tools of the Mind programme made a significant contribution to EF development as indicated by low scores on teacher-rated problem behaviour compared to control group children. On the other hand, Farran and Wilson (2014) reached the opposite conclusion and suggested that despite the high implementation fidelity children who attended the Tools of the Mind programme did not differ in gains on academic achievement, EF, or teacher ratings of social behaviour compared to children who attended regular preschools at the end of pre-K. Limited effects of various content-specific curricula are also highlighted in a meta-analysis of 14 randomised trials (Preschool Curriculum Evaluation Research Consortium, 2008). Most curricula focused on literacy and language development rather than mathematics or general domains. Of the 14 curricula, although two content-specific curricula (literacy or numeracy) had significant impacts on language or mathematics skills in their targeted domains, most curricula showed no significant impacts of any of the academic outcomes. In addition, none of the curricula made a positive contribution to the development of social skills.

In summary, high-quality preschool programmes can amplify the possibilities for all children to have a successful start at formal schooling and subsequent school success and beyond. Although the effect of particular curriculum types remains largely inconclusive, it appears that targeting specific skill sets and providing purposeful support in facilitating the targeted content domain is most effective. Variations in the effectiveness of preschool curricula might be due to classroom process quality such as the ways teachers organise and implement activities and interact with children (Mashburn et al., 2008; Yoshikawa, Weiland, & Brooks-Gunn, 2016). As this aspect of preschool quality appears to have a direct impact on children's early experiences, the next section will address classroom process quality with a particular focus of teacher-child interactions.

2.3.1.2 Classroom process quality

One way to evaluate preschool quality is to assess classroom process quality. Classroom process quality refers to the ways in which teachers interact with children in the classroom and appears to be critical for child outcomes (Yoshikawa et al., 2016). The increased use of direct observation measures such as the Early Childhood Environment Rating Scale (ECERS-R; Harms & Clifford, 1980) and the Classroom Assessment Scoring System (CLASS; Pianta, LaParo, & Hamre, 2008) have provided a detailed description of process quality and its contributions to a range of child outcomes.

For example, Mashburn et al. (2008) examined the associations between pre-K quality and development of academic, language, and social skills. Pre-K classroom quality with a particular focus on teachers' effectiveness in providing both emotional support (e.g., teacher sensitivity, autonomy support, mutual respect) and instructional support (e.g., effective feedback, concept development, language modelling) was measured using the CLASS. In addition to classroom interactions, overall features of programme design and infrastructure such as teacher education, class size, and a ratio were assessed against the minimum standards of preschool quality recommended by the National Institute for Early Education Research (NIEER; Barnett, Hustedt, Robin, & Schulman, 2004). Direct assessments were conducted at the beginning and end of pre-K school year to measure academic performance such as preliteracy and prenumeracy. Teachers also rated children's pre and post social skills such as the ability to get along with peers, follow directions, complete a task, and participate in class discussions. Hierarchical regression analyses showed that higher levels of instructional support were significantly associated with increases in vocabulary (B = .69, $p < .05$), understanding of spoken language (B = 1.07, $p < .01$), rhyming (B = .33, $p < .01$), applied problem solving (B = .66, $p < .05$), and letter naming (B = .43, $p < .05$), after controlling for pre-test scores, child and family characteristics, and overall programme quality. While emotional support was not significantly associated with any aspect of academic performance, it was significantly associated with increases in social competence (B = .06, $p < .05$) and decreases in problem behaviours (B = -.05, $p < .01$) at the end of pre-K school year. Somewhat unexpectedly, none of the programme features were associated with measures of children's academic and social learning, but instead the quality of classroom interactions was the strongest and most consistent predictor of children's progress. Other studies demonstrate parallel findings for low-income families. For example, a study by Burchinal, Vandergrift, Pianta, and Mashburn (2010) showed that high levels of emotional support at pre-K entry predicted children's better social competence (B = .09, $p < .05$) and lower behavioural problems (B = -.10, $p < .05$) at the end of the pre-K year, whilst high levels of instructional support at pre-K entry predicted enhanced language (e.g., Expressive language: B = 3.97, $p < .05$) and mathematics skills (B = 8.30, $p < .001$) at the end of the pre-K year. This pattern of associations was carried forward through kindergarten (Curby et al., 2009). A recent meta-analysis of 14 studies (Perlman et al., 2016) that examined the associations between the CLASS and child outcomes also indicated a small yet significant role of organisational support (e.g., provision of effective learning activities, behavioural management, productivity) in enhancing the inhibitory aspect of EF ($r = .06$).

Despite a positive association between classroom process quality and children's improved school outcomes (Table 2.3.1.2-1), only a limited number of classrooms appear to provide high-quality interactions (Bryant, Clifford, & Peisner, 1991; LoCasale-Crouch et al., 2007). For example, LoCasale-Crouch et al. (2007) examined teacher-child interaction quality across 692 pre-K classrooms using the CLASS and associated teacher and programme characteristics. Cluster analyses showed that only about 15% of the classrooms were rated as showing the highest levels of emotional and instructional support, whilst nearly 19% of the classrooms fell at the bottom of the scales and were rated as showing the poorest quality of these instructions. The majority of classrooms were collectively rated as showing mediocre quality. Although there was no significant difference in teacher and programme characteristics (e.g., teacher qualification, class size, child-adult ratio) between the highest and lowest quality classrooms, the poorest quality pool of classrooms had the highest proportions of children living in poverty and lowest levels of maternal education, all of which are known as established risk factors for school difficulties. This suggests that children with

Study	Number of classrooms /studies	CLASS domain (predictor)	Outcome
Mashburn et al. (2008)	N = 671 pre-K classrooms	Emotional Support Instructional Support	• Social competence (B = .06, $p < .05$) • Decreases in problem behaviours (B = .05, $p < .05$) • Vocabulary (B = .69, $p < .05$) • Understanding of spoken language (B = 1.07, $p < .01$) • Rhyming (B = .33, $p < .01$) • Applied problem solving (B = .66, $p < .05$) • Letter naming (B = .43, $p < .05$)
Burchinal et al. (2010)	N = 671 pre-K classrooms	Emotional Support Instructional Support	• Social competence (B = .09, $p < .05$) • Decreases in problem behaviours (B = -.10, $p < .05$) • Expressive language (B = 3.97, $p < .05$) • Reading (B = 5.54, $p < .05$) • Math (B = 8.30, $p < .01$)
Perlman et al. (2016)	N = 14 preschool studies	Organisational Support Instructional Support	• Inhibitory control ($r = .06$) • Social Skills ($r = .09$)

Table 2.3.1.2-1. Summary of the reviewed studies on the associations between the CLASS domains and child outcomes

more disadvantaged family backgrounds who probably need the most support in terms of social and academic learning and who can benefit the most are less likely to have access to the classrooms that offer quality interactions.

Together, these findings have provided evidence that high-quality interactions in classrooms can positively increase school readiness by promoting social-emotional, self-regulatory, and academic skills. The obvious limitation of these correlational studies is that they cannot claim the causal role of classroom quality in enhancing the growth in children's abilities. One observation measure alone cannot possibly capture the multifaceted nature of classrooms where all factors in both the family and school systems, such as parenting and interactions with peers and materials, interactively influence overall school experiences and subsequent performances of the children. In addition to observable interactional styles between teachers and children, teachers' perceptions of the relationships that they share with their students are also an essential part of classroom quality and play a significant role in the ways they interact with children in classrooms. The next section addresses the role of teacher-child relationships.

2.3.1.3 Teacher-child relationships

In the school system of the CSM, the quality of teacher-child relationships is central and has a significant influence on children's healthy cognitive and social-emotional development (Hamre & Pianta, 2001; Pianta, 1999; Pianta & Walsh, 1996; Rudasill & Rimm-Kaufman, 2009). Most learning occurs through social interactions (Zins et al., 2007), which are called proximal processes in the PPCT model. Therefore, social contexts within the school setting, particularly the quality of teacher-child relationships, play a vital role in meeting children's basic psychological needs, thereby shaping children's motivation and self-regulatory skills (Ryan & Deci, 2000). Relevant studies have provided compelling evidence that children with positive teacher relationships characterised by high levels of trust and warmth tend to exhibit better work habits, greater motivation and social-emotional development, and higher academic achievement (e.g., Birch & Ladd, 1997; McCormick, O'Connor, Cappella, & McClowry, 2013; Pianta et al., 2012; Pintrich, 2003; Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008). By contrast, children who experience negative relationships with their teachers characterised by high levels of conflict and overdependency tend to show poorer academic performance and higher internalising and externalising behavioural problems including aggression, truancy, disengagement, and lack of self-regulatory skills (e.g., Berry, 2012; Birch & Ladd, 1997; Hamre & Pianta, 2001; Hughes et al., 2001; Ladd & Burgess, 2001). For example, Pianta and Stuhlman (2004) conducted a longitudinal study involving 490 children and followed these children from preschool through first grade to investigate the impact of teacher-child relationships on the development of children's school readiness skills. Teachers' perceptions of their relationships with individual students were measured each year using the Student-Teacher Relationships Scale (STRS; Pianta, 1992). Teachers rated children's academic achievement, behaviour problems, and social competence skills; kindergarteners and first graders took a battery test measuring their vocabulary skills. Direct observation was also conducted to measure children's social competence such as self-reliance, positive affect, and attention to activities. Child demographics, gender, socioeconomic status, and preschool outcomes were controlled statistically. Regression analyses showed that relationship closeness in preschool was significantly associated with lower levels of teacher-rated internalising behavioural problems in first grade ($\beta = -.10$, $p < .05$) and that higher conflict in kindergarten was significantly associated with higher levels of teacher-rated externalising behavioural problems ($\beta = .12$, $p < .01$) and lower levels of teacher-rated social competence in first grade ($\beta = -.11$, $p < .01$). However, no aspect of direct measurements such as vocabulary and observed social competence was predicted by preschool or kindergarten relationship quality. This indicates a potential limitation of teacher ratings that may bring the risk of subjectivity and bias. Teachers are likely to rate a child's competence based on their perceptions of behavioural orientations, thus it is possible that ratings reflect teachers' experiences or expectation of children's general behaviour rather than independent targeted skills (Abikoff, Courtney, Pelham, & Koplewicz, 1993; Pianta & Stuhlman, 2004). Despite the limitation, the study demonstrates that the impact of relational capacity carries forward through the early years of school and highlights the importance of the interpersonal aspects of children's experience for developing school-related skills.

As the bioecological-contextual model proposes, children are an essential part of the relationship construct and the development of teacher-child relationships is interdependent. This means "teachers influence children and children influence reactions from teachers" (Rudasill & Rimm-Kaufman, 2009, p. 108). Therefore, child factors in relation to students' educational outcomes should be taken into account (Wu, Hughes, & Kwok, 2010). In fact, some characteristics of the child including aggressive and withdrawal behaviour, self-regulatory capacities, and gender have been identified as shaping teachers' perceptions of children's dispositional tendencies, and consequently affecting the teacher-child relationship quality (Eisenhower, Baker, & Blacher, 2007; Hamre & Pianta, 2001; Rudasill & Rimm-Kaufman, 2009). For example, Rudasill and Rimm-Kaufman (2009) examined 819 first grade children and the extent to which individual differences in temperament (shyness, inhibition, and attention) were associated with teachers' perceptions of their relationship quality with the children. The results suggested that parent-reported children's shyness, attention, and gender were correlated with teacher-child conflict at a significant level (r = -.28, r = .27, r = -.13, respectively, $p < .01$); children with greater shyness, lower attentional skills, and boys were more likely to experience a conflictive relationship with teachers. A bidirectional study by Berry (2012) demonstrated that directly measured IC and teacher-child conflict mutually influenced each other across the primary school years. That is, children with lower levels of IC before formal schooling were more likely to experience higher subsequent levels of conflict with their teachers. Likewise, children who had more conflictual relationships with their teachers before formal schooling were more likely to develop lower subsequent levels of IC. Together, these findings indicate that children's developmental trajectories are influenced by reciprocal interactions between child characteristics and relational experiences, supporting the bioecological-contextual model that views child development as dynamic processes.

Considerable evidence also suggests that positive teacher-child relationships operate as protective factors, particularly for behaviourally and academically at-risk children (Baker, 2006; Buyse, Verschueren, Doumen, van Damme, & Maes, 2008; Meehan, Hughes, & Cavell, 2003; Myers & Pianta, 2008; Valiente et al., 2008). For example, in a study of 761 first and second graders who were at academic risk, Liew, Chen, and Hughes (2010) found that children with low EF (e.g., IC) performed similarly well as those with higher EF when paired with a positive and supportive teacher. Moreover, while evidence suggests that the quality of parent-child relationships is a more consistent predictor of child outcomes (NICHD Early Child Care Research Network, 2000; Pianta et al., 1997), the teacher-child relationships may mediate the negative effect of controlling parenting and provide an alternative pathway for academically at-risk children. For example, results from one study indicated that close relationships with teachers characterised by high degrees of warmth and positive emotions appeared to enhance reading competencies for children who experienced more authoritarian parenting at home (Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002). These studies indicate that relational quality is particularly important for children with early academic and/or behavioural vulnerabilities whose family characteristics are indicative of limited social-emotional and affective recourses.

In summary, although child's factors such as temperament and behavioural output largely influence teachers' perceptions of children's dispositional behaviours, thereby affecting the relationship quality (Hamre & Pianta, 2001; Rudasill & Rimm-Kaufman, 2009), the probability of children at risk developing further behavioural and emotional problems is more likely to escalate if not averted. Given its motivational significance and compensatory role, establishing a positive teacher-child relationship in classrooms is essential so that it can provide an emotionally secure base for children with or without developmental vulnerabilities and support their school readiness skills (Pianta, 1999; Baker, Grant, & Morlock, 2008). In addition to the relationship quality at school for a range of child outcomes, relationship quality at home also plays a significant role in the life of a child. The next section will now focus on the role of parent-child relationships as part of the family factors for influencing the development of school readiness and school outcomes.

2.3.2 Family factors

2.3.2.1 Parent-child relationships

As the bioecological-contextual model points out, factors in family systems are of primary importance in determining the successful development of skills necessary for formal schooling. Relationship quality in particular is at the core of the CSM and serves as a foundation for other interpersonal relationships (O'Connor & McCartney, 2007; Pianta et al., 1997). Numerous studies have demonstrated that high-quality parent-child relationships, primarily maternal relationships, support the development of emotional understanding, and cognitive, social and behavioural skills (e.g., Cooke, Stuart-Parrigon, Movahed-Abtahi, Koehn, & Kerns, 2016; NICHD Early Child Care Research Network, 2003; Pianta et al., 1997). In addition to predicting the development of cognitive and social-emotional skills, evidence proposes that quality of parent-child relationships also affects school outcomes. For example, Connell and Prinz (2002) examined the role of parent-child relationships in promoting school readiness for at-risk kindergarten children (N = 47). All the children were African American, and the majority of them lived in low-income, single-mother households. Academic readiness including preliteracy, prenumeracy, and motor ability was measured by teachers using readiness screening tasks, while communication skills and cognitive development as well as receptive communication skills were measured using a developmental battery at the end of the kindergarten school year. Teachers also rated children's social skills including good work habits and cooperation. An observation tool was utilised to rate parent-child interaction across four dimensions such as goal-corrected behaviour, parental control, instructional quality, and affective mutuality. Hierarchical regression analyses showed that although parent-child interaction quality did not predict performance on cognitive development, it was significantly and uniquely associated with higher levels of communication skills ($\beta = .31, p < .05$), social skills ($\beta = .30, p < .05$), and receptive communication skills ($\beta = .45, p < .01$) after controlling for both demographic characteristics and years in childcare. The findings support the positive association between the quality of parent-child relationships and a range of school-related outcomes, especially for at-risk children. However, the small sample size did not provide adequate statistical power to detect other potential effects. The assessment of childcare exposure was also limited to years in childcare and did not account for setting quality including structural and interactional capacity. As the bioecological-contextual model emphasises, both the family and school systems are co-active and interactively influence child development. Therefore, the inclusion of factors in the school systems such as teacher-child relationship quality can lead to better understanding of the association between relational quality and child outcomes. Indeed, a study by Pianta et al. (1997) that incorporated both observed child-mother and child-teacher relationships indicates a dynamic interplay between these relational qualities. The maternal relationships characterised by mutual positive affect and closeness were significantly correlated with positive teacher-child relationships ($r = .27$, $p < .05$), suggesting that children who had positive relationships with their mothers were more likely to form more positive and unconflicted relationships with their teachers. Hierarchical regression analyses also showed that higher quality of mother-child relationships in preschool predicted lower teacher-rated behavioural adjustment ($R^2 = .37$, $p < .05$) and better performance on concept development ($R^2 = .52$, $p < .05$) in kindergarten. On the other hand, when combined with the child-mother relationship, the quality of child-teacher relationships in preschool only predicted higher scores on concept development ($R^2 = .72$, $p < .05$) and did not predict any other school outcomes at the end of the kindergarten school year. These findings suggest that child-mother relationship quality in preschool was a more consistent and stronger predictor of teacher-rated classroom adjustment in kindergarten compared to child-teacher relationship quality.

Parenting styles, which affect the nature of parent-child relationship quality (Darling & Steinberg, 1993), have also been found to be associated with school readiness. Punitive parenting characterised by high levels of control and anger is linked with higher levels of aggression, internalising problems, and lower levels of cooperation and EF (Karreman, Van Tuijl, van Aken, & Deković, 2006), whereas positive parenting characterised by high levels of warmth, consistency and sensitivity is associated with higher levels of persistence, self-regulated behaviours, and academic achievement (Joussemet, Koestner, Lekes, & Landry, 2005; Karreman et al., 2006; Walker & MacPhee, 2011).

In summary, these findings not only emphasise the important role of factors in family systems, in particular the parent-child relationship and parenting styles as building blocks of school readiness skills, but also highlight the dynamic interaction between the school and family systems through which the effects of family factors are transmitted to influence the teacher-child relationship and subsequent school achievement.

2.4 Chapter summary

This chapter reviewed the bioecological-contextual model to better understand the ways that school readiness is promoted and facilitated. School readiness refers to the level of development at which a child is ready for learning and social functioning upon a transition to formal schooling. Extensive evidence exists about the importance of early academic skills for long-term school success, while others also maintain that a broader constellation of skills such as EF and social-emotional skills are equally critical for school readiness and early school success. The bioecological-contextual model suggests that the development of these school readiness skills occurs in an interactive manner within nested systems including the child, family and school. Each system involves multiple factors at different levels, and relations amongst these factors are coactively and reciprocally influencing the child's development. Therefore, child development cannot be determined by a single factor; rather, it is affected by integrative links within and across systems. Converging research has supported the assertion that school readiness skills (including EF, social-emotional skills, and academic competence) mutually influence each other, although the directionality between EF and social-emotional skills remains unclear.

Following the bioecological-contextual model, this chapter also reviewed multiple contextual factors including child factors (e.g., child's school entry skills), school factors (e.g., preschool curriculum, classroom quality, teacher-child relationships), and family factors (e.g., parent-child relationships) that may influence the development of school readiness skills. While high-quality preschool programmes can help form a foundation for children's academic, social-emotional, and behavioural learning, research also underscores the importance of targeting specific aspects of learning and providing high-quality interactions between teachers and children in facilitating children's skill development. In addition to the effective use of curriculum and purposeful teacher-child interactions, relationship quality in both school and home environments also plays a crucial role in promoting school readiness skills. Consistent with the bioecological-contextual model, substantial research has demonstrated that adult-child relationships are bidirectional and multi-determined, with teacher, parent, and child characteristics as well as attributes of social environments serving to affect the quality of this relationship. In other words, teachers' interactional styles and parenting influence children. Likewise, children's behavioural and emotional dispositions mutually influence responses from teachers and parents.

The increasing number of early childhood education settings indicates a growing awareness about the significance of early learning and school readiness. As tens of thousands of children in British Columbia alone, where the current study took place, transition from preschool to kindergarten every year, providing early childhood education with high levels of classroom interactions and relational quality is of primary importance to prepare children for early and long-term school success. The next chapter will present key areas of early childhood curricula including a curriculum framework and different teaching practices, and then review the contents of three preschool programmes included in the current study (Montessori, Reggio Emilia, and BCELF programmes) and their potential role in promoting school readiness skills.

Chapter 3: Early childhood education curricula

Alternative preschool programmes are often distinguished by their particular views of children, specific philosophy and goals, or distinct structure of the programme. As progressive programmes, Montessori education and the Reggio Emilia approach provide strong alternatives to 'business as usual' or 'traditional' play-based programmes and continue to gain global popularity (Cossentino, 2005; Gandini, 2011). Thus, it is of great interest to examine to what extent the respective curricula contributes to the development of school readiness skills. The aim of this chapter is to review Tyler's curriculum model (1949) and to explore the impact of different teaching practices in early childhood education in order to 1) describe the content of three preschool programmes included in the current study; and 2) explore existing studies on the effectiveness of these programmes.

3.1 What is curriculum?

Defining what curriculum is poses challenges at many levels. Challenges include understanding of child development as well as educational goals and values and how to create learning environments that best serve the optimal development (Saracho & Spodek, 2002). Firstly, there is a huge variability in conceptions and understanding of a curriculum amongst educational scholars such that there is no single universally agreed definition (Marsh, 2009). This heterogeneity leads to difficulties in determining curriculum planning, development, implementation, or evaluation (Saracho & Spodek, 2002). Secondly, narrowed definitions that focus on only limited aspects of curriculum can be problematic, especially when they are biased (Marsh, 2009). For example, there has been an intense emphasis on early academic instructions over non-academic skills (e.g., EF, social-emotional skills) in preschool curricula based on a strong pressure by which young children are expected to achieve basic skills and academic standards in order to be ready for formal schooling (Kleeman, Reichenberg, & Shimoni, 2013; Liew, McTigue, & Kattingon, 2010; Selmi, Gallagher, Mora-Flores, 2014). This academic orientation not only undermines emotional well-being, learning attitude, and autonomous motivation but also dampens creative expression (Hirsh-Pasek, Hyson, & Rescorla, 1990). Elkind (1981) also criticised academic pressure on young children as counterintuitive to young children's natural tendency to learn by exploration and experiences. It is not, however, that EF and social-emotional skills should be the only focus in the curriculum development. As a meta-analysis of six longitudinal studies indicates, school-entry attentional capacity ($\beta = .07$, $p < .05$) and early academic skills especially mathematics ($\beta = .33$, $p < .001$) are indeed the strongest predictors of later academic achievement (Duncan et al., 2007). Since mathematics encompasses both conceptual and procedural competencies, a lack of basic mathematical skills can hinder children from understanding and mastering more complex mathematical problems later on (Scarborough, 2001). Similarly, attention difficulties interfere with the attainment of foundational academic skills, which can have adverse effects on subsequent learning in the long term (Rabiner, Carrig, & Dodge, 2016). Therefore, one cannot dismiss the importance of facilitating early cognitive foundation for later school success. Research suggests that academic, EF, and social-emotional competencies appear to be interrelated and complementary to the development of one another (e.g., Blair & Razza, 2007). A combination of these skills is necessary in order to nurture self-directed, competent, and motivated learners; it is also important that a curriculum facilitates the development of these skills by addressing the comprehensive development of the whole child (Diamond, 2010; Liew et al., 2010; Schonert-Reichl & Hymel, 2007). Although there are discrepancies regarding the definition, this study adopts the definition proposed by Ramey & Ramey (1998) and understands curriculum to mean the content and organisation of a school programme that provides activities and learning experiences to promote students' overall well-being including physical, social-emotional, and cognitive development. The next section will focus on Tyler's systematic curriculum model (1949) to conceptually understand what constitutes curriculum.

3.2 Tyler's curriculum model

Tyler (1949) suggested a systematic curriculum model, which advocates distinct objectives and plans in order to precede favourable educational outcomes. According to this model, a curriculum consists of four main dimensions: objectives (e.g., what are the educational purposes?), content (e.g., what educational experiences are provided to achieve the purposes?), methods (e.g., how are the educational experiences organised and delivered?), and evaluation (e.g., how to determine the educational purposes are achieved?). In order to provide guidance for selecting educational purposes, Tyler (1949) emphasised the importance of incorporating 1) learners' needs and interests; and 2) social and communal values in relation to contemporary life. In this curriculum model, 'purposes' are the most critical criteria by which the selection of learning materials, content outline, instructional organisation, and the evaluation procedures are determined. Therefore, educational objectives are the fundamental anchors for changing the thinking, feeling, and behaviours of individuals and lie at the heart of overall planning and the following educational experiences (Lau, 2001).

Tyler (1949) identified three key principles for selecting learning contents or activities. Learning experiences should 1) provide an opportunity to practice the behaviour specified by the educational purposes; 2) meet the physical and/or social needs and developmental levels of the learners; and 3) be flexible to allow teachers' creativity in planning. Tyler also suggested that learning experiences would need to facilitate acquiring functional information, thinking skills, and social attitudes by stimulating learners' interests, as the level of interests is a vehicle for meaningful learning.

Organisation of these learning experiences refers to methods or procedures by which selected learning activities are delivered (Stanley, 2009). Tyler (1949) postulated that activities should be organised in a way that 1) allows repetition to reinforce acquired knowledge; 2) incorporates sequential learning so that preceding knowledge contributes to higher-order learning; and 3) integrates different subject areas so that learning occurs in a horizontal manner rather than in isolation.

Evaluation refers to a process that examines whether developed and organised learning experiences actually produced any changes in behaviour defined by the educational purposes. Tyler (1949) suggested several ways of conducting adequate evaluations including not only questionnaires and paper tests in a pre-and post-test manner but also qualitative measures such as collections of students' work, interviews, and observations for a wide range of social behaviours that cannot be simply captured by paper tests.

Within a framework for the child-centred approaches that underpin most early childhood curricula, the Tyler model, however, is criticised as a top-down system that considers education as merely a means to transmit and disseminate social values and cultural knowledge without accounting for voices of children and teachers (Hlebowitsh, 1995; Wraga, 1998). Children are passive recipients of materials and/or knowledge; and teachers have no autonomy in deciding educational goals and thereby they are both disempowered (Macdonald-Ross, 1975). Tyler (1949), however, placed importance on incorporating students' active and purposeful participation in education, stating that "education is an active process" (p. 11) where interests, concerns, and developmental needs of the students should be the central focus in determining educational activities and their delivery procedures thus learning becomes intrinsic. Teachers' inputs are also valued in the Tyler model, especially when planning and implementing learning activities so that teachers can exercise their creativity (Stanley, 2009). In fact, the Tyler model was generated as a tool to help teachers become more conscious and accountable for their curriculum implementation and improvement (Hlebowitsh, 1992; Wraga, 1998).

Another criticism of the Tyler model concerns the linearity of the four elements being controlling and prescriptive with too much emphasis on educational objectives (Pinar, 1975). Although the Tyler model supports clearly specified educational purposes, it strongly claims that curriculum building is a continuous process in which constant efforts are made in revising and improving any inadequacies in the effectiveness of learning experiences that are identified in the course of evaluations (Hlebowitsh, 1992; Stanley, 2009). Therefore, the model should be treated in an organic and unified way rather than in a step-by-step and mechanical manner (Hlebowitsh, 1992). For example, although some child-centred programmes such as the Reggio Emilia approach do not have a prescribed set of curricula (Hall et al., 2014), these programmes also experience a continuing process of re-planning and redevelopment of the learning activities based on constant reassessments of children's interests and developmental stage in order to attain their proposed educational objectives.

3.3 Early childhood curriculum

Early childhood curriculum is significantly different from that of primary and high school in part because young children experience a rapid growth in social-emotional, physical, and cognitive domains during early years and their learning capacity is largely influenced by the developmental level as well as pace of each individual (Saracho & Spodek, 2002). Therefore, more developmentally appropriate approaches such as child-centred curricula have become more common in early childhood practices (Winsler & Carlton, 2003). The child-centred model is based on a constructivist view that emphasises that learners construct their knowledge through exploration and experiences of their environment (Winsler & Carlton, 2003). Teachers are intended to serve as facilitators by providing open-ended opportunities for learning and peer interactions and incorporating content knowledge into everyday activities while eschewing workbooks and worksheets (Stipek & Byler, 1997). Because the authority of teachers is naturally limited by the positive image of and respect for children, child-centred approaches have been recognised as more positive for young children than adult-centred, didactic instructional approaches for promoting children's development including social and cognitive skills (Kinos, Robertson, Barbour, & Pukk, 2016; Stipek, Feiler, Daniels, & Milburn, 1995). While child-centred approaches value children's ideas and interests as well as opportunities to explore objects and academic topics at their own pace (Lerkkanen et al., 2016; Stipek & Byler, 2004), didactic or teacher-directed approaches are typically characterised by passive forms of instructions of specific academic skills and place more emphasis on teachers' greater control over selecting learning contents. Teacher-directed practices primarily differ from child-centred practices in the amount of teacher dominance, management, and provision of autonomy and social-emotional support (Kikas, Peets, & Hodges, 2014).

3.3.1 Teacher-centred, didactic practices

Didactic teaching is based on behaviourist principles of learning, which suggests that certain basic skills should be taught in a sequential manner toward task mastery, and errors need to be corrected immediately so as to avoid learning wrong responses (Brophy, 1999; Stipek, 2004). In this model, teachers have control over transmitting information directly to students, selecting the learning contents, providing intellectual stimuli, and monitoring students' progress (Austin, 2013), and the focus is on the systematic teaching and acquisition of the academic skills rather than students' autonomous learning (Garrett, 2008; Stipek & Byler, 2004). Although child-centred practices are currently the dominant theoretical perspective and more common than teacher-centred practices in the field of early childhood education (Lerkkanen et al., 2012; Winsler & Carlton, 2003), the benefits of didactic approaches are documented, especially for children from disadvantaged backgrounds who are at risk of school problems.

For example, Stipek (1995) investigated the effects of different teaching approaches on basic skills achievement and motivation amongst 227 poor, minority, and middle-class children ages 4-6 (M = 58 months for preschool; M = 72 months for kindergarten). Nearly half of the children in the sample were economically disadvantaged. Observation was conducted to determine the teaching styles: didactic or child-centred practices. Didactic practices scored high on the academic emphasis (e.g., amount of time spent on academic topics) and low on the social climate (e.g., positive interactions), whereas child-centred practices scored low on the academic emphasis and high on the social climate. Didactic programmes had more children from poor families than in child-centred programmes. Children's achievement on number and letter/reading skills as well as motivation outcomes including expectations for success, enjoyment of school, and learning attitude were measured. Univariate analyses of covariance (ANCOVA) revealed that children in didactic programmes performed significantly better than children in child-centred programmes on their letters/reading achievement ((F = 1, 192) = 16.79, $p < .001$), suggesting that the teacher-directed instructions were more beneficial for raising academic achievement amongst poor, minority children. Although the academic merit of teacher-directed approaches was highlighted, the results also indicated potential detrimental effects of highly structured practices on children's motivational orientations on learning. Compared to children in didactic programmes, in classrooms where teachers offered more autonomous, emotional and instructional support, children perceived themselves more capable ((F = 1, 210) = 11.75, $p < .001$), showed more independence ((F = 4, 209) = 4.13, $p < .01$), were more receptive to challenge ((F = 1, 211) = 5.44, $p < .05$), and showed less anxiety about school ((F = 1, 208) = 10.30, $p < .01$). These results indicate that depicting teacher-directed and child-centred practices as dichotomous might be premature as different teaching practices are better suited for achieving different purposes and serving diverse cultural as well as economic differences (Spitek & Byler, 2004). Some limitations should be mentioned. Firstly, as the researchers pointed out, whether the adverse effects of didactic programmes would persist was unknown. Secondly, as teachers tend to alter their instructional approaches depending on the situational and collective demands (Kikas et al., 2014; Spitek & Byler, 2004), it might be possible that teachers in classrooms where children exhibited lower motivational orientations deliberately placed more emphasis on didactic teaching to meet the needs of students.

In a recent study, Kikas et al. (2014) examined the extent to which child-centred, teacher-directed teaching, and child-dominated practices had an impact on the development of academic skills and task persistence amongst 523 children for the first two years in Estonian primary schools. Children's mathematics (e.g., facts, procedures) and reading (e.g., comprehension, spelling) achievement as well as teacher ratings on students' task persistence were collected at the beginning of the first grade and the end of the second grade. Teacher behaviour was also rated based on three dimensions: child-centred, teacher-directed, and child-dominated practices. Observation items included teacher provision of classroom management, choice of activities, support for interpersonal skills and autonomy, and academic instruction. Although the results from the multi-level modelling did not show either child-centred or teacher-directed practices predicted academic achievement, variability in the benefits of different teaching practices was revealed depending on the collective starting point of students. For example, child-centred approaches were most beneficial for increasing task persistence in classrooms where many children exhibited higher initial levels of task persistence ($\beta = .24$, $p < .05$); however, this teaching approach was significantly associated with a decrease in task performance in classrooms where initial class-average task persistence was low. Unfavourable effects of child-dominated practices where children made most of the choices were found. In classrooms where teachers offered little to minimal support and put too much emphasis on free choice, children with low initial mathematics skills were significantly less likely to develop subsequent mathematics ($\beta = -.83$, $p < .05$), spelling ($\beta = -.85$, $p < .05$), and task persistence ($\beta = -.28$, $p < .01$) at the end of second grade. Conversely, teacher-directed practices were most beneficial for increasing task persistence in classrooms where initial class-average task persistence was low; however, the emphasis on a teacher-directed approach was marginally significantly associated with decrease in task persistence in classrooms where initial class-average mathematics skills were high ($\beta = -.21$, $p = .08$). These results postulate that child-centred practices work more effectively for highly persistent children, whereas teacher-directed practices work more favourably for children who have difficulties staying focused on tasks. Kikas et al. (2014) also suggest a potential damage of child-dominated practices for the development of academic and learning skills, especially for those who have lower skill sets, as these children are not likely to be equipped with necessary executive control skills to make use of excessive autonomy or freedom.

These results point to a critical implication: teaching practices need to pay more attention to children's collective and possibly individual characteristics, as the same teaching practices can positively and adversely affect developmental outcomes of the children. It should be noted, however, that the average class size in the sample was quite small (N = 16). The associations between smaller class sizes and educational consequences such as academic attainment and student behaviour have been previously demonstrated (e.g., Blatchford, Goldstein, Martin, & Browne, 2002; Blatchford, Goldstein, Bassett, & Martin, 2003). Therefore, it might be possible that the nature of small class sizes in the study by Kikas et al. allowed teachers to be naturally more attentive to the needs of the students even in a more teacher-oriented classroom, thereby contributing to the optimal development of the children.

As shown, these studies have found teacher-centred approaches to be as effective as child-centred practices in improving children's academic achievement in particular; however, the long-term benefits seem to be limited in reducing social problems such as delinquency and criminal acts (Schweinhart & Weikart, 1988). In addition, teacher-centred approaches have negative impacts on learning motivation (Lerkkanen et al., 2012; Stipek et al., 1995) as well as other social development (Valeski & Stipek, 2001). Within teacher-centred learning, the learning is predominantly driven by achieving academic standards, which in turn creates a strong dependency on standardised assessments (Schweinhart & Weikart, 1988). Since the teacher is the solo leader in the classroom, authority is more important than children's initiatives (Garrett, 2008). In order to maintain teachers' control, children's compliance and passive attitudes tend to be valued over active learning (Freiberg, 1999). This contrasts with the contextualisation of child-centred approaches where students' active participation and initiatives are of central importance for the learning process. Consequently, there has been a gradual shift in the teaching paradigm from being highly structured, teacher-directed instructional approaches to more developmentally appropriate, child-centred approaches, especially in early childhood curricula (Winsler & Carlton, 2003).

3.3.2 Piaget's and Vygotsky's developmental theories underpinning child-centred approach

The concept of child-centred education is largely influenced by Piaget's cognitive constructivist theory and Vygotsky's social constructivist theory (Tzuo, 2007). Although both theories agree that individuals construct knowledge and actively engage in meaning-making, Piaget and Vygostky fundamentally differ in their views concerning how this construction process takes place. For the Piagetian view, the knowledge construction is predominantly an individual process based upon previous knowledge and experiences;

learning takes place through interactions with the environment (Lourenço & Machado, 1996; Tzuo, 2007). Piaget's theory has been substantively criticised for its perceived neglect of social factors, although the Piagetian view, like Vygotsky, also values the importance of the social world in knowledge construction and considers social interactions as embedded in the cognitive structure (Lourenço & Machado, 1996; Piaget, 1975). From the Vygostky perspective, learning is an interactive process such that both the social world and individuals are essential part of the knowledge construction (Tzuo, 2007). The fundamental difference lies in the direction of an impact of the social interaction and whether the social context overweighs the individual or vice versa (Dockett & Perry, 1996). Knowledge is created by the individual through experience and then tested and polished through social interactions in the Piagetian view, whereas knowledge is mainly constructed as a result of social structures and relationships that embody the cultural heritage without which learning does not occur in the Vygotskian view (Cole & Wertsch, 1996; Dockett & Perry, 1996).

Another fundamental difference lies in their views on developmental growth. Piaget focused on fixed stages of cognitive development, whereas Vygotsky considered development as more fluid and flexible (Blake & Pope, 2008). Piaget's stage theory proposes that cognitive development undergoes a continuous transformation throughout the varying stages and all people pass through each stage, although there are significant individual differences in the developmental levels and rate depending on maturity, experience, and cultural mediation (Papalia & Olds, 1996; Ojose, 2008). Vygotsky's theory suggests that the upper boundary of learning is determined by the zone of proximal development (ZPD), which is an imaginary gap between what learners can do independently without help and what they can potentially accomplish with assistance from more capable adults or peers (Winsler, 2003; Blake & Pope, 2008). Therefore, social forces such as collaborative learning and scaffolding are a primal source in the learning process (Dockett & Perry, 1996; Vianna & Stetsenko, 2006).

Both similarities and differences between Piagetian and Vygotskian theories have provided a theoretical foundation for understanding children's development and learning, locating teachers' roles, and setting up learning environments, thereby contributing to the discourse of child-centredness (Tzuo, 2007). One of the educational implications of Piaget's theory is that individual children might be operating at different stages of cognitive development and their environment plays a critical role to assist development (Ojose, 2008). Accordingly, the teachers' role should be to observe and understand the varying developmental levels of each child so that instructional approaches can be adjusted accordingly. Classrooms guided by the Piagetian view also promote children's autonomy and freedom of choice by which children explore hands-on, manipulatives in a carefully prepared environment (DeVries, 2000). On the other hand, classrooms guided by the Vygotskian view value a balance between active teaching and learner-centred activities (Tzuo, 2007) and promote group collaboration, cross-age tutoring, and assisted learning with the help of teachers who utilise effective scaffolding so that children can reach the upper level of ZDP (Blake & Pope, 2008). Another implication of Vygotsky's view is to pay sufficient attention to cultural values and context in the classroom. Therefore, teachers are required to be more sensitive to how cultural biases can impact the nature of their interactions with children, and their role should be to incorporate activities that correspond with cultural diversity, especially to support children from various social and cultural backgrounds (Brown & Lan, 2015).

3.3.4 Benefits of child-centred approaches

The benefits of child-centred approaches have been documented in different studies (e.g., Perry, Donohue, & Weinstein, 2007; Lerkkanen et al., 2016). For example, Lerkkanen et al. (2016) compared the effects of child-centred and teacher-directed teaching practices on first grade children's reading and mathematics skills in Finland. The reading and mathematics skills of 1132 Finnish children (M = 85.77 months old, SD = 3.44 months) were measured at the beginning and the end of first grade. Classroom observation was conducted to assess the percentage of time teachers spent on child-directed and teacher-centred approaches in three main areas: instruction (e.g., teaching concepts, instructional conversations), management (e.g., choice of activities, child responsibility), and social climate (e.g., support for interpersonal skills). The results showed that a higher level of child-centred approaches was associated with higher pre-reading skills and predicted better development of reading (B = 1.20, $p < .01$) and mathematical skills (B = .77, $p < .01$). Conversely, teacher-directed approaches were strongly and negatively associated with the development of reading skills, particularly amongst children with higher initial reading skills (B = -.93, $p < .05$). The findings highlighted the benefits of a child-centred approach where teachers were sensitive to individual interests and pre-existing skill levels. However, it is worth mentioning that the Finnish educational system is typically learner-centred in nature and children are encouraged to actively participate in educational planning and take increased responsibility for their own learning (OECD, 2010). In addition, teachers in Finland are generally better trained and well qualified compared to teachers in other developed countries (OECD, 2010; Sahlberg, 2007). As a result, it could be that the teachers in the study had better understanding of child-centredness and were better equipped to effectively implement developmentally appropriate practices, which then contributed to positive development of basic academic skills amongst young children. Therefore, the findings might be unique to the Finnish population and generalisability is diminished.

In a similar vein, Perry et al. (2007) examined the effects of different teaching practices in promoting children's academic, behavioural, and social-emotional adjustment amongst 257 first grade children in the US. Children's competencies were assessed at the beginning and end of the school year, using direct academic assessments and behavioural ratings. In exploring academic achievement at the end of the school year, a regression model was employed in which teaching practices were utilised as predictors of the percentage of children who met grade-level achievement standards. The analyses revealed that child-centred practices accounted for approximately 30% of the variance of reading fluency standard ($\beta = .58$, $p < .05$) and 24% of the variance of the mathematics standard ($\beta = .49$, $p < .05$). This indicates that in more child-centred classrooms, a higher percentage of children ended the school year with better academic skills. With regard to interpersonal (e.g., positive socialisation) and intrapersonal (e.g., child affect) behaviour, child-centred practices accounted for approximately 23% and 29% of the variances respectively at a significant level, indicating that children in more child-centred classrooms exhibited more positive behavioural characteristics. The results showed that classrooms where teachers placed greater emphasis on instructional and social-emotional support by attending to children's needs and initiative and establishing a socially supportive environment had a positive impact not only on children's academic skills but also on their behavioural development. It should be mentioned, however, that the conceptualisation of child-centred practices in the study took on more of a social-constructivist view in which teachers' active role was emphasised. In fact, the observation measure used in the study predominately focused on teachers' behaviour in providing effective lessons and opportunities for socialisation in mostly whole group settings and thus little attention was paid to individual child's agency and autonomy. Hence, it may be that the positive findings were attributed to teacher effectiveness in offering instructional and social-emotional support rather than the actual benefits of child-initiated activities.

3.3.5 Difficulties with child-centred approaches

While research generally supports the benefits of child-centred practices for young children in promoting academic and social development, there are shortcomings in developmentally appropriate, child-centred education. Firstly, teachers often lack nuanced understanding about what developmentally appropriate approaches entail and hold misconceptions about their roles (Parker & Neuharth-Pritchett, 2006; Tzuo, 2007). Although the fundamental notion of developmentally appropriate practices is based on a belief that instructional time, learning environment, and educational activities need to correspond to developmental levels and the needs of children, interpretations of what is and what is not suitable for young children have not reached a consensus (Dickinson, 2002). The term 'developmental appropriateness' has been erroneously understood to mean that teachers should refrain from directly teaching children or focusing on subject knowledge despite evidence to the contrary (Dickinson, 2002), and the concept has also become synonymous with free choice and free play in a more child-dominated approach (Hatch et al., 2002; Wood, 2014). In child-dominated classrooms, children generally make decisions and direct most of their own daily activities (Stipek & Byler, 2004). Teachers remain passive and only interact with children when necessary; their roles focus more on ensuring a certain level of order in classrooms rather than actively responding to children (Kikas et al., 2014; Taimalu, Kikas, Hinn, & Niilo, 2010). As a result, teachers are prone to making 'early childhood error' when they step too far back and fail to provide appropriate guidance and support (Bredekamp & Rosegrant, 1992), which in turn interferes with academic and motivational development (Kikas et al., 2014). For example, Winsler and Carlton (2003) investigated this potential early childhood error in preschools by comparing teachers' perceptions on what was happening in the classrooms to the observable classroom activities. Participants included 28 preschool children with predominately Caucasian background (M = 45.4 months, SD = 4.5) and two teachers with more than 10 years of early childhood teaching experience. Teachers were interviewed regarding their perceptions of classroom activities and child behaviour. Naturalistic observation was conducted over a 10-week period, which focused on five different areas: goal-oriented activity, sustained focus, social context (e.g., solitary or with others), behaviour (e.g., appropriate or aggressive), and affect (e.g., positive, neutral, or negative). The results suggested that both teachers believed in learning through exploration and endorsed the idea of developmentally appropriate practices that would respond to children's interests by providing concrete experiences for children. They also perceived that children were engaged in goal-directed and sustained activities most of the times and that children expressed an overall high percentage of positive affect all day. Contrary to the beliefs and perceptions of the teachers, observation revealed that children 1) spent significantly less time on goal-directed and sustained learning activities; 2) had significantly less one-on-one time with their teachers; and 3) expressed significantly less positive affect than the teachers had anticipated. The most noticeable finding was that teachers rarely interacted with children individually (average 5.3% of 1301 observations). The absence of one-on-one teacher-child interactions was more evident, especially for four-year-olds who spent 0% of their time with their teachers alone, although these children were observed to interact with their peers (40% of observations). The limitations should be addressed, however. The major weakness of this study is its small sample size. Only two teachers participated in the study and thus generalisability is limited. Another limitation is that the study did not employ any standardised measures of developmentally appropriate practice, and thereby the results are not comparable with other studies. In addition, although the results highlighted that there were significant disparities between teachers' perceptions and child activity, optimum percentage of time that would be 'appropriate' was ambiguous and unknown. Therefore, it is difficult to determine whether the classrooms in the sample were actually making the so-called early childhood education error or not. Nonetheless, Winsler and Carlton (2003) noted that these results confirmed the general concern regarding the lack of teacher-child interactions and a strong reliance on the assumptions that children would naturally construct meaningful activities without any guidance from their teachers in many early childhood programmes.

Despite teachers' self-perceived ideas about what classroom experiences they are providing for children, the actual classroom practices might be failing to meet the goals and expectations of developmentally appropriate education, partly because of a lack of consensus and confusion around appropriateness. The reported discrepancy between teachers' beliefs and actual implementation has been also documented in other studies (e.g., Charlesworth, Hart, Burts, & Hernandez, 1991; Stipek & Byler, 1997; McMullen et al., 2006; Wen, Elicker, & McMullen, 2011). For example, Wilcox-Herzog (2002) compared the self-reported teaching beliefs of early childhood educators (N = 47) in the US and their actual classroom practices. Teachers completed a self-report questionnaire concerning teacher sensitivity, teacher play style, verbalisation, and involvement. Following the same construct as the questionnaire, observation was conducted to assess teaching behaviours. The results suggested that although most of the teachers believed in the developmentally appropriate practice and perceived themselves as capable of putting their beliefs into actions, the intercorrelations showed no statistically significant relationships between teachers' beliefs and their classroom behaviours (r = -.07 to .19). Linear regression analyses also revealed that teacher beliefs were negative predictors of teacher sensitivity (β = -.13), play style (β = -.02), verbalisation (β = -.17), and involvement (β = -.23), although not statistically significant. It should be mentioned that the sample size was small such that the study might be underpowered to detect the true difference. Teachers in the sample also differed in their teaching training/certification and thereby there may have been an inconsistency in their domain-specific knowledge about how to provide appropriate developmental, child-centred education. A similar finding was obtained in a study by Wen et al. (2011) in which although all of the preschool teachers (N = 57) expressed their endorsement on child-centred learning, these teachers employed a relatively high frequency of teacher-directed behaviours.

Several reasons stemming from emotional, contextual, and educational factors could be contributing to this disconnect between teachers' beliefs and behavioural manifestation. Firstly, teachers' self-efficacy has a significant influence on their teaching practices (McMullen, 1999; Weber & Omotani, 1994). Teachers with low personal self-efficacy who do not believe that they can enhance students' learning and performance tend to be more authoritative and have difficulties in promoting students' task persistence, whereas teachers with a strong sense of personal self-efficacy who believe that they can positively affect student learning achievement are more likely to exhibit greater instructional skills (Ashton & Webb, 1986). Teaching involves a psychologically demanding process and their beliefs about their own ability and education play a critical role in creating a learning environment that promotes students' productivity and motivation (Rimm-Kaufman & Sawyer, 2004). Secondly, educational backgrounds and training also influence the implementation of developmentally appropriate practices (McMullen, 1999). Research shows that when teachers have varied training and educational levels, those who do not have specialised early childhood training are less likely to be engaged in spending time with children and providing verbal interactions (Wilcox-Herzog, 2002). In addition, it is suggested that when teachers are trained within a stronger theoretical framework or educational philosophy such as Montessori, there will be less incongruency between teachers' beliefs and their classroom behaviours (Wing, 1989). Lastly, situational barriers might interfere with the degree of alignment between teachers' beliefs and practices. The core principles of the child-centred approach can be in conflict with the ideas of parents who often value academic ability over social goals (Barbarin et al., 2008). Consequently, teachers experience pressure from these parents to prepare children academically for formal schooling (Stipek & Byler, 1997). If contextual characteristics such as school philosophy, parental expectations, teacher training, policy framework, and cultural values do not adequately support the implementation of child-centred education, it is likely that teachers may not be able to practise what they believe regardless of self-efficacy in teaching and educational background (Wen et al., 2011).

One of the major weaknesses of the established child-centred framework is that it predominantly focuses on activities espoused from children's interests rather than educational outcomes and thereby often disdains the attainment of desirable basic skills and understanding (Darling, 1994; Wood, 2007). Consequently, there is a possibility that children may not be actually learning in child-centred education, especially through free play and free choice where teacher support or guidance is minimal (Wood, 2007). Although there is a presumed idea about play that naturally reveals children's interests, Wood (2007) points out that expressing interests does not equate to making meaningful connections and whether educators have the capacity to recognise and respond to these interests determines the quality of learning. For example, whilst playing with a sandbox may provoke children's interests and encourage learning-relevant processes, it is unlikely that children naturally investigate and discover the concepts of mass, volume, and density without educative stimuli and assistance (Wood, 2007). Johnston and Buzzelli (2008) support this view claiming that children will not obtain educational goals without adequate help of teachers. These claims highlight the difficulty in achieving equilibrium between responding to and stimulating children's interest in the child-centred approach, especially in relation to play (Wood, 2007). The ideology of free choice and free play is also problematic from a collective perspective because having routines and rules is a regular part of social order and participating in organised activities is often expected in formal schooling (Markström & Halldén, 2009). More attention should be paid to better articulate what social values are appropriate for young children, what forms of knowledge children can construct by themselves through self-initiated activities such as free play, and how to integrate personal knowledge into subjects so as to achieve appropriate learning progression (Wood, 2007).

In summary, findings from the body of literature that focuses on the effect of different teaching practices on children's outcomes appear to be inconclusive and content-dependent.

The real struggle appears to lie in finding a delicate balance between teacher-directed and child-centred activities in which teachers effectively promote and accommodate children's initiation and autonomy into activities while learning contents are collaboratively negotiated between teachers and children so that learning opportunities as well as motivation are maxmised (Winsler & Carlton, 2003). Discrepancies between teachers' curriculum beliefs and their actual behaviour also suggest practical difficulties in the effective implementation of child-centred approaches. Dissatisfaction with pure child-centred or teacher-directed teaching practices has led to seeking a more progressive curriculum where teacher-planned and child-centred dynamics are well balanced.

3.3.6 Progressive practices

In order to find the "happy medium" (Winsler & Carlton, 2003, p. 156) and avoid the early childhood error, both Piaget's and Vygotsky's theories can be integrated into classroom practices. Reflected by both theories, schooling needs to function as a place that respects children's unfolding natural development and provides an enriching experience in a social and cultural context (Berk & Winsler, 1995). Kinos et al. (2016) frame it as child-initiated practices whilst Tzou (2007) reconceptualises this integrated, progressive model as high teacher control-high children's freedom. These seemingly contrasting terms such as freedom and control might pose a question concerning how child autonomy and freedom can be nurtured whilst teacher control is still present (Tzou, 2007) and whether child-initiated practices may lead to chaos or even neglect (Kinos et al., 2016). The integrated model, however, does not suggest a teacher control versus child freedom structure; neither of them should be dominant (Tzou, 2007). It also does not propose that children take complete control while teachers remain inactive in child-initiated practices (Kinos et al., 2016). Rather, it is a responsive approach where teachers take an active role in providing instructional and emotional support that is sensitive to children's needs and interests (Lerkkanen et al., 2012). Both children's individual characteristics and an increased, more active role of teachers play a part in optimal development and learning (Tzou, 2007; Winsler & Carlton, 2003). In such classrooms, child freedom and teacher direction coexist and continually interact with one another (Lerkkanen et al., 2012; Tzou, 2007). This means that children have freedom to engage in self-directed activity and self-determined learning at their own pace whilst they are also accountable for their own actions (Duffy & Duffy, 2012; Winsler & Carlton, 2003). On the other hand, teachers pay sufficient attention to the developmental and sociocultural needs of children and then provide guidance and opportunities accordingly so that children can attain a higher level of zone of proximal development (Tzou, 2007; Winsler & Carlton, 2003). Dewey (1998) eloquently describes the core principles of the integrated, progressive approach:

> Building the idea of individualist development instead of the idea of top-down forcing; embracing behavioural freedom (democracy) as opposed to practice external discipline; practicing active education instead of passive learning from teachers and texts; embracing the thought of learning to use skills and techniques as a means to achieve one's goal instead of isolated learning by practice; taking advantage of the current opportunities and benefiting from these in the best way possible, thus becoming acquainted with an ever changing world (societal needs), rather than focusing on stationary goals while preparing for a distant future. (pp. 22-23)

One of these progressive approaches is Montessori education (Tzou, 2007). The pedagogical approach in Montessori classrooms is one of self-directed learning to support children's autonomy and independence. Children learn in an organised, well-prepared environment with a high degree of choice and control over their daily activities, and they are encouraged to think and act on their own (Edwards, 2006; Lillard, 2005). Teachers provide developmentally appropriate and individualised lessons based on intensive and continuous observation of child behaviour. Another practice that holds the idea of the integrated model is the Reggio Emilia approach (Kinos et al., 2016). The guiding tenet of the Reggio Emilia approach is the co-construction of learning experiences between children, adults and the environment where democratic participation between children and adults is a critical aspect of everyday activity (Kinos et al., 2016; Valentine, 1999).

The current study included Montessori education and the Reggio Emilia approach along with a traditional play-based programme. In addition to the four components of the Tyler model (educational objectives, learning areas, methods, and evaluations), educational values will be discussed. Educational values are beliefs or dispositions that shape specific educational aims and structures of a curriculum (Le Métais, 1997). An overview of three curricula included in the study (Montessori, Reggio Emilia, and BCELF programmes) will be highlighted in the following sections.

3.4 Three preschool programmes included in the current study

3.4.1 Montessori education

a) Educational values and objectives

Montessori education is an alternative school curriculum developed by Dr. Maria Montessori, who was Italy's first female physician, over 100 years ago (Lillard, 2005). Montessori programmes are globally popular and active in more than 4000 schools in the US alone (Cossentino, 2005). The child is situated at the heart of Montessori education; each child is a unique individual whose needs are different from those of adults. Children are seen as having an innate desire for learning, freedom of action, and functional independence (Montessori, 1973). This is closely aligned with the notion of Piaget's cognitive constructivism (Elkind, 1967), which encourages children to actively participate in their own education so that they become self-directed and responsible for their own learning and, by extension, responsible members of society. Like Piaget, Montessori viewed development as a series of six-year periods, each of which possesses specific characteristics forming its foundation for the next phase, and personality undergoes significant changes at each stage as if a child is reborn (Montessori, 1967a). According to Montessori, "education should not limit itself to seeking new methods for a mostly arid transmission of knowledge: its aim must be to give the necessary aid to human development" (1973, p. 84).

Montessori education believes that the child is a cosmic agent of change for the world, and thus recognising the power of a child who is the common denominator for bringing humanity together is necessary (Montessori, 1966; Stephenson, 2013). This Montessori view of cosmology is called '*cosmic education*' in which individual action has an impact on larger chains of activity (Cossentino, 2005), and the ability to take part in a social organisation is fundamental for moral construction and cultural understanding (Montessori, 1973). In order to achieve the betterment of the community, Montessori education is a comprehensive approach aiming at developing the whole child with a strong emphasis on the cardinal virtues of concentration, coordination, independence, care for self and others as well as the learning environment, and integration of mind with body (Cossentino, 2005; Lillard, 2011).

b) Learning areas

Learning activities in Montessori classrooms are grouped into different subject areas including Practical Life, Sensorial, Language, and Mathematics (Montessori, 1967a). For example, Practical Life exercises are the activities of everyday life such as washing, polishing, cleaning, sewing, food preparation, and watering plants, all of which prepare children for later activities and to function more self-sufficiently (Saracho & Spodek, 2009). The exercises are carried out with real objects such as vegetables and fruits, glass jars, and polishes in a real rather than make-believe setting (Standing, 1998). Montessori emphasised that only meaningful activities with real objects could help engage the mind in the movement and thereby contribute to developing attentional skills and concentration (Montessori, 1967a). Grace and courtesy lessons are also a significant part of the Practical Life exercises in Montessori classrooms to demonstrate appropriate social behaviours and manners (Standing, 1998; Lillard, 2005). These lessons include how to open and shut a door quietly; how to carry a material; how to approach peers and teachers politely; how to greet gracefully; how to hand sharp objects to others, how to groom themselves; how to serve food; and so on. These lessons are spontaneous and indicative rather than scripted and forceful so that children can observe communally accepted behaviour and choose to do it voluntarily (Standing, 1998).

Sensorial activities are designed to help children understand abstract ideas more easily and precisely (Standing, 1998) and to refine their senses including vision, hearing, taste, smell and touch through the interactions with the sensorial materials (Lillard, 2005). Lillard (2005) points out that the senses are educated "in the context of making perceptual judgments while acting on the environment" (p. 57). As such, Sensorial activities also play an important role in assisting the development of concentration and ability to make judgments in purposeful movement (Lillard, 2005).

Language activities are grouped into oral language, written language, reading, and writing. Expressive language is a vital tool for the expression of a child's intelligence (Montessori, 1967a). Therefore, the acquisition of spoken language is encouraged from early on through a wide range of activities such as songs, poems, and stories (Standing, 1998). Enrichment of vocabulary is also cultivated through classified cards (e.g., items in the kitchen, different transportation means), related language for sensorial concepts (e.g., small, thin, rough), and names of items in an activity (e.g., sponge, cotton balls, jug).

Parallel to other curricular areas, mathematical activities are also introduced from early on through interactions with specially designed didactic materials that are physical representations of numbers and math concepts (Lillard, 2005). Children use these materials consistently over a long period of time while teachers sequentially introduce materials from highly transparent to more abstract representations. As children get older, instructions become more explicit to explain a relation between the manipulative and the underlying math concept (Laski, Jor'dan, Daoust, & Murray, 2015). Mathematical activities include learning numeric symbols and quantity, counting, fractions, and decimal system operations such as addition, subtraction, multiplication, and division.

c) Methods

Child-directed learning. The pedagogical approach in Montessori classrooms is one of self-directed learning to support children's autonomous and independent learning (Lillard, 2011). Although Maria Montessori's idea of child-centeredness has been criticised as being too restrictive (Duckworth, 2006; Tzou, 2007), there is a delicate balance between teacher control and student autonomy in the Montessori system. Teachers provide individual and/or small group lessons across different learning areas based on systematic observation and dialogue with children while children choose their daily activities (Lillard, 2005). This freedom of choice based on individual personal interests is central to the Montessori principle of self-directed learning, which is more likely to develop deep concentration and optimal cognitive and emotional functioning (Lillard, 2005). Although children have a high degree of freedom, − in deciding what to work on, when to finish their work, and who they want to work with − this does not mean total freedom. Lillard (2005) refers to three constitutional limitations on choices in Montessori classrooms so that children can learn how to make constructive and self-regulated decisions. Firstly, children can only choose the materials that have been shown to them. Teachers only present materials that are developmentally appropriate to individual or group of children, thus children have a limited choice in a type of activity they can choose from. Secondly, there is only one set of each material in the classroom. By reducing the number of materials, children quickly learn to share limited resources and are likely to observe others who are using the desired material. Lastly, there is an expectation in the classroom that the choice has to be made based on a constructive use of the materials and a respect for the community. In other words, children are guided to think what works for the collective benefits not just for themselves. In Montessori, the freedom of choice is accompanied by responsibility for self and others. Thus, although teachers normally do not disturb children who are focused and engaged in self-directed, constructive work, teachers are required to intervene when children's misbehaviour is not serving the interest of the group.

Role of the teacher. Montessori (1967b) proposed three stages of teacher preparation. In the first stage, teachers need to prepare and organise a stimulating learning environment that meets the needs and interests of the children. Teachers must prepare a classroom where it becomes a place of comfort and peace while also aesthetically pleasing with its cleanliness and order (Montessori, 1967b). Instead of imparting knowledge, the role of the teacher is that of a facilitator who connects children to the learning environment and brings children into close contact with reality by providing appropriate lessons based on a belief that curiosities and sensitivities of individual children will guide the learning process and reveal what is necessary for achieving functional independence (Edwards, 2002; Lillard, 2005). Through systematic observation, teachers interpret developmental needs and individual interests of the children and modify the environment accordingly. As such, Montessori teachers are the custodians of the environment and the dynamic link between the children and the learning environment and thereby a part of the environment.

In the second stage, teachers must act lively to encourage children to an activity and amuse them. Teachers can interest the children by various exercises including storytelling, singing, games, rhymes, and poetry. Before children develop concentration, teachers are required to intervene without the use of rewards or punishments if a child's behaviour is not constructive or his/her actions disturb the work of other children. This is because prefatory praise and correction at the wrong time undermines the process of learning (Lillard, 2005): "Interfere by all means to stop disturbances, but we need not punish or scold or admonish when we stop bad behaviour" (Montessori, 1989, p. 16). Therefore, Montessori's strong emphasis on promoting child independence from adults does not mean that the role of teachers is diminished or teachers remain passive. Teachers respect children's independence and focus on providing necessary support in constructing productive work while setting clear boundaries so that children can develop confidence and inner discipline (Edwards, 2002; Tzuo, 2007).

In the third stage, teachers must be mindful not to interfere with children's activities when children are engaged in deeper levels of focus and have developed a stronger sense of responsibility towards themselves and others (Lillard, 2005). The teacher's role at this stage is to present new material. The presentation of a new activity should not be imposed on children but should instead be natural and spontaneous. In order to respond to children, an ability to observe and interpret the needs of individual children is fundamental. In doing so, teachers must guide children to act and think for themselves and to acquire functional independence by being self-sufficient.

The manipulative materials. Laski et al. (2015) identified four principles for the effective use of manipulative materials that Montessori education naturally exemplifies, particularly in relation to mathematics: 1) use a manipulative over an extended period of time; 2) move gradually from concrete to more abstract representations; 3) choose manipulatives that do not have irrelevant characteristics; and 4) provide explicit explanations for the relation between the manipulative and the mathematics concept. Firstly, the repeated use of manipulative materials helps children forge a link between the physical material and the underlying concept of mathematics, which then leads to deeper understanding (Martin, 2009). As it is already a challenge for young children to correctly understand the relation between a symbol and its referent, repeated experience is essential to effectively utilise symbols for more sophisticated reasoning such as problem solving (DeLoache, Peralta de Mendoza, & Anderson, 1999). Montessori classrooms usually consist of three-year multi-age grouping. This multi-year time frame provides ample opportunities for children to repeatedly use the same or similar manipulative materials that gradually increase in difficulty.

Secondly, a high degree in transparency of concrete representations is essential to help children make a connection between materials and the concepts. Although concrete representations are vital as an initial introduction to the concepts, research suggests that instructions need to gradually progress from concrete-to-abstract representations in order to enhance knowledge transfer in the long run (McNeil & Fyfe, 2012). This idea of "concrete fading" (McNeil & Fyfe, 2012, p. 441) is embedded in the Montessori instructions and materials. In the Montessori classrooms, children progress in a sequential manner from concrete materials with a high degree of transparency to advanced materials with more abstract instantiations over a three-year period.

Thirdly, simple and basic manipulative materials without irrelevant references have been shown to be most effective for mathematics learning such as word problems. On the contrary, manipulatives that resemble real objects such as money or stuffed animals can potentially interfere with mathematics learning. McNeil, Uttal, Jarvin, and Sternberg (2009) postulate that these resembling objects may be distractive for learning and lead children to extracting ideas that are unrelated to the underlying mathematical concepts. Montessori mathematical materials are simple and do not resemble everyday objects. Like Sensorial materials, particular quality (e.g., quantity, length) is isolated so that manipulative materials do not give irrelevant perceptual impressions. This simplicity that avoids perceptual confusion, in turn, helps children focus more on the relevant attributes and promotes mathematics learning.

Lastly, manipulatives alone might not be sufficient for children to spontaneously make a meaningful connection between the material and the mathematics concept unless it is accompanied by explicit instructional guidance (Ball, 1992; Carbonneau, Marley, & Selig, 2013). Ball (1992) argues that a constructivist view of manipulatives is unrealistic for knowledge transfer, although tactile experiences can promote perceptual impression and thinking. A type of instructional guidance can be provided verbally or using gestures to direct children's attention to the link between the concrete and symbolic representation (Singer & Goldin-Meadow, 2005). In the Montessori approach, both gestures and language are used to point out the relevant features of the didactic materials helping children understand basic concepts such as place-value as well as more advanced mathematical operations.

Environment. Montessori prepared environments are designed to provide children with a place where their developmental needs are nurtured and they can experience independence, responsibility, and freedom of choice while feeling a sense of belonging to a community (Leonard, 2015). As such, preparing Montessori environments follows key principles of order, beauty, and social development. Firstly, Montessori classrooms are orderly with child-sized, light furniture and objects, all of which help facilitate the child's sense of order and independent actions without the help of adults (Lillard, 2005). Materials are organised and displayed on low shelves within each subject area in a logical manner; each material has its own place. Children can freely take out the material of their own choice and may use it as long as the material holds their interest. Children are responsible for returning the material to the original place in the condition that they first found it on the shelf (Lillard, 2005). The participation in this full cycle of activity is essential for children so that they can not only learn an appropriate social act but also internalise the structure in their environment and ultimately establish mental order and intelligence (Montessori, 1973). Secondly, the classrooms are aesthetically pleasing with patterns and colours to attract children's attention and invite activity (Lillard, 2005). Colours and orders are usually matching and/or consistent within activities. For example, the materials for the flower arrangement activity may be all green, and the colours of different decimal places repeat the same pattern at all levels. The environment also incorporates nature by introducing plants, flowers, and fruits so as to provide opportunities for children to make a link between the materials and the real world. Thirdly, the classroom is a place for community where children freely interact and learn from each other. The Montessori classroom typically includes multi-age groupings, which provides unique opportunities for both "imitative learning and peer tutoring" (Lillard, 2005, p. 201). For example, young children can observe older children and engage in imitative learning whilst older children can demonstrate desirable social behaviour and act as a tutor/mentor. By observing how others perform, children can also learn their own capabilities (Schunk & Hanson, 1985). By helping others, children can develop self-confidence and motivation (Lillard, 2005). As such, peer learning through observation and demonstration is also a fundamental part of the Montessori environment (Lillard, 2005).

d) Evaluation

Within Montessori classrooms, evaluation procedures are embedded in a variety of ways. One way of monitoring children's progress and understanding is through the *three-period lesson* (Lillard, 2005), which is often used as a way to introduce a child to a new concept, vocabulary, or activities (Richardson, 1997). The first period is the introduction in which the teacher introduces the names or characteristics of the material. The second period concerns recognition in which the teacher asks a child if he/she can recognise the correct objects or names. The third period concerns recalling (Montessori, 1967a) in which the teacher informally tests whether the child can correctly recall these names or characteristics of the material. In doing so, the teacher is required to observe children closely to determine whether children are ready to progress to the next period (Montessori, 1967b). Teachers do not correct children during any period. Instead, they simply repeat a certain period as many times as necessary or present the material again another time. As such, although the structure of the three-period lesson is prescribed, teachers remain flexible and modify their lessons according to the pace and capabilities of the individual children.

As with the three-period lesson, observation is an integral and critical part of all aspects of the Montessori's approach. Observation allows teachers to assess children's progress and situations and identify the needs of the children. Subsequently, teachers can modify lesson planning and classroom management. Observation occurs daily by recognising the variability of the individual children and most importantly without interfering with concentration of the children (Lillard, 2005; O'Donnell, 2012). Montessori postulated the importance of subtle observation as surveillance could adversely affect children's motivation and performance: "Praise, help, or even a look may be enough to interrupt him, or destroy the activity. It seems a strange thing to say, but this can happen even if the child merely becomes aware of being watched" (Montessori, 1967a, p. 280).

3.4.2 Reggio Emilia approach

a) Educational values and objectives

Reggio Emilia is the name of an Italian city where members of the community including parents and educators developed a municipal educational system for young children under the leadership of Loris Malaguzzi (Edwards, 2002; Gandini, 1993). The Reggio Emilia approach also provides an alternative to traditional education and sees a child as a competent learner and active citizen (Edwards, 2002). This positive image of the child postulates that the child has rights rather than simple needs and desires (Hall et al., 2014). Similar to the view of Montessori education, the Reggio Emilia approach sees a child as a protagonist who has an innate desire to discover and understand the world around him or her. The child is not a passive recipient of instructions but rather an active contributor of knowledge construction by working collaboratively with others (Hewett, 2001). In addition to being "authors of their own learning" (Malaguzzi, 1994, p. 55), children are considered researchers who enquire, question, discuss, hypothesise, problem solve, and reflect on their findings (Staley, 1998). This in-depth learning is embedded in the contexts of projects (Katz & Chard, 1989), which in turn lead to expanding children's thinking and understanding (Hewett, 2001). For the construction of knowledge, the Reggio Emilia approach criticises Piaget's perceived view of a child as a solitary learner; rather, it proposes that a child is considered as a social being (Hewett, 2001). Social interaction is strongly emphasised in the learning that takes place in the classroom (Malaguzzi, 1993). Children experience conflict and negotiation through work with others by which they learn to articulate themselves and become more aware of errors in their own thinking (Staley, 1998).

Children are also seen as citizens of the world with rights and responsibility to their community (McNally & Slutsky, 2016). Delrio (2012) suggests that the Reggio Emilia approach is committed to addressing three key community responsibilities for guiding children through their educational aims: civil liability, ethical liability, and political liability. Firstly, civil liability refers to the rights that children have to receive quality education and equal opportunities at every age (McNally & Slutsky, 2016). The adults' duty is therefore to create schools that offer respect, listening, and time and to remove all obstacles that might interfere with the development of human beings. Secondly, ethical liability refers to recognising children's rights and dignity as citizens. Strong emphasis is placed on creating a sense of affiliation in the community where children feel safe and cared for and thus assisting them to become an active part of a process of change for the betterment of the community. Lastly, political liability refers to intercultural coexistence. As migration is currently a global phenomenon, Reggio Emilia schools take a bridging approach to connect with families and children from different countries based on the principles of equality, acceptance, and solidarity. Thus, adults and children co-create a culturally open environment that embraces differences and thereby all the members in the community can gain collective understanding of new cultures. Consequently, the main educational purpose of the Reggio Emilia approach is to build a community with optimal conditions for shared learning where children can develop intellectual, expressive, and creative autonomy, whilst feeling a sense of social belonging and self-identity within the context of a group with diverse sociocultural heritages (Malaguzzi, 1998; Rinaldi, 2006).

b) Learning areas

Unlike Montessori education, the Reggio Emilia approach does not have a pre-determined range of activities with cognitive goals. Rather, the curriculum is contextual and negotiated in which a continuous dialogue between children and teachers determines the activity and/or project (Hall et al., 2014). A static list of skills and facts that usually expects certain learning outcomes is considered to interfere with the potential of children (Hewett, 2001; Rinaldi, 1993), as a heavy focus on fixed skills would push schools for "teaching without learning" (Edwards, 1993, p. 8). Instead, knowledge is viewed as more fluid and formed through interactive social relationships that often entail debate and cognitive conflict (Hewett, 2001).

There is a strong emphasis on the expressive arts as symbolic forms of knowledge representation over literacy and numeracy because too much reliance on only verbal and literacy skills can limit child's creative and communicative capacity (New, 2007; Valentine, 1999). Instead, children are encouraged to use different forms of non-verbal languages such as painting, drawings, dance, and many other artistic activities to symbolically express their ideas and communicate their greater understandings (New, 2007; Valentine, 1999). As the learning process also outweighs the final product, involvement in expressive arts allows children to revisit and reflect on their work repeatedly, which then contributes to consolidating their feelings, thoughts, and ideas into richer and more meaningful contexts (Leekeenan & Nimmo, 1995).

c) Methods

Project-based learning. The Reggio Emilia approach is inspired by a sociocultural constructivist model which views that a child primarily constructs knowledge through social interactions with others (Edwards, 2003; Gandini, 1993; Dodd-Nufrio, 2011). As such, the Reggio Emilia approach criticises Piaget's theory for its perceived interpretation of the child as an independent learner neglecting the role of social factors (New, 2007). Instead, social interactions are embedded in everyday activities, particularly within the context of prolonged, open-ended projects through which children and teachers collaboratively work together to co-construct knowledge (Hall et al., 2014; New, 2007). This project-based learning is central to the Reggio Emilia approach aiming to facilitate inquiry skills, problem-solving, and reflective thinking, all of which are essential for learning (McNally & Slutsky, 2016). Because the Reggio Emilia approach does not have a prescribed set of learning activities, flexible learning and emergent projects are foundations for learning (McNally & Slutsky, 2016). Projects are generally child-originated and teacher-framed within the context of play (Edwards, 1998); topics or activities are decided based on children's interests and shaped by teachers through continuous dialogue with children in a circular manner of planning, documentation, and discussion (Fraser, 2006). Teachers frame an overall educational objective but do not formulate specific lesson plans (Rinaldi, 1998). Rather, teachers remain flexible and creative in their educational planning so that they can proactively respond to the collective ideas of the children (McNally & Slutsky, 2016). In order to maintain the delicate balance between teacher control and child freedom within the framework of the progressive approach, the sense of collaborative relationships between teacher and children is strongly emphasised in this process (New, 2007). This concept of collaboration empowers children and provides teachers with opportunities for ongoing professional development and evaluating children's progress, benefiting both children and teachers (Hall et al., 2014).

Role of the teachers. Following the view of an active and competent child, the teachers are considered as partners in the learning process who co-construct knowledge with children (Edwards, 1993; Gandini, 1993; Hewett, 2001). Reciprocal and interactive collaboration between teachers and children, *the happy medium*, is the central ethos for learning in the Reggio Emilia approach where individuals alone cannot reach the upper tier of proximal zone of development (Hewett, 2001). Consequently, learning is achieved through equal participation and joint action from both teachers and children. The role of the teacher goes beyond the partnership with children; teacher also serves as a facilitator. Teachers utilise the pedagogy of listening and subsequently provide stimuli and resources as needed without imposing an external agenda so that children can advance their cognitive and mental functioning (Hewett, 2001). Based on their dialogue with children, careful listening, and detailed documentation of children's progress, teachers alternate engagement and attention according to the needs of the children; they can be inside the active learning situation as a co-learner by experiencing the process together with the children or they can attentively remain outside of the project as a guide by provoking occasions of discovery (Edwards, 2002; Hewett, 2001).

In order to fulfil these multifaceted roles, teachers thrive to engage in reflective practice through which they are conscious and critical of their evolving roles (Filippini, 1993). The constructivist philosophy applies to the teachers themselves; their roles are not blindly accepting existing beliefs or systems but challenging these preconceived ideas through discussion and joint collaboration with other teachers, parents, children and others in the community. In doing so, teachers elevate their teaching practices to guide children to understand themselves in relation to the surrounding world that they are living in (Malaguzzi, 1993; Valentine, 1999).

Relationships. There is a clear congruence between the Reggio Emilia approach and the Contextual System Model (CSM). The way in which the Reggio Emilia approach places importance on parents, families, and the community and the interactive relationship between child/family and schooling systems for the development of the child is in tune with the idea of the CSM. In the Reggio Emilia approach, relationships are fundamental for learning by assisting children to gain a sense of belonging and confidence (Malaguzzi, 1998). Reggio Emilia teachers understand that learning is not about a direct transmission of information but rather is a result of social relations with others, thoughts, and environments over an extended period of time (McNally & Slutsky, 2016; Rinaldi, 1998).

The principle of collaborative relationships also goes beyond the classroom. The Reggio Emilia approach views parents as equal partners such that parental involvement is essential for the overall educational experiences of the children (Gandini, 2012; McNally & Slutsky, 2016). There is a strong sense of shared challenge, purpose, and responsibility of educating children between teachers and parents (New, 2007). As a part of building quality relationships between home and school, active and open communication through an ongoing process of dialogue and sharing of documentation of children's classroom experiences is central to the Reggio Emilia approach so that both teachers and families have the opportunity to share and exchange ideas and interests (Hall et al., 2014; McNally & Slutsky, 2016). These active interactions between home and school that acknowledge the importance of equal partnership will, in turn, provide teachers with not only a better understanding of the children but also a new perspective on how a family can become an "intrinsic element of collegiality and integration of different wisdoms" (Spaggiari, 1998, p. 104).

Environment. Care and attention is paid to the details of the physical environment of the Reggio Emilia classrooms. In the Reggio Emilia approach, the environment is seen as *a third teacher* whose role is to ignite children's imagination and invite interactions (Strong-Wilson & Ellis, 2007). The classrooms are prepared to be 1) aesthetic; 2) multi-sensory; 3) linked with outdoor environments; 4) rich in relationships; and 5) flexible, with the aim of promoting collective participation (Fraser, 2006; Gandini, 2012). Firstly, the environment is aesthetically pleasing using colour, natural light, plants, and transparency to create an open and welcoming place that encourages expressions and ideas (Gandini, 2012; Strong-Wilson & Ellis, 2007). Secondly, the environment provides a multi-sensory experience with real objects of different colours and shapes such as buttons, shells, pasta, fabrics, twigs, and paper, all of which are purposefully selected and arranged to invite explorations so that children can make meaningful connections (Gandini, 2012; Strong-Wilson & Ellis, 2007). Thirdly, the environment incorporates the essence of outdoors by including plants and natural materials into classrooms, which invite social interactions and enhance children's reasoning, coordination, observational skills, and awareness of the outside world (Valentine, 1999;

White, 2004). Fourthly, the environment is a relational space where teachers and children share ideas and work together. Collaborative explorations and constructions that permeate to all areas of the Reggio Emilia approach contribute to cultivating children's awareness of the importance of relationships (Gandini, 2012). Lastly, the environment is flexible so that it allows teachers to modify the space according to the needs of the children or children can directly manipulate or modify it (Gandini, 2012; Strong-Wilson & Ellis, 2007). Teachers are responsible for sustaining an active dialogue with children and thereby understand the changing needs of the children, whilst children are given opportunities to co-construct their own learning environment by investing their creativity and imaginative energy (Strong-Wilson & Ellis, 2007).

d) Evaluation

Active documentation is a living testimony of the child's learning process and experiences in the Reggio Emilia approach (Strong-Wilson & Ellis, 2007). Documentation takes place in multiple forms including visual arts, videos, transcribed conversations, photographs, and written notes and reveals not only what children are learning but also how this process is taking place in the classrooms (Schroeder-Yu, 2008). Ongoing documentation does not focus on collecting finished work but recordings take place daily and during the course of learning experiences (Rinaldi, 2001). By doing so, documentation provides teachers with guidance for reflection on pedagogical work and future planning (Hall et al., 2014). In the Reggio Emilia approach, children are believed to have 'hundreds of languages' including sculpture, play, drawing, painting, words, and drama (New, 2007). As these multiple forms of children's languages are documented and reflected, teachers learn and evaluate children's growing understanding of a topic and how children individually and collectively construct their knowledge and thereby make an informed decision about how to guide children in their learning (Schroeder-Yu, 2008; Valentine, 1999). As such, documentation can be seen as a formative, alternative assessment of the children's learning progress whilst it also allows children to revisit their own work so that they can develop self-reflective awareness and a sense of ownership of their learning (Hall et al., 2014; Valentine, 1999).

Documentation is also central to a democratic process. As children's learning is explicitly visualised, pedagogical work within the Reggio Emilia schools becomes an integral part of the public awareness and discourses (Dahlberg, 2012); all partners in the community including children, teachers, and parents are invited and encouraged to take part in contributing to the collaborative knowledge construction through sharing, dialogue, listening, and discussion (McNally & Slutsky, 2016). Consequently, documentation is not a mere display of the work of children. Rather, it is an innovative way of opening up school to a public space and involving all members of the community into educational discussions, thereby improving democratic teaching and providing children with opportunities for social exchange and intellectual transformation (Dahlberg, 2012; McNally & Slutsky, 2016).

3.4.3 Traditional play-based (British Columbia Early Learning Framework: BCELF) programme

a) Educational values and objectives

The child-centred, play-based approach has been a dominant practice for early childhood education across Canada (Peterson et al., 2016). However, each province offers its own play-based programmes such that there is no national strategy for early childhood curricula (Friendly, Beach, & Turiano, 2002). Despite the varying geographical and cultural frameworks, play-based curricula share some common views of children and their areas of learning (Stephen, 2006). In this image, a child is viewed as a natural learner who is curious, capable, and full of potential with his/her distinctive social, linguistic, and cultural heritage (e.g., British Columbia Early Learning Framework, 2008). The British Columbia Early Learning Framework (BCELF; Government of British Columbia, 2008), which is largely inspired by the Reggio Emilia approach, outlines an overall vision of early learning for the province of British Columbia (BC) in Canada and strongly supports the use of play-based practices. As a traditional play-based curriculum in BC is encouraged to follow this framework to reflect on and incorporate the underlying visions and principles into practice and early learning (Government of British Columbia, 2008), traditional play-based programmes included in the sample are referred to as the BCELF programme or the BCELF interchangeably in the current study. In the BCELF, every child is an essential part of an ecological system and has a responsibility to the community where he/she belongs. Children learn through enquiry and exploration in relation to themselves, other people, and the world around them whilst teachers, families, and other members of the community actively support children's learning and optimal development. A strong emphasis is placed on play by recognising and valuing play as a vital vehicle for social, emotional, intellectual, and physical development (Rajendram, 2015). The BCELF believes that children have a right to play and learn best through play. Consequently, the main educational aim of the BCELF is to incorporate play into young children's learning and to assist the development of the whole child who is able to communicate thoughts and feelings, empathise with others, and understand and exercise social responsibility (Government of British Columbia, 2008).

b) Learning areas

Similar to the Reggio Emilia approach, there is no prescribed play-based curriculum such that there are no pre-determined sets of activities to promote these areas of learning. Many factors in both the family and school systems including language, school settings, cultural heritage, religion, and other family and child characteristics inevitably influence everyday activities and organisation of them. However, having a framework offers a general guideline for schools to provide experiences and environments that can support the development of children's social, physical and academic learning. As such, the BCELF identifies four areas of early learning: 1) well-being and belonging; 2) exploration and creativity; 3) languages and literacies; and 4) social responsibility. Firstly, promoting a sense of well-being and belonging is essential so that children can learn ways to stay healthy including nutrition and exercises and feel connected in the surrounding environment. This sense of confidence and security is essential for children to explore the world and successfully build a relationship with others. Secondly, exploration and creativity are central to all learning. Through explorative and creative play, children not only learn to think, reason, and problem-solve in meaningful contexts by using their senses but also develop a sense of wonder for natural environments and extend their understanding of the physical world. Thirdly, language is a central tool for communicating emotional, social, creative and physical needs and influences children's early learning experiences. Language is not limited to oral expressions but also includes a variety of expressive mediums including drawing, symbols and signs. By promoting the development of diverse language abilities, children learn how to communicate their thoughts and ideas creatively and reflect on perspectives of others. Lastly, as a part of the ecological system, children have a responsibility for themselves and others in the community. Through social interactions and active participation in communal activities, children are given opportunities to learn their cultural heritage, appreciate diversity, and become more aware of the impact of their own actions on the wider world. In doing so, children develop skills to resolve social conflict, self-regulate their emotion and feelings, and engage in conversations with others (Wood, 2013).

c) Methods

Play-based learning. In the BCELF, play is the central medium for cognitive and social learning and nurtures children's innate curiosity and exuberance (CMEC: Council of Ministers of Education, Canada, 2014). In playing, children have fun while exploring the world around them. Through play, children acquire linguistic, social, and cultural knowledge, express thoughts and ideas in a creative way, and learn about themselves as well as others (CMEC, 2014). The positive experiences associated with play are essential for instilling a joy for learning (Peterson et al., 2016). Traditionally, free play is operationalised as child-directed, fluid, fun, active, creative, intrinsically motivated, and mostly momentary and thereby concerned more with the means than the goals (Ashiabi, 2007). Free play often involves social pretend play, which requires a broad representational ability and creates imaginary situations of social rules and relationships (Elias & Berk, 2002; Pyle, & Danniels, 2017; Saracho, 2002). According to Vygotsky (1980), it is this pretend play that allows children to access and engage in the adult world. As children participate in pretend play, children test their ideas, negotiate rules, and engage in a spontaneous dialogue with others while accommodating others' point of views (Saracho, 2002), providing them with opportunities to enter a zone of proximal development (Vygotsky, 1980). Because of its interdependent nature, pretend play is critical for children to exercise appropriate social interactions and thereby develop self-control skills for sustaining successful play in relation to other players (Lillard, 1996; Wood, 2013). Children also utilise a variety of objects and materials such as playdough, blocks, dolls, sand, and water to build or represent something. This type of constructive play invites self-expression, exploration, sensorial experiences, relationship building, concentration, and problem solving and is often incorporated into pretend play (Wood, 2013). The nature of constructive play is open-ended and can be extended into the outdoor environment, which provides children with a diverse range of opportunities to assess and manage potential challenges and risks (Wood, 2013).

Theme-based learning is another central part of the BCELF. Daily curricular activities integrate book reading, introduction of early literacy and numeracy, fine motor development, and art, all of which are tied into the same theme (Wasik, Bond, & Hindman, 2002). When all the learning activities are inter-connected around a single topic or theme and presented in an integrated and relevant manner, children are repeatedly exposed to the concepts and associated language and thereby can learn more effectively in a meaningful context and not in isolation (Wasik et al., 2002). The theme may be selected by teachers or emerge based on an ongoing dialogue with the children. Theme-based learning is also fluid as time allocated to a specific topic may vary depending on the intensity of the children's interest (Wasik et al., 2002).

Role of the teachers. Teachers play a significant part supporting children's learning in the BCELF. In order to implement the effective and integrated play-based curriculum in classrooms, it is essential for teachers to have a solid understanding of the meaning of play activities and the capacity to support learning goals and optimal development (CMEC, 2014). Wood (2013) illustrates a range of roles that teachers can adopt in the play-based curriculum: 1) be a flexible planner; 2) be a skilled observer; 3) be a respectful listener; 4) be a sensitive co-player; and 5) be a researcher. Firstly, teachers need to be flexible in their planning while observing and incorporating the interest of the children. Play is fluid as children's interest can change momentarily. As such, pre-determining topics may not appropriate. Based on a careful observation, teachers should reflect the emerging needs of the children and support learning experiences. Secondly, teachers need to be skilled observers. Observation allows teachers not only to identify interests and interactive patterns of individual children but also to learn meaning and intentions of children's play activities and potential learning opportunities. Thirdly, teachers need to be good listeners. By listening carefully and giving full attention to children, teachers can respect children's ideas and intentions. Children communicate their feelings and thoughts using multimodal ways. Therefore, attentive listening enables teachers to reflect children's symbolic and abstract representation and emotionally engage with children's playful minds. Fourthly, teachers need to be sensitive co-players who understand when and how to be involved in learning and playing. In child-initiated play, teachers may consciously step back and let the play unfold so that the involvement of teachers will not be intrusive or hijack the flow of children's activities. However, it is equally essential for teachers to actively demonstrate appropriate social behaviours and safety strategies so that children can identify problems, develop conflict resolution, and ultimately construct knowledge. Lastly, teachers need to be researchers in order to facilitate children's learning based on their interests and questions (Hewett, 2001). As an effective researcher, teachers are required to be observant, critically reflective, and analytical so that they can be in tune with children's patterns and dispositions of behaviours and their approaches to learning.

Environment. The physical environment needs to be safe, beautiful, engaging, and flexible to support children's holistic development including their cognitive, physical, emotional, and social learning while offering rich and varied experiences (Government of British Columbia, 2008). Both indoor and outdoor environments should be accessible and organised in a way that promotes children's play and exploration (Saracho, 2002). In particular, spatial arrangement plays a key role in uniting playing, learning and teaching (Wood, 2013). As the environment is a direct reflection of the teachers' educational belief and children's learning, teachers need to ensure that the environment meets the developmental needs of the children and supports the educational goals of the curriculum (Biddle, Garcia-Nevarez, Henderson, & Valero-Kerrick, 2013).

The BCELF identifies three attributes that can facilitate holistic learning. Firstly, the classroom should support healthy lifestyles by incorporating healthy eating and physical activity. Physical activity is essential not only for developing fine-motor skills, coordination, and social skills but also for building self-confidence. Secondly, the classroom should be rich in nature. An outdoor and play environment with a variety of natural elements benefits children in developing risk management, social skills, and self-control by extending affordances for choices, activities, and potentially risk and hazards (Wood, 2013). Thirdly, as language is a central means for communication, creating a language-rich environment is essential for supporting children's overall learning experiences. A language-rich classroom is one in which children are recurrently exposed to meaningful linguistic input and adults consciously provide children with a variation of language and high levels of responsiveness (Justice, 2004).

<u>*d) Evaluation*</u>

The BCELF proposes five steps as a guideline for examining learning processes (Figure 3.4.3-1): 1) record ordinary moments; 2) interpret ordinary moments; 3) share description with others; 4) link learning pedagogical narration to the framework; and 5) incorporate collective reflections into the planning process. The first step is observing and documenting. Careful observation is the basis for discovering and recognising children's interest, patterns of behaviour, and progression in each of the learning areas. Documenting is also a commonly used tool to capture ordinary moments in an everyday life and visually monitor children's progress over time (Wood, 2013). Different forms of documentation include written notes, audio-recording of conversations, photographs, video clips, and collections of

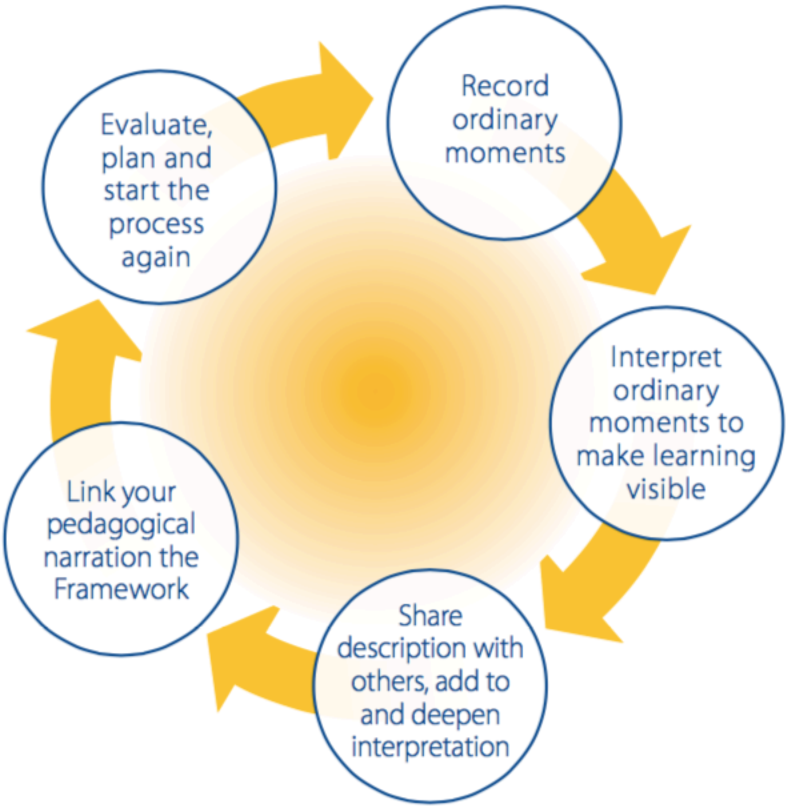

Figure 3.4.3-1. The BCELF evaluation guideline (Government of British Columbia, 2008, p. 14)

children's work such as painting and drawings (Government of British Columbia, 2008). Documentation can provide visible evidence of concurrent learning across different contexts in order to assess how and if a child is acquiring, sustaining, and applying knowledge and skills (Carr et al., 2009). As a third step, teachers can interpret and reflect collective evidence based on observation and documentation and assess the way in which children are making meaning of their learning. The next step is to include others in the community including children, co-teachers, and parents in order to avoid making a narrow judgment and to incorporate others' perspectives into the interpretations. The fourth step involves critical reflective practice in which teachers evaluate their own teaching against the learning progress and outcomes and examine the ways in which their delivery and organisation of the classroom activities achieve educational goals. In the fifth and final step, teachers can use these processes of assessments as well as ongoing conversations with the children to inform concurrent activities and plans, and consequently expand children's learning.

3.5 Research on three preschool approaches

A school curriculum that addresses the development of the whole child by fostering social, cognitive and emotional competence can provide a foundation for better school readiness and subsequent school success. Although generally not couched in terms of school readiness, three approaches included in the current study have been shown to be manifestly associated with some aspects of enhanced school readiness skills including EF, social-emotional skills, and academic competence.

3.5.1 Montessori and school outcomes

Although empirical research is limited in quantity, Montessori education has been shown to be effective in improving children's educational outcomes including EF, social behaviour, and academic competence, especially when implemented properly (e.g., Lillard, 2012; Lillard & Elise-Quest, 2006). Indeed, programme quality is evidently crucial in measuring the effectiveness of Montessori education, as preschool children enrolled in authentic Montessori programmes showed significantly greater gains in outcome measures such as EF, social skills, and academic achievement compared to children in both lower fidelity Montessori and play-based programmes at the end of the school year (Lillard, 2012). However, the limitations should be addressed. Although high-fidelity Montessori implementation was linked to better outcomes, the Lillard study (2012) lacked randomised controls and parents chose schools for their children. Therefore, it may be possible that the particular parenting, not the school programme, was responsible for the differences of outcome measures.

In a more recent study by Lillard et al. (2017) that mitigated this potential selection bias by incorporating a random lottery system for school admission, a similar result was found favouring Montessori programmes. In a three-year longitudinal study, children ($N = 70$) in high-fidelity state Montessori preschools who had gained admission through a district-level lottery system at age 3 were compared to non-Montessori school children ($N = 71$) who had lost that lottery. Both groups of children were tested four times over three years on a range of skills including academic achievement, social skills, EF, and task orientation. The results from an ANOVA on Time 4 postulated that Montessori children scored significantly higher in academic achievement (F (2,119) = 7.24, p = .008) and theory of mind (F (2,115) = 4.47, p

= .04). Fisher's Exact test also showed that more Montessori children made the mastery oriented choice than control children (*p* = .03), indicating that Montessori children were more likely to develop a growth mindset toward the end of their preschool years. However, an ANCOVA on Time 4 while controlling for Time 1 showed no overall group differences with respect to social problem-solving skills (F (1,117) = .20, p = .66) and EF (F (2,118) = 3.00, p = .09). The results contradict the Lillard and Elise-Quest's study (2006) that found Montessori children demonstrated superior EF and social skills.

The researchers also analysed the data from a subgroup of children with a household income below the median split ($32,627) so as to examine the influence of Montessori education on the income achievement gap. Firstly, the gains in academic achievement amongst the lower income children were examined by using an ANCOVA. When controlling for academic achievement at Time 1, the lower income Montessori children showed significantly higher academic achievement than the lower income control children (F (1,62) = 6.86, p = .01). Secondly, Montessori children from lower income families were compared to the higher income control children on their academic achievement by using a series of t-tests at four time points. Although Montessori children from lower income families significantly fell behind the higher income control children at school entry (t (64) = 2.47, p = .02, d = .61), the difference of effect size was gradually reduced over time, and by the end of their second year in preschool, there was no significant achievement gap between the two groups (t (64) = 1.59, p = .12, d = .40). By the end of the third year, the difference was further reduced by another third (t (62) = 1.59, p = .41, d = .21). Therefore, the effect size of the income achievement gap was reduced from 3/5 of a standard deviation at age 3 to 1/5 at the end of kindergarten. A similar pattern was found within the Montessori sample in which lower income Montessori children performed statistically as well as the higher income Montessori children by the end of kindergarten (t (56) = 1.41, p = .16, d = .37). By contrast, the income achievement gap was larger for the control sample in which the higher income control children outperformed the lower income control children by a full standard deviation (d = .98). Thirdly, the predictive power of EF for academic achievement was examined. While initial levels of EF predicted the growth of academic achievement over three years for children in the control group (B = -.067, p = .05), initial levels of EF were not predictive of achievement growth for Montessori children (B = .009, p = .76). In other words, Montessori children performed equally well in academic achievement regardless of their initial levels of EF and having low EF did not negatively affect the outcomes of children in Montessori schools. The limitations should be mentioned. Firstly, although the study utilised a school lottery system, it does not represent all children and is not a true random experimental design. Therefore, unobserved variables such as family characteristics might have influenced the findings. Secondly, the Montessori and control schools differ in many ways including educational values, methods, materials, and teacher training. Thus, it is unknown whether it was other aspects of respective schools that influenced the results or whether the Montessori programme itself was the source of difference. Despite these limitations, the findings indicate that Montessori education may play an important role in enhancing academic outcomes of all children, while also matching the performance of economically disadvantaged children. Importantly, the higher academic performance in Montessori schools did not mean the loss of social skills or mastery orientation, as Montessori children showed better social cognition (also known as theory of mind) and developed more mastery orientation.

As shown, existing research on Montessori education including the development of school readiness skills is overall positive. However, the findings must be interpreted with caution due to methodological limitations such as lack of random assignment (e.g., Lillard, 2012), questionable implementation fidelity (e.g., Lopata, Wallace, & Finn, 2005; Miller, Dyer, Stevenson, & White, 1975), and small sample sizes (e.g., Lillard & Else-Quest, 2006). Firstly, one common weakness in Montessori research is its lack of randomised controls (Lillard, 2005). Although it is clearly difficult to conduct a randomisation in real school settings due to practical and ethical issues, the effect of parental choice cannot be ignored in non-random designs, as certain parents may be more prone to choose Montessori schools and their parenting styles and associated home environments may be strongly influenced by Montessori philosophy (Lillard, 2005, 2012). As such, one can argue that parents rather than the Montessori programme may be responsible for the better outcomes.

Secondly, authenticity of Montessori methods and materials is questionable in some Montessori research (Lillard, 2005). For example, Lopata et al. (2005) compared the academic achievement of fourth ($N = 291$) and eighth graders ($N = 252$) who attended state Montessori or traditional schools. Students were matched based on gender, ethnicity, and socio-economic status. The study found that although there was no significant group difference in the area of language arts at fourth grade, the achievement gap grew over time and Montessori children scored significantly lower at eighth grade compared to the control school children, and no difference was found for the mathematics scores at eighth grade.

Thus, the results did not support the benefits of Montessori education for elevating academic achievement. However, only one Montessori school was included in the study and the authentic implementation of the Montessori methods in this particular school was unclear, as the researchers failed to determine whether the participating Montessori school met a minimum level of fidelity including teacher training and materials. As the quality of the Montessori programme as well as the correct use of Montessori materials appears to influence Montessori outcomes (Lillard & Heise, 2016; Lillard, 2012), existing research about the effectiveness of Montessori education with low or unknown fidelity is questionable.

Thirdly, a small sample is often a problem in Montessori research. The number of schools and classrooms involved in the Montessori studies are usually small due to a limited number of authentic Montessori schools available. Participants also lack socioeconomic diversity, as most Montessori schools are privately owned and thus only for those who can afford the tuition fees. In small-scale studies, an effect of individual teacher quality cannot be separated from the programme effect (Lillard, 2005). A teacher's ability to establish a positive relationship with students by responding to their academic and psychological needs clearly has a meaningful impact on the developmental trajectories (e.g., Hamre & Pianta, 2001, 2005; Valiente et al., 2008). As such, it is possible that varying teacher effectiveness, not the school programme, affects children's educational outcomes positively or negatively when fewer schools are involved (Lillard, 2005).

Due to these problems, although Montessori is relatively common as a form of alternative education (Lillard, 2012), there is still limited methodologically robust research on the effectiveness of Montessori education as compared to other educational systems globally as well as in the context of Canada. While randomised control studies are preferable for assessing the programme effectiveness, random assignment of students to certain schools is not often practical or feasible. As such, longitudinal lottery studies or quasi-experimental studies are usually the best available (Lillard et al., 2017). Given the complexity of identifying the root of the cause for positive, neutral or negative outcomes, additional information such as measures of the quality of teacher-child interactions can be also included in these studies in order to examine whether variation in teacher interaction styles may contribute to children's outcomes (Lillard et al., 2017; Marshall, 2017).

3.5.2 Reggio Emilia approach and school outcomes

Biroli et al. (2017) evaluated the effectiveness of the Reggio Emilia approach using non-experimental comparison groups in three different Italian cities that are in close geographic proximity including Reggio Emilia, Parma, and Padova. The survey data on individuals from five different age cohorts were used (N = 4019): ages 50, 40, 30, 18, and 6 as of 2012. A propensity score was estimated as a matching method. The researchers compared children who attended preschools with the Reggio Emilia approach with those who did not receive any formal childcare in the city of Reggio Emilia and with those who attended alternative preschools in the city of Reggio Emilia and in the other two cities on a variety of outcomes including education attainment levels, employment, marital status, mental and physical health, and civic participation. Regression analyses showed that the benefits of attending Reggio Emilia preschools were larger than not attending any preschools; however, differences between attending the Reggio Emilia preschools and other types of preschools were not sufficient to claim overall superiority of the Reggio Emilia approach.

In the child cohort, for example, significantly more positive results for a measure of social-emotional skills were found for the Reggio Emilia preschool children compared to children who attended other preschools in the city of Reggio Emilia. However, when compared to the control children who attended non-Reggio schools in Parma, significantly positive results were not preserved. When compared to non-Reggio school children in all three cities, the Reggio Emilia preschool children liked school significantly more. However, the Reggio Emilia preschool children showed significantly lower IQ and more obesity when compared to the religious school children in all three cities.

For the adult cohorts, in comparison with other types of schools, only two outcomes were significantly positive for the Reggio Emilia approach preschools: volunteering participation in the age-30 cohort and high school graduation in the age-40 cohort. No other significant differences were found. In comparison with those who did not attend any preschools across the three cities, the Reggio approach individuals were significantly more likely to work longer hours for both the age-30 and age-40 cohorts. For the age-30 cohort, the Reggio approach individuals were significantly more likely to achieve higher high school grades and vote when compared to no preschool groups in all three cities. Most positive and significant effects were found from the comparison of Reggio Emilia preschools against no preschool groups for the age-40 cohort. For this cohort, the Reggio approach individuals showed significantly higher voting rates relative to no preschool groups in all three cities, were significantly less likely to be depressed and obese relative to no preschool group in Reggio Emilia, and were significantly more likely to achieve higher high school grade and get married relative to no preschool groups in Parma and Padova.

These findings failed to support the overall benefits of attending Reggio Emilia preschools for boosting long-lasting outcomes, especially when compared to other preschool types. Limitations should be mentioned. Firstly, a lot of commonalities in the characteristics of the programmes were found between the Reggio Emilia approach and alternative preschools. As the three cities included in the study were geographically close with similar social and cultural values, it is possible that a common source of ideas and social behaviour might have influenced the outcomes. Secondly, the Reggio approach received substantial publicity in the 1960s and 1970s. As such, neighbouring cities may have incorporated the ideas and features of the Reggio approach into their programmes. It is also possible that the Reggio approach may have included and adopted some characteristics of non-Reggio programmes. Therefore, it is difficult to tease the Reggio approach from other types of programmes and compare them fairly. Lastly, this was a non-experimental study and parents chose to send their children to their respective preschools. As such, the potential impact of selection bias on outcome measures cannot be ruled out.

The Reggio Emilia approach is known and sought out as a progressive practice by educators around the world (Cadwell, 1997; Goffin & Wilson, 2001); however, a substantial lack of empirical evidence on the effectiveness of this approach is noticeable. Currently, there is no peer-reviewed empirical research that examines the programme effectiveness on the development of EF and social-emotional skills. There are two key challenges for evaluating the Reggio Emilia approach: absence of a prescribed curriculum; and cultural diversity and influence (Gandini, 2011). Firstly, unlike other educational approaches such as Montessori, the Reggio Emilia approach does not have a formalised set of curricula and there is no official teacher certification training. Rather, it is a localised approach as an alternative to national, centralised curricula (Gandini, 2011). The absence of prescription of the curriculum allows the Reggio approach to advocate progressive views of the child and respect cultural and social diversity as opposed to just following instrumental-based views of education (Soler & Miller, 2003). Therefore, it is a philosophy to be adapted within respective cultural and social contexts rather than a curriculum that dictates how teachers should organise lessons or what the learning sequences should be for children to acquire specific skills. As such, the way in which a Reggio-inspired school is created has many possibilities without diminishing the fundamental ethos of the approach. However, because there is no written definition of what constitutes a Reggio Emilia approach, the implementation of the Reggio Emilia approach can vary across schools, and there is a reported difficulty amongst teachers in understanding and adopting the approach into their practices (e.g., Ardzejewska & Coutts, 2004; Wai-Yum, 2003). For example, Ardzejewska and Coutts (2004) surveyed Australian primary school teachers and examined their understanding and challenges when implementing the Reggio approach. The results highlighted that teachers held varying knowledge of the Reggio approach and that many of them had difficulty distinguishing central tenets of the Reggio approach from those of other child-centred practices. Thereby, there is a lack of educational transferability and accountability to the wider community (Soler & Miller, 2003).

Secondly, "cultural knots" (Gandini, 2011, p. 78) and associated images of the child might affect the degree of the integration of the Reggio approach into a different culture. Firlik (1996) points out that there are significant cultural differences in patterns of thinking and attitudes between the Reggio approach and the American educational system. According to Firlik (1996), one of the most prominent obstacles for an authentic implementation of the Reggio Emilia approach in the US concerns attitudes toward the individual and the group. For example, the notions of individualism and collectivism are integrated in the macrosystem in the bioecological model and governs the ways people behave and interact with others. While individualism in the US generally values assertiveness and independence, the Reggio Emilia approach values more collective decision-making, collaboration, and communal involvement. Krechevsky and Stock (2000) concur with this by suggesting that in American schools learning is considered as an individual process rather than a social and communicative act; teachers act as consumers rather than facilitators, and evaluating learning outcomes outweighs the quality of learning process. On the other hand, the Reggio Emilia approach is largely influenced by a socio-cultural constructivist view in which children primarily learn through social interactions and the involvement of the community is essential to support children's learning (Edwards, 2003). As such, these evidential differences in the attitudes toward the group and learning pose a question about the compatibility of the Reggio

Emilia approach with the educational visions of other cultures, and consequently affect the overall programme fidelity.

Taken together, the limitations that emerged from the lack of a prescribed curriculum and uncritical practices of the Reggio Emilia approach in other local cultures could be attributed to the substantial lack of empirically driven data with which to validate the effectiveness of the Reggio Emilia approach. Moreover, educators in dialogue with the Reggio Emilia approach are not convinced of the validity and usefulness of empirical research that measures children's developmental outcomes (Edwards, 2002). Dahlberg, Moss, and Pence (1999) argue that although it can offer reassurance and objectivity, assessing and quantifying the quality of early childhood curricula often only seeks to illustrate conformity to a limited number of measurable criteria and fails to engage in understanding what is actually happening in the everyday life of the programme. However, without empirical evidence based on external criteria, it is difficult for outside audiences to understand the programme effectiveness such that more empirical research is warranted.

3.5.3 Generic play-based approach and its outcomes

The established discourse of child-centred practices regards play as a central means for learning and optimal development. Play is an integrating process and acts as a foundation for learning such that most of early childhood curricula are designed to incorporate different forms of play, especially high-levels pretend play, as their central means for children's learning (Zigler & Bishop-Josef, 2004). Pretend play has been shown to be a correlate of a range of school readiness skills. For example, Elias and Berk (2002) conducted a short-term longitudinal study involving 51 Caucasian children ages 3-4 from middle-income families and examined the relation between observed free play and self-regulatory behaviour in preschool classroom contexts including clean-up periods and group circle time. Naturalistic observation was conducted twice at four-month intervals to assess self-regulatory behaviour (e.g., attentiveness, responsibility, levels of involvement, cooperation) and different aspects of pretend play (e.g., frequency, persistence). Teachers also rated children's impulsivity. After controlling for age, verbal ability, and Time1 clean-up or circle time attention, both frequency and persistence of pretend play were significantly associated with self-regulatory behaviour at Time 2 clean-up ($r = .32$, $r = .33$, $p < .05$, respectively), but not Time 2 circle time attention. The results also showed that although no difference was found at Time 1, frequency of pretend play predicted better self-regulatory behaviour at Time 2 clean-up amongst only children with higher levels of teacher-rated impulsivity ($r = .81$, $p < .05$). There are several limitations. Firstly, the gains in self-regulatory behaviour appeared to be context specific, as evidenced by a lack of associations between pretend play and circle time attention. Secondly, pretend play normally lasted approximately 30-50 minutes. Other activities that children were involved in for the rest of the day might have influenced the development of self-regulatory behaviour. Thirdly, the conceptualisation of self-regulation in the study was more closely alighted with the notion of social skills. As such, aspects of prosocial behaviour (e.g., cooperation for clean-up) rather than self-regulatory behaviour might have affected the findings. Despite these limitations, the study suggests a potential role of pretend play in supporting children who are struggling to inhibit impulses and who may be at greater risk for school problems.

The benefit of higher levels of pretend play to social skills has been also documented. In a study involving 41 primary school children ages 5-7, Uren and Stagnitti (2009) investigated the association between child-initiated pretend play, social skills, and school involvement. One-on-one direct assessment was conducted to measure individual skills in solitary pretend play (e.g., elaborateness, complexity). Lower skills indicated that children had difficulty in initiating, contributing, and sustaining play. Teachers also rated children's social skills (e.g., cooperative, helpful) during interactive peer play and a child's involvement in classroom activities. Findings showed that children with higher pretend play skills showed significantly better social skills during peer play ($r = .35$, $p < .05$) and higher classroom involvement ($r = .47$, $p < .01$), whilst children with poor pretend play skills were significantly more disconnected in peer play ($r = -.35$, $p < .05$) and less involved in the classroom activities ($r = -.46$, $p < .01$). Although the study indicated a relation of pretend play skills to social competence and classroom involvement, pretend play was assessed outside of a social context. This is problematic as solitary play occurs far less frequently than pair or group play activities in the preschool settings (Whitebread, Coltman, Jameson, & Lander, 2009). Therefore, children's play skills and involvement in the everyday social interactions and their impact are unknown.

The use of play in a curriculum has been shown to be advantageous for better school outcomes. For example, Walsh et al. (2006) examined children ages 4-5 in Northern Ireland

and compared their school-related skills between play-based and formal approaches. The Enriched Curriculum is a play-based approach inspired by constructivist and Vygotskian views with a strong emphasis on the importance of play, literacy, attentional capacity, physical well-being, and relationship skills. The Northern Ireland Curriculum is a formal school approach in which acquisition of basic academic skills is of primal importance through subject-based and teacher-led instructions. Systematic classroom observation was conducted in 32 play-based classes and 38 formal approach classes to measure the quality of children's learning behaviour and skills (e.g., motivation, confidence, higher-order thinking, physical well-being, social skills). Findings about the time children spent in child-centred and teacher-led activities clearly reflected the respective educational focuses: the formal approach children spent much more time in teacher-directed activities (82.2%) than play-based children (56.3%), whereas play-based children spent much more time in child-initiated activities (43.7%) than the formal approach children (17.8%). With respect to learning outcomes, play-based approaches were significantly superior on all measures (e.g., social interaction, $x^2 = 37.9$, $p < .000$; Concentration, $x^2 = 13.5$, $p < .01$) compared to formal school approaches. Further analysis involving total scores also revealed that play-based approach children showed significantly better performance compared to the formal approach children. These findings indicate that children in the play-based approach tend to be more confident, socially adept, independent, confident, and physically healthier. Limitations should be noted. Firstly, the only assessment used in the study was observation, and no other measures were included to capture a more comprehensive picture of children's learning in the classrooms. Thus, observer bias might have influenced the findings. Secondly, the study examined only the concurrent relation between play-based approaches and school outcomes. As such, a long-term benefit of the play-based curriculum is underdetermined. Thirdly, the initial performance levels of the children were not collected such that the superior outcomes for the play-based children might be attributed to previous experiences or potentially higher levels of initial skills.

The most common methodological issue in relation to play, especially pretend play, is that many studies are limited by their nature of correlational approaches (Lillard, 2013). Although correlational studies can suggest a connection between children's pretend play and school readiness skills, the causal link remains underdetermined. Experimental evidence to substantiate the association between pretend play and school readiness skills is also rare (Carlson & White, 2013). As play is spontaneous, flexible, intrinsically driven, and child-initiated (Krasnor & Pepler, 1980; Whitebread et al., 2009), directing play themes and objects, setting a specific time period for pretend play, and conducting a study in an adult-controlled setting such as laboratory environments can hardly capture the essence of children's natural play (Bergen, 2013). Cultural and socioeconomic variations might be other influential factors that have an impact on the levels of involvement in play. For example, Goncu, Tuermer, Jain, and Johnson (1999) found that American and Turkish children engaged in more pretend play than children from Guatemala and India, although pretend play also occurred amongst Guatemalan and Indian children. In addition to cultural variations, the influence of socioeconomic status has been also documented. For example, in a dated but relevant study, Griffing (1980) compared pretend play of a group of 169 African American kindergarten children ages 5-6 from low socioeconomic status or middle class families. The study found that there were substantial differences in the amount and quality of play engaged in between low class and middle class children. Children from lower class families showed consistently lower levels of pretend play characterised by little to modest displays of pretend play with objects, interactions with other players, persistence in a play episode, and verbal communication. These findings indicate that playing is a universal phenomenon but different cultural and socioeconomic contexts affect the depth and richness of pretend play. As such, it is unclear if pretend play is the only, or the primary catalyst of the child outcomes, especially when experimental studies are rare in research on pretend play.

Another prominent methodological issue, especially when evaluating the effectiveness of play-based approaches, is that there is a difficulty in measuring the impact of play in classrooms in isolation, as other factors including teachers' involvement, availability of the materials, time allotted for play, and classroom structure have a significant interactive influence on the child outcomes (Lillard, 2013). This challenge in separating the element of play from other aspects of classroom factors has been highlighted in conflicted results from a series of evaluation studies on the Tool of the Mind programme (e.g., Diamond, Barnett, Thomas, & Munro, 2007; Barnett et al., 2008; Wilson & Farran, 2012). The Tool of the Mind programme is a Vygotsky-inspired curriculum that offers a range of play activities including dramatic play aimed at developing EF (Barnett et al., 2008). A recent meta-analysis of seven randomised controlled studies (Baron, Evangelou, Malmberg, & Melendez-Torres, 2017) suggests limited programme effectiveness; the Tools children performed significantly better in mathematics but did not outperform control group children in relation to the development of literacy and EF. Dramatic play with active teacher involvement is central to the Tool of the Mind programme; however, this particular form of play cannot be separated from other aspects of the programme. Moreover, most of the control groups in these studies are also play-based programmes, thus making it even more difficult to claim that a strong emphasis on pretend play is the unique contributor to the gains in mathematics or no programme effect on executive functioning skills.

An increasing number of teachers and educational professionals who work with young children have expressed concern about the alarming disappearance of play from early childhood education (Miller & Almon, 2009; Nicolopoulou, 2010). Play is child-initiated and thereby is responsive and natural to children's learning (Elkind, 1981; Samuelsson & Carlsson, 2008; Wood, 2013). Therefore, hijacking kindergarten and even preschools into teacher-centred instructions with a heavy emphasis on academic skills is counterproductive to children's desire to explore, use their imagination, and exercise their bodies (Elkind, 1981; Miller & Almon, 2009). Academically oriented programmes also do not necessarily guarantee future success in the long term (e.g., Golinkoff, Hirsh-Pasek, & Singer, 2006). At the same time, existing research on the role of pretend play is not only inconclusive but evidence for assertions that a play-based curriculum provides a long-lasting boost in children's development of school readiness skills is also scarce. As such, more systematic research on the effects and outcomes of different preschool curriculum, play-based and otherwise, for children's development of school readiness and subsequent school success is warranted.

3.6 Gap in the literature

Conclusive evidence points to the significant role of EF and social-emotional skills, along with academic competence, for promoting school readiness including better social functioning and academic achievement. Although some research on Montessori, Reggio Emilia, and generic play-based approaches have demonstrated the potential benefits of these particular programmes to facilitating this developmental process, further research is needed for three reasons. Firstly, despite the prevalence of the programme, empirical research on the influences of Montessori education is limited and inconclusive (Lillard, 2005), especially in comparison with non-Montessori schools. Secondly, the effectiveness of play-based programmes including the Reggio Emilia approach is also scarce and inconclusive (Hall et al., 2014; Lillard et al., 2013). Finally, there has been little research that has examined the development of both EF and social-emotional skills with the examination of other influential factors, particularly relational capacity and classroom quality. As the bioecological-contextual model proposes, social and affective interactions taking place both within and between the family and school systems are significantly influential in determining the development of children's school readiness and subsequent school success. Therefore, the present study aimed to address these gaps by 1) determining the effectiveness of these preschool curricula (Montessori, Reggio Emilia, and BCELF programmes) in Western Canada on the development of children's school readiness skills including EF, social-emotional skills, and pre-academic competence; and 2) examine other sources of influences in the child, family and school in relation to the development of these school readiness skills.

Chapter 4: Methodology

This chapter presents the methodological framework employed in the current study to address the research questions. The current study set out to pursue two main aims. The first aim was to determine the effectiveness of three preschool curricula in Western Canada – Montessori, Reggio Emilia, and British Columbia Early Learning Framework (BCELF) programmes – on the development of children's school readiness skills including executive function (EF), social-emotional skills, and pre-academic competence over one school year. The second aim was to examine the sources of influences in the child, family and school in relation to the development of these school readiness skills across time.

4.1 Rationale of the study

Research findings point out the significant role of EF and social-emotional skills in contributing to children's cognitive and social functioning at school and beyond. However, a large number of kindergarten teachers in the US, for example, described their children as experiencing behavioural problems with executive functioning and social-emotional skills, particularly difficulty with following directions, controlling behaviours, and working cooperatively with peers (Rimm-Kaufman et al., 2000). Most teachers regard children's ability to communicate their wants and ideas, to possess an optimistic attitude toward learning, and to apply empathetic understanding of others' feelings to social interactions as fundamental characteristics for school readiness and later school success. Deficits in these skills are also linked to escalating and long-term problems throughout school years. Consequently, the increasing lack of executive functioning and social-emotional skills amongst young children is concerning (Lewit & Baker, 1995). A lack of foundational skills desired for formal school entry as well as the increase in expulsions and suspensions of preschoolers highlight a pivotal role that early childhood education can play in providing appropriate and timely support so that children can have opportunities to learn how to regulate their behaviour and develop fundamental cognitive and social-emotional skills.

There is a wide range of preschool curricula currently available in Canada including Montessori, Reggio Emilia, and traditional play-based approaches such as the BCEFL programmes; however, there has been a significant lack of comprehensive curriculum evaluations in order to determine and differentiate the effectiveness of these programmes on school readiness skills including EF, social-emotional skills, and academic competence. With increasing demands for quality educational services, programme evaluation is particularly important with respect to curriculum decisions. The results can shed light on how and whether a certain preschool curriculum reliably promotes school readiness for young children and thereby provides domain-specific and policy-relevant information.

The following sections include research questions, research design, participants, assessment challenges, procedures, data collection instruments, structural validity, analytical plan, and finally ethical considerations.

4.2 Research questions

Two research questions were investigated with a particular focus on curriculum effectiveness:

1) Are there any differences in classroom process quality (Emotional Support, Classroom Organisation, and Instructional Support) by preschool types (Montessori, Reggio Emilia, and BCELF programmes) in Western Canada?
2) Is enrolment in different preschool programmes associated with changes in EF, social-emotional skills, and pre-academic competence over one school year?

In order to better understand the development of school readiness skills at more holistic levels, it is important to include other factors within the context of children's lives and their interactions with one another. Therefore, the current study also investigated five sub-research questions to examine other sources of influences in the child, family, and school in relation to the development of school readiness skills.

3) Is any aspect of classroom process quality measured by the CLASS associated with changes in EF, social-emotional skills, and pre-academic competence?
4) What are the associations between EF and pre-academic competence over time?
5) What are the associations between social-emotional skills and pre-academic competence over time?
6) What are the associations between EF and social-emotional skill over time?
7) What are the associations between teacher-child/parent-child relationship quality and school readiness skills over time?

4.3 Research design

4.3.1 Quasi-experimental design

A quasi-experimental design shares similar characteristics of an experimental design to test descriptive causal hypotheses (Shadish, Cook, & Campbell, 2002; White & Sabarwal, 2014). Well-executed randomised controlled studies where the outcome differences between the treatment and control groups can be attributed to the intervention are considered to be most credible and rigorous for evaluating the effectiveness of a particular programme; however, conducting these classic experiments is often not feasible in educational settings due to ethical and/or practical reasons (Adelson, 2013; Bryman, 2012; Walser, 2014). In the current study, selected preschool programmes had already been implemented prior to the study, thus the random allocation of individual children to particular programmes was not possible. Consequently, a quasi-experimental design was employed in order to achieve the objectives of the present study.

The quasi-experimental design views a programme as an intervention and evaluates its effectiveness (White & Sabarwal, 2014). This design, however, generally contains greater threats to internal validity due to the absence of a random process and offers less support for a cause-and-effect relationship (Brooks, Chavez, Tritz & Teasley, 2015; Bryman, 2012). In educational research, evaluations of educational programmes tend to be error-prone due to methodological limitations, especially selection bias, because pre-existing unobserved family or child characteristics associated with school selection may be attributed to observed differences in children's outcomes (Gilliam & Zigler, 2001; Gormley, 2007; Wong, Cook, Barnett & Jung, 2008). Given these limitations, care should be taken to achieve a practically important level of bias reduction. The following section will discuss steps in controlling for selection bias by linking to the contexts of the current study.

4.3.2 Reducing risks of selection bias

Quasi-experimental studies, by definition, lack random assignment (Shadish et al., 2002). To compensate for the absence of randomisation, efforts should be made to reduce the risk of selection bias, thereby obtaining a more valid estimate of the treatment effects (Shadish et al., 2002). Firstly, it is essential to select comparison groups that are as similar as possible to maximise overlap amongst the groups in order to minimise baseline differences (Cook, Shadish, & Wong, 2008; Walser, 2014); choosing the comparison groups from the same local community or "a more circumscribed and local setting" (Shadish et al., 2002, p. 504) is highly recommended. If two groups share similar sets of covariates, the likelihood of participation in a given intervention can be deemed as coincidental (Brooks et al., 2015), and consequently the estimated bias can be significantly reduced. In the current study, all the selected preschools were located in similar demographic areas and the pre-test measures indicated that most of the families demonstrated similar characteristics including their socioeconomic status and parental education levels (see *4.5 Participant description*).

Secondly, the strength of the quasi-experimental design is also determined by the amount and quality of data collected from individual groups in a study (Goesling & Lee, 2015). In educational research, the demographic variables alone, although essential to establish equivalence amongst groups, may only achieve little bias reduction (e.g., Diaz & Handa, 2006; Shadish, Clark, & Steiner, 2008). By contrast, variables concerning students' prior academic achievement and personality predispositions, and parental expectations have shown to influence outcome measures (Brooks et al., 2015; Goesling & Lee, 2015; Taylor, Clayton, & Rowley, 2004). As such, having a rich set of these covariates beyond basic demographic characteristics is critical to achieve selection bias reduction (e.g., Diaz & Handa, 2006; Shadish, Clark, & Steiner, 2008). In the current study, pre-test was conducted in the beginning of the school year to collect data on children's fluid intelligence and initial academic achievement, parental expectations, family's school choice, and children's everyday behavioural and emotional displays along with demographic characteristics (See *4.5 Participant description*).

Lastly, different analytic methods including matching, regression adjustment and/or the use of alternative propensity score are commonly used to account for group differences and thereby reduce selection bias. The propensity score is a composite score balancing all observed baseline covariates that are related with predicted likelihood of participation, thus artificially reconstructing a similar situation to random assignment (Adelson, 2013; Braitman & Rosenbaum, 2002; Steiner & Cook, 2013). Using a simple regression framework such as analysis of covariance (ANCOVA) has been shown to be as effective as, or sometimes even better than, propensity scores when the distributions of the covariates are closely overlapped between groups (Adelson, 2013; Shadish et al., 2008; Steiner, Cook, & Shadish, 2010). For example, Shadish et al. (2008) investigated whether nonrandomised experiments, when adjusted properly, could approximate the results from randomised experiments. A total of 445 undergraduate students participated in the study; all of them were randomly assigned to be either in a randomised experiment group or nonrandomised experiment group. While the participants in the randomised group were randomly assigned to mathematics or vocabulary training, those in the nonrandomised experiment group self-selected into one of the trainings. Outcome measures included vocabulary and mathematics achievement. The initial results without adjustments showed that the effects of both mathematics and vocabulary trainings were larger for those who were in the nonrandomised group, though the absolute value from the nonrandomised group was not significantly different from the randomised group. This difference in the absolute value between unadjusted and adjusted results represented the estimated bias. Adjusted results indicated that the use of ANCOVA substantially reduced the estimated bias by 94% for vocabulary achievement and 84% for mathematics achievement, while the use of propensity score reduced bias by an average of 74%. The study successfully showed that nonrandomised experiments could yield the results from randomised experiments by using ANCOVA without the use of propensity score. Therefore, the current study employed the use of linear regression with prospective longitudinal data such as an autoregressive model to effectively reduce the bias at pre-test, thereby improving the rigour of the quasi-experimental design.

In summary, selection bias as a result of the lack of random assignment becomes a concern in quasi-experimental studies as the extraneous variables may have an impact on the findings. As such, whether study results are due to an implementation of a particular programme or related to existing differences between groups can be inconclusive. Quasi-experimental studies, however, can effectively approximate the results from randomised controlled studies with proper adjustments such as choosing comparison groups strategically to establish practical equivalence, collecting a rich set of covariates, and utilising various analytic methods. Bryman (2012) supports this by suggesting that the results of studies with such a design are credible and that their ecological validity is strong, as these studies are normally taken place in a school setting with children working within their normal environments. Consequently, the quasi-experimental designs are more practical for educational researchers to especially conduct impact evaluation on students, learning environments and interventions, all of which are more representative of the real world settings (Adelson, 2013; White & Sabarwal, 2014).

4.4 Sampling

Sampling strategy. Purposive sampling was employed, which enabled the documentation of comparisons between different groups and relationships amongst variables (Punch, 2009) – in the current study comparisons amongst children who attended different preschool types. This sampling strategy was suitable as it "makes sense to select the sample in such a way that there is maximum chance for any relationship to be observed" (Punch, 2009, p. 52) and helps to "establish a good correspondence between research questions and sampling" (Bryman, 2012, pp. 333-334). Since there is a general lack of curriculum evaluation studies in Western Canada, this sampling strategy was selected to target particular groups of preschool children in specific demographic areas.

School selection criteria. As for Montessori schools, all the schools were selected based on an authentic implementation of Montessori teaching principles according to Association Montessori Internationale (AMI), the international organisation founded by Dr. Maria Montessori. According to Canadian Montessori Quality Assurance that adheres to the principles of AMI, the criteria for a classic Montessori classroom includes 1) one AMI trained teacher in each classroom who provides individual and small group lessons; 2) a complete set of Montessori materials provided by authorised suppliers; 3) an uninterrupted 3-hour activity time; 4) a mixed-age group (e.g., age three to six); 5) the programme that runs consistently five days per week; and 6) a large class size – between 28-35 children in a single classroom to ensure social development. All Montessori schools that were contacted met these requirements except for the classroom size due to the government regulations, which require a lower adult-child ratio with a maximum group size of 20 (Friendly, Macdonald, & Forer, 2015).

As for Reggio Emilia schools, unlike Montessori education there are no official teacher trainings to become "Reggio Emilia certified" teachers (Gandini, 2011). The Reggio Emilia approach is regarded as a practice that is inspired by philosophy, ideas and theories from many psychologists and educators including Piaget, Vygotsky, and Montessori (Hall et al., 2014; Hewett, 2001). The curriculum is not fixed in advance and is rather regarded as "emergent" (Lewin-Benham, 2006) such that there are no established measures of programme fidelity. Consequently, the schools were selected based on their self-nomination as a Reggio Emilia school and whether these schools adhered to the distinctive physical and educational traits suggested by the North American Reggio Emilia Alliance (NAREA) including visible documentation and open spaces with distinct lack of clutter.

As for traditional play-based schools, only schools which specifically offered a play-based programme without particular attachment to either Montessori education or the Reggio Emilia approach were selected. There are no established measures of programme fidelity either. Therefore, the schools were identified based on their self-nomination as a play-based preschool and whether these schools were aligned with certain organisational, physical, and social attributes suggested by the British Columbia Early Learning Framework (BCELF; Government of British Columbia, 2008). These characteristics included 1) a provision of open-ended materials and activities; 2) open spaces for circle time and physical movements; and 3) an emphasis on social interactions. Along with these attributes, only schools that operated in similar and/or same demographic areas as in Reggio Emilia and Montessori schools and those that were registered as a preschool rather than a daycare were selected. This is because operational philosophy, teacher licence required, and opening hours of daycares would be quite different from that of preschools.

Sample size. Sample size was taken into account to obtain sufficient statistical power, thereby detecting a true effect. For this purpose, G-Power 3 was used to calculate an adequate sample size (Faul, Erdfelder, Buchner, & Lang, 2009) with a Fixed Model R2 increase. For repeated measures ANOVA, G-Power 3 showed that the total sample size required for a medium effect size ($f2 = 0.25$) would be 111 (approximately 37 in each of the three groups) to have 95% power at the 5% alpha level; and 102 (approximately 34 in each of the three groups) would be required to have 90% power at the 5% alpha level. For structural equation modeling (SEM), the simulation study (Wolf, Harrington, Clark, & Miller, 2013) showed that a three-factor, six-indicator model with factor loadings of .65 would require 120 participants; a three-factor, six-indicator model with factor loadings of .80 would require 100 participants. Together, with the prospect of factor analysis as one of the tests along with ANOVAs, a sample size of at least 102 was identified.

Sampling process. Overall, 57 preschools (nine Montessori, 10 Reggio Emilia, and 38 BCELF preschools) in urban areas of a Western Canadian city that met the school selection criteria were contacted to participate in the study via phone calls as well as emails. Permission was sought from the head teachers via a letter of invitation. Fourteen schools (25%) agreed to participate in the study: six Montessori (67%), four Reggio Emilia (40%), and four BCELF schools (11%), which highlighted the difficulty recruiting participants, especially BCELF preschools. This recruitment challenge could be attributed to scheduling conflict, mistrust of researchers (Foss, Druin, & Guha, 2013) and/or lack of interest in the research topic.

A total of 198 children (82 Montessori, 53 Reggio Emilia, and 53 BCELF) from these 14 schools were initially invited to participate in the study. Since it is regularly a considerable challenge for researchers to obtain parental consent forms due to parental nonresponse or refusal, a set of procedures was employed to increase the chance of obtaining more consent forms (Fletcher & Hunter, 2003; Wolfenden, Kypri, & Freund, 2009). Firstly, the researcher distributed personalised consent forms labelled with children's names along with an information letter directly to teachers and parents as part of a direct contact strategy. This also created an opportunity for parents or teachers to put questions to the researcher. Secondly, a multiple wave procedure for collecting consent forms was employed. Before commencing the current study, those parents who still had not returned their consent forms were directly contacted by respective classroom teachers or administration staff a few times via emails or even phone calls when possible, and asked to return the forms. Regardless of these explicit procedures, return rates remained quite low, especially for the BCELF parents (55%).

As a result, a total of 124 children (51 Montessori, 44 Reggio Emilia, and 29 BCELF) at pre-test and 119 children (48 Montessori, 42 Reggio Emilia, and 29 BCELF) at post-test with informed parental/guardian opt-in consent forms took part in the study (Table 4.4-1). In addition to the considerable challenges in recruiting play-based schools, the lower participation rate of the BCELF school children resulted in unequal sample groups with BCELF children falling short of a desirable number of 34. Practical constraints such as schedule conflict of recruited schools, limited time of the researcher, and mostly unavailability of participants that fit the selection criteria were substantial barriers and inevitably determined the final sample size of the current exploratory study. Accordingly, an alternative analytical procedure such as multiple indicator-multiple cause (MIMIC) approach was considered. This model was advised under conditions of small and/or unequal sample sizes to estimate the factor means (Kaplan & George, 1995) (See *4.12 Statistical analysis plan*). The results, however, should be interpreted with caution. The following section will outline the description of participants.

Variable	Programme type			Total
	Montessori	Reggio Emilia	BCEFL	
Number of schools contacted	9	10	38	57
Number of schools participated	6	4	4	14
School response rate (%)	67	40	11	25
Children invited to participate (n)	82	53	53	198
Children participated at pre-test (n)	51	44	29	124
Children participated at post-test (n)	48	42	29	119
Children participation rate (%)	63	83	55	63

Table 4.4-1. Participation rate of schools and children

4.5 Participant description

Children. Participants were 119 children enrolled in 14 different preschools. The participants were made up of three groups of children living in a Western Canadian city in British Columbia (BC) and attended different forms of preschool programmes (Montessori, Reggio Emilia, and BCELF schools). Children ranged in age from 46 to 57 months (M = 52.36, SD = 3.22) at pre-test and from 54 to 66 months (M = 59.36, SD = 3.22) at post-test. All of the children turned four years old by the end of December 2015 and were expected to proceed to kindergarten in the next academic year of 2016. Over 81% of children were of White heritage, 18% were Asian, and 1% were Hispanic. All the children who participated in the study were fluent in English. The majority of the children (83%) were returning students from the previous year and were familiar with their teachers as well as the classroom environments.

Parents. The 14 preschools that participated in the study were all privately operated, as there are no subsidies from the governmental body for this age group in BC. Consequently, most of the families shared similar socioeconomic status as middle class. Of the 101 parents who completed the questionnaire at pre-test, 75 parents (60%) reported that they earned an average annual income between CAD 44,000 and 88,000; 16 parents (13%) earned less than CAD 44,000; five parents (4%) earned greater than CAD 88,000; and the rest (23%) is unknown as they chose not to answer the question. By programme types, the parents at the Reggio Emilia schools showed the highest mean score of 2.01, with two indicating an annual income between CAD 44,000 and 88,000, while the parents at the Montessori schools showed the lowest mean score of 1.74, with one indicating an annual income less than CAD 44,000. However, one-way analysis of variance (ANOVA) revealed that there was no statistically significant difference between groups in levels of family income, F (2, 98) = 1.73, $p > .05$.

Parental education. Of the 101 parents, 97% of the respondents were mothers. Overall, 47 parents (47%) reported that they had a four-year university degree; 19 parents (19%) had a two-year college degree; nine parents (9%) had a high school diploma; three parents (3%) had a Doctor of Philosophy degree (PhD); and six parents (6%) had a professional degree such as Medical Degree (MD) and Juris Doctor degree (JD). By programme types, parents at both Montessori and BCELF schools had the highest mean score of 3.19, with three indicating completing a four-year university degree, while the parents at the Reggio Emilia schools had the lowest mean score of 2.91, with two indicating completing a two-year college degree. However, one-way ANOVA revealed that there was no statistically significant difference between groups in levels of parental education, F (2, 98) = .436, $p > .05$.

Parental expectations. Parental expectations for social skills, learning attitude, and academic skills were surveyed using the National Household Education Survey (NHES) by the US Department of Education (Appendix B). Although Montessori parents showed the highest expectations for all three domains, one-way ANOVA showed that there was no statistically significant group difference.

Parental school choice. Parents were also asked an open-end question regarding their school selection, "*If your current type of school was not available, what type of schools would you choose for your child*?". Of the 22 Reggio Emilia parents who answered the question, 15 of them (68%) favoured Montessori; of the 18 BCELF parents who answered the question, eight of them (44%) favoured Montessori.

Teachers. Twenty-five preschool teachers participated in the study, 10 Montessori, 10 Reggio Emilia, and five BCELF school teachers. The majority of the teachers were Caucasian women, except for one Asian woman and one Caucasian man. Regarding teaching experience, there was a statistically significant difference by programme types, F (2, 116) = 16.107, $p < .01$. The BCELF school teachers had the highest mean score of 3.14, with three indicating 11-15 years of teaching experience followed by the mean score of 2.88 of Reggio Emilia teachers, with two indicating 6-10 years of teaching experience, while Montessori teachers had the lowest mean score of 1.77, with one indicating 1-5 years of teaching experience which was significantly lower than the Reggio Emilia and BCELF school teachers. Teachers at Montessori schools had an average of 6.5 years of teaching experience, teachers at Reggio Emilia schools had an average of 9.1 years of teacher experience, and teachers at BCELF schools had an average of 12.6 years of teacher experience.

Teacher education. Regarding the teachers' level of education, one-way ANOVA indicated that there was a statistically significant difference by programme type, F (2, 116) = 29.196, $p < .01$. Montessori teachers had the highest mean score of 2.92, reaching nearly three which indicates a university degree; their educational level was statistically significantly higher than the Reggio Emilia and BCELF school teachers. This is not surprising, as the minimum educational requirement for undertaking Montessori teacher training is normally that one holds a bachelor degree. All the Montessori teachers had an Association Montessori Internationale (AMI) teacher diploma. Of the 10 Montessori teachers, three of them had a two-year college degree; six had a university degree; and one had a master's degree. Of the 10 Reggio Emilia teachers, all had an Early Childhood Educator (ECE) Certificate or Diploma and three had a university degree. Of the five BCELF teachers, all of them also had an ECE Certificate or Diploma and two had a university degree (Table 4.5-1). Research suggests inconclusive evidence concerning an association between teacher experience or education and classroom quality/student achievement (Early et al., 2007; Ladd, Clotfelter, & Vigdor, 2007). Firstly, the first years of teaching show the highest teacher productivity; teacher effectiveness measured by student levels of academic achievement increases sharply in the first few years and then does not exhibit a dramatic progression afterwards (Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2008; Rice, 2010). Secondly, teacher effectiveness does not show a statistical difference between teachers with more than 20 years of experience and those with five years of experience at a significant level, though more experienced teachers are more effective than those with no experience (Ladd et al., 2007). Finally, the results from seven studies of preschool programmes reviewed by Early et al. (2007) found no clear pattern of a convincing association between teacher's educational levels and children's academic gains. These findings suggest that teacher experience and credentials are important yet may only reflect a small portion of much broader teacher quality. In the current study, teacher's years of experience and educational levels were excluded in the end since the inclusion of these covariates had little influence on the parameter estimates.

Teacher expectations. Teacher expectations for social skills, learning attitude, and academic skills were also investigated using the National Household Education Survey (NHES) (Appendix B). One-way ANOVA revealed that there was a statistically significant difference in all scales across the three programme types. For social skills, Montessori teachers showed significantly higher expectations than BCELF teachers ($p = .04$). Montessori teachers and Reggio Emilia teachers or Reggio Emilia and BCELF teachers did not differ significantly from each other. For learning attitude, Montessori teachers showed significantly higher expectations than Reggio Emilia ($p = .001$) and BCELF teachers ($p = .001$). Reggio Emilia and BCELF teachers did not differ significantly from each other. For academic skills, Montessori teachers showed significantly higher expectations than both Reggio Emilia ($p = .001$) and BCELF teachers ($p = .02$). BCELF teachers also showed significantly higher expectations for academic skills than Reggio Emilia teachers ($p = .03$).

These results highlighted different perceptions held by teachers depending on programme types. Montessori teachers consistently expressed higher expectations in all areas than Reggio Emilia and BCELF school teachers. Although research suggests that teacher expectations have a significant impact on students' performance especially academic outcomes (e.g., Rubie-Davies, Hattie, & Hamilton, 2006; Speybroeck et al., 2012), teacher expectations are excluded from the main analyses in the end since the inclusion of these variables as covariates had little influence on the parameter estimates.

Variable	Programme type		
	Montessori	Reggio Emilia	BCELF
Number of schools	6	4	4
Number of classrooms	10	5	4
N (girls) in pre-test	51 (25)	44 (18)	29 (16)
N (girls) in post-test	48 (24)	42 (18)	29 (16)
Average age of children in months at T1 (*SD*)	52.1 (2.99)	51.82 (3.47)	53.46 (2.91)
Percent White	77%	84%	86%
Parental education (*SD*)[1]	3.19 (1.27)	2.91 (1.27)	3.19 (1.35)
Family income level (*SD*)[2]	1.74 (0.53)	2.03 (0.74)	1.88 (0.58)
Years of teacher experience (*SD*)[3]	1.77 (0.78)	2.88 (1.35)	3.14 (1.45)
Teacher education (*SD*)	2.92 (0.56)	2.39 (0.72)	2.43 (0.50)
Tuition fees average per month if attended 5 days a week (CAD)	525	530	410

Table 4.5-1. Demographic characteristics of children, families, and programmes

4.6 Programme type

Table 4.6-1 highlights characteristics of three preschool programmes selected for the study: Montessori, Reggio Emilia, and BCEFL schools. All of them offered 2.5-to 3-hour sessions for 4-year-olds either in the morning or in the afternoon. All Montessori classrooms contained multi-age groupings, whereas all the BCELF schools and most of the Reggio Emilia schools had same age groupings. The following section will outline the selection of the participating schools, respective teacher training, classroom environment, and programme characteristics.

4.6.1 Montessori schools

Teacher training. AMI teacher training for ages 3-6 consists of a minimum of 710 hours of instruction and training. In general, trainees receive at least 400 hours of classroom-based lectures in the Montessori theory as well as other key areas in child development, a minimum of 140 hours of supervised practice with Montessori materials and 170 hours of observation and teaching practicum in Montessori schools (AMI, 2016).

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[1] Parent and teacher education scale ranged from 1-6 (1 = high school; 2 = two-year college degree; 3 = University degree; 4 = Masters degree; 5 = Doctorate degree; 6=Professional degree.

[2] Family income level scale ranged from 1-3 (1 = less than CAD 44,000; 2 = CAD 44,000-88,000; 3 = more than CAD 88,000), with higher scores indicating higher family income level.

[3] Teacher's years of experience scale ranged from 1-5 (1 = 1-5 years; 2 = 6-10 years; 3 = 11-15 years; 4 = 16-20 years; 5 = over 20 years).

	Montessori	Reggio Emilia	BCELF
Image of the child	・Having innate need for learning ・An active participant in his/her own education ・Having 'Sensitive periods' for learning	・Having rights rather than simple needs (Rinaldi, 1993) ・Having '*the hundred languages*' ・A co-creator of knowledge ・Social being (Hewett, 2001)	・Having rights to play ・Capable and full of potential ・Social being
Learning	・A mixture of child-centred activities and didactic teaching ・Individualised or small group lessons ・Hands-on learning (Lillard, 2013)	・Child-originated and teacher-shaped activities (Forman & Fyfe, 2012) ・Emergent learning ・Project-based, collaborative learning (Hall et al., 2014)	・A mixture of child-centred and teacher-led activities ・Theme-based learning
Area of focus	・Independent and autonomous learning ・Self-directed learning ・Freedom with responsibility ・Courtesy and manners ・Care for self and others (Duffy & Duffy, 2012)	・Cooperation and collaboration ・Problem solving and analytical skills ・Verbal literacy ・Emphasis on art and creativity (Hewett, 2001)	・Social, physical, and cognitive development ・Exploration and creativity ・Language and literacy skills ・Social interactions
Attitude toward play	・Share many elements of playful learning while eschewing pretend-play (Lillard, 2013)	・Long-term project as a vehicle of learning ・Free-play including pretend play is encouraged	・Children learn best through play ・Free-play including pretend play is encouraged
Environment	・Prepared environment is a central focus to promote deep concentration and self-discipline (Lillard, 2005) ・Mixed age groups (e.g., 3-6 years old)	・Treat environment as a third teacher (Hall et al., 2014) ・Usually, same-age groups (Edwards, 2003)	・Flexible environment to support early learning ・Same-age groups
Materials	・Scientifically designed, self-correcting materials with specific learning objectives ・Hands-on materials (Lillard, 2005)	・Sensory (sand and water), open-ended, authentic, and natural materials (Hall et al., 2014)	・Open-ended, construction, sensory, and creative materials
Role of a teacher	・A facilitator of learning by linking developmentally appropriate materials and a child ・'Follow the child'	・A co-constructor of knowledge ・Listen to a child; 'pedagogy of listening' (Rinaldi., 2006)	・A facilitator of learning through play
Documentation/ Observation	・Extensive observation training during teacher training ・Daily observation to understand a developmental stage, levels of focus, and particular interests of a child	・Extensive documentation to 1) monitor children's progress; and 2) communicate with co-constructors (child, teacher, and parent) about on-going learning (Hall et al., 2014)	・General lack of observation training during teacher training ・Observation practice may vary across schools
Relationship with parents	・The partnership between teachers and parents is essential to help children become holistic human beings (Edwards, 2003) ・Parents and teachers have a unique and distinctive role (AMI-USA)	・A harmonious relationship between home and school is of central importance ・Parents are active contributors of learning and knowledge (Edwards, 2003)	・Parents are considered as partners in children's learning and well-being

Table 4.6-1. Curriculum characteristics

Classroom environment. The classroom is divided into several sections such as Practical Life, Sensorial, Language, Mathematics, Geography and Culture, and Music areas, all of which are equipped with purposely designed, self-correcting Montessori materials. Each material caters to specific aspects of child development and children are encouraged to interact with these materials in order to experience active and concrete learning.

Programme characteristics. Montessori is an alternative education with a strong emphasis on supporting children's independence and fostering concentration through its guiding tenet of student-directed learning. The central element of Montessori education shares many elements of playful learning where a delicate balance between didactic teaching and child-led activities is maintained while eschewing pretend-play (Lillard, 2013). Montessori children have freedom of choice; however, each material has a particular purpose and thereby a specific interaction with these materials is expected (Lillard, 2013). In this sense, the work itself is more structured in Montessori classrooms compared to Reggio Emilia and play-based curricula where children have freedom to explore materials in their classrooms without established expectations. Montessori education also emphasises the importance of a carefully prepared learning environment with the provision of learning materials that can respond to children's inner drives and thus promote self-discipline and concentration (Lillard, 2005). Children are actively involved in educational planning; their autonomous learning is strongly encouraged.

Daily schedule was minimally structured; from the moment when children arrived in each classroom, they freely selected materials off the shelves and worked either individually or in a small group. A snack was provided throughout the day on a self-service basis.

4.6.2 Reggio Emilia schools

Teacher training. All the teachers completed their early childhood education (ECE) certificate or diploma programmes and have gone to a number of Reggio Emilia related workshops as part of their professional development. The basic ECE training consists of a minimum of 902 hours of instruction and training, which cover the key areas of child development, curriculum planning, family and community resources, nutrition as well as practicum in early childhood educational settings (Friendly et al., 2015).

Classroom environment. Environment is treated as a third teacher in Reggio Emilia schools (Hall et al., 2014) and there is care and attention paid to the details of physical learning spaces (McNally & Slutsky, 2016). Each classroom had a dramatic play area, a sand box, art space, reading corner, and shelves with a mixture of typical preschool materials such as blocks and puzzles and natural objects such as rocks, twigs, cones, and wooden cubes. All the classrooms were decorated with the work of the children such as painting, drawings, and paper objects along with pictures that teachers had been taking as documentation of children's learning processes.

Programme characteristics. The Reggio Emilia approach places substantial importance on collaboration and cooperation in learning; children are expected to work closely together with their peers and teachers in various projects (Hall et al., 2014). The Reggio Emilia practice is a project-based approach in which children's questions and ideas initiate activities with the help of teachers. The role of teachers is to listen and document children's voices through the pedagogy of listening (Rinaldi, 2001) and to facilitate a project together with the children (Hall et al., 2014; McNally & Slutsky, 2016). Therefore, unlike Montessori education, the Reggio Emilia approach does not have a set curricula. It is considered as "emergent" or "contextual" learning with child-originated and teacher-framed activities through which children and teachers learn together as co-creators of knowledge (Forman & Fyfe, 2012). Each classroom normally started their day with circle time where teachers and children discussed their interests while any questions/ideas raised by children were documented in a written form. After circle time, children were free to choose any materials off the shelves, choose activities prepared by the teachers, or engage in a classroom project.

4.6.3 BCELF preschools

Teacher training. All the teachers had ECE certificate or diploma and the training process was the same as the Reggio Emilia teachers. The basic ECE course is offered at an approved institution and the trainees received a minimum of 902 hours of instructions and training in the key areas of child development and practicum, which is required for licensing by the ECE Registry (Friendly et al., 2015).

Classroom environment. Each classroom was divided into different sections such as child-sized kitchen, dramatic play area, water and/or sand tables, reading corner, art space, and open area with typical preschool materials such as wooden or/and plastic blocks, dolls, beads, and puzzles. Each classroom had a few tables seating four to six children for sit-down activities and a distinctive open area for circle time and free movements.

Programme characteristics. A traditional play-based approach is the most common curriculum used in preschool settings in British Columbia with a strong emphasis on children's right to play. Unlike the Reggio Emilia approach, typical play-based schools do not routinely undertake large projects as part of their daily learning, though short-term projects occasionally occur. Central focuses of a BCELF programme are physical development, social-emotional well-being, social responsibility, and a provision of opportunities for exploration and creation through a variety of indoor and outdoor play (BC Ministry of Education, 2008). Within the BCEFL, play is viewed as a vehicle of learning that can provide the most natural and meaningful process through which children can construct knowledge, explore the world around them, develop physical and intellectual capacities, and build relationships with their peers (BC Ministry of Education, 2008).

Daily schedule was a mix of free playtime, outdoor time, circle time, and snack time, all of which followed a predictable routine. During the unstructured playtime, children were free to choose any materials/toys from the shelves. Outdoor time was usually free play. Circle time involved a variety of group activities such as attendance, storytelling and singing.

4.7 Attrition and response rate

At the end of post-test, attrition during the study was minimal. No teachers dropped out during the school year. Attrition of the children over the course of the study was low: three children from Montessori schools and two children from Reggio Emilia schools left the study due to chronic illness or relocation. In the autumn pre-test, 124 children had the direct assessments of EF and academic achievement and teacher reports on 123 children (99%) and parent reports on 101 children (81%) were received. For the post-test data collection in the early summer of 2016, 119 children had the same direct assessments as in autumn and teacher reports on 119 (100%) and parent reports on 87 children (73%) were received.

4.8 Assessment challenges

Traditional methods of assessing EF and social-emotional skills include self-report, teacher and parent ratings, peer ratings, observation, and direct assessments. When measuring EF and social-emotional skills, however, there is a discrepancy in the conceptual frameworks of these skills. This conceptual clutter has been one of the main reasons for revealing inconsistencies over the choice of measurement instruments and inconclusive evidence of effectiveness (Campbell et al., 2016; Samyn, Roeyers, Bijttebier, Rosseel, & Wiersema, 2015; Schmitt, McClelland, Tominey, & Acock, 2014; Wigelsworth, Humphrey, Kalambouka, & Lendrum, 2010). It is essential to establish a clear conceptual framework and use particular measures accordingly so that it can reduce source biases and add validity of the findings (Denham et al., 2003; Fantuzzo, Perry, & McDermott, 2004; Schmitt et al., 2014). In addition to the conceptual issues, the measurement issues also need to be explored. Therefore, this section discusses key challenges when measuring children's EF and social-emotional skills before describing in detail the measures used in the current study.

Executive function (EF). Schmitt et al. (2014) examined the predictive utility of various EF measurements including teacher rating, observation, and direct behavioural assessment and found these measures domain-specific. Findings indicated a significant positive correlation between teacher rating and direct behavioural assessment ($r = .35, p < .01$). The results also suggested that 1) the teacher ratings were the strongest predictor of literacy (letter-word knowledge); and 2) the direct assessment measured by the Head-Toes-Knees-Shoulders tasks (HTKS; McClelland et al., 2007) was the strongest predictor of early mathematic skills such as applied problem-solving, although both assessments were significantly and positively associated with academic achievement. Fuhs, Farran, and Nesbitt (2013) also compared the unique contributions of teacher ratings and direct assessments of prekindergarten children's EF. The results found that both of the measurements were the significant predictors of children's academic gains in literacy, language, and mathematics, although the direct assessments were only marginally correlated with language gains. The subject specific associations were highlighted in which 1) the teacher reports were stronger predictors for language and literacy; and 2) the direct assessments of EF were stronger predictors for mathematics. Fuhs et al. (2013) argued that children's daily use of EF measured by teacher ratings might have a larger influence on the development of literacy and language, whereas the cognitive process measured by direct assessments might have more direct impact on mathematics.

These findings demonstrate the domain specificity of performance-based measures and reporting scales (Ponitz, McClelland, Matthews, & Morrison, 2009; von Suchodoletz et al., 2013; McAuley, Chen, Goos, Schachar & Crosbie, 2010). For example, a review by Toplak, West, and Stanovich (2013) postulated that indirect and direct assessments essentially assess different aspects of cognitive levels because of the differences in the administration and task demands. The researchers reviewed 20 studies that examined the measurable associations between performance-based and rating measures of EF and found only a moderate median correlation ($r = .19$) between the two. They suggested that direct assessments tap into the efficacy of processing at the cognitive level (algorithmic mind), whereas rating measures tap into individual rational thinking dispositions at the intentional level (reflective mind), thus these measures should not be treated interchangeably. Stanovich (2009) supports this distinction by arguing that most of the performance-based measurements of EF largely restrict intentional and reflective-level functioning and result in assessing the algorithmic mind rather than the reflective mind. For these reasons, using both types of assessments together at a cognitive-level as well as reflective-level functioning for assessing EF is recommended to make meaningful inferences and clarify findings.

Ecological validity is compromised when administering direct assessments in a quiet, one-on-one environment with minimal distractions because such a neutral setting does not represent a real-life context in school or home (Anderson & Reidy, 2012; Fuhs et al., 2013). As children normally have to deal with situational demands while completing a task in the classroom, it is desirable to conduct direct measurements in naturalistic environments, thus increasing the ecological validity (McClelland & Cameron, 2011). In contrast, observational measures can capture typical behavioural regulation in classroom contexts with increased ecological validity and objectivity (Smith-Donald, Raver, Hayes, & Richardson, 2007). Using observational tools, however, can be a lengthy process and situational variation can make comparisons challenging. In fact, the study by Schmitt et al. (2014) did not suggest a strong predictive utility of an external observer report of executive functioning skills to academic achievement of preschoolers ($\beta = .02$ for math; $\beta = -.08$ for literacy). Similarly, teacher and parent ratings are situation-specific and could result in rater bias (Schmitt et al., 2014; Smith-Donald et al., 2007). These ratings vary depending on “expectation, experience, and personality" of the rater (Smith-Donald et al., 2007, p. 175) and may be inflated by respondents' emotional engagement (Schmitt et al., 2014). The report measures, however, allow a large volume of data to be collected in a relatively inexpensive way and are useful to offer valuable information regarding children's real-life behaviours, as the teachers and parents have extensive daily interactions with a given child in the classroom, home, or social environments (Hughes, 2011; Smith-Donald et al., 2007).

Attention should also be paid to the use of child-friendly as well as developmentally or age appropriate measures of EF. Anderson and Reidy (2012) point out that the degree of interest and motivation can vary greatly amongst young children, which in turn can lead to cognitive and motivational fatigue and affect their overall performance. Accordingly, employing measures that appeal to children's interest and maintain their motivation is one practical approach. In previous research, many of the EF tasks tended to focus on adult populations and resulted in the lack of age-appropriate tasks for young children (Anderson & Reidy, 2012; Garon et al., 2008). The remaining challenge is to retain the critical component of EF while scaling down the adult-oriented EF tasks for young children (Garon et al., 2008); these adult-derived tasks may be irrelevant to young children and pose a risk of essentially measuring non-EF skills (Anderson & Reidy, 2012). Fortunately, there have been increased efforts in developing adequate measures for young children in the last 20 years (Hughes, 2011). Hughes and Graham (2002) highlighted relevancy of simplified EF tasks to children's performances. Firstly, when comparing to adults, perceived novelty of a new task lasts longer amongst young children such that they exhibit slower shifts from controlled actions (alternative responses) to automatic actions (habitual responses). This potentially ensures greater interpretability of underlying controlled processing and task performance. Secondly, young children have limited processing capacity, which can increase their responsiveness to specific functional demands. Accordingly, simplified EF tasks for children can likely reduce task impurity and successfully isolate targeted variables, namely controlled processing. Lastly, children do not mask their behaviour compared to adults. This behavioural transparency makes their response suppression more evident and observable and thus likely reduces a risk of low process-behaviour correspondence.

Social-emotional skills. Traditionally, social-emotional assessments heavily depend on teacher and parent ratings (Halle & Darling-Churchill, 2016). Similar to the issues addressed for the rating measures of EF, one of the key challenges of using social-emotional indirect measurements is rater-bias. Teacher ratings can be affected by negative halo effects (Mashburm, Hamre, Downer, & Pianta, 2006; Phillips & Lonigan, 2010). Earlier research by Abikoff et al. (1993) examined the accuracy of teacher ratings and found a unidirectional bias. In their study, the presence of aggressive and oppositional defiance of children inflated teachers' ratings on the degree of disruptive behaviours despite the lack of behavioural evidence, whereas children with inattentiveness and overactivity were not rated as displaying oppositionality. The results highlighted a risk of systemic errors in teachers' ratings in which their judgement could be largely influenced by subjective biases irrespective of a child's actual competence (Mashburn et al., 2006).

Informants' perception and expectation of social-emotional skills also have a significant influence on their responses (Phillips & Lonigan, 2010; Yates et al., 2008). For example, some teachers or parents may favour greater obedience as the most preferred quality of children, whereas others may give more importance to autonomy of children. These individual differences in preference and perceived acceptability determine whether certain behaviour is viewed as acceptable or problematic, thus affecting how social-emotional skills are measured (Campbell et al., 2016; Yates et al., 2008).

Additionally, social-emotional desirability varies greatly across different cultures (Edmunds & Stewart-Brown, 2003). Self-oriented cultures where individual needs and desires are prioritised may put a higher value on autonomy and individuality, whereas collectivistic cultures where group harmony outweighs the individual's well-being may put more emphasis on hierarchical relatedness and communal spirit (Bergeron & Schnerider, 2005; Chen & French, 2007; Gernhardt, Lamm, Keller, & Döge, 2014). This cross-cultural variability plays an important role in expressing and understanding social-emotional competence (Chen & French, 2007; Denham, Ferrier, Howarth, Herndon, & Bassett, 2016; LaFreniere et al., 2002). For example, in a study of preschool children from Japan, Canada, and the US, Japanese children showed significantly lower anger and anxiety compared to American and Canadian children (Masataka, 2002), indicating cultural differences in social-emotional dispositions. With rising levels of immigration and associated cultural and ethnic diversity, there is an increased need for incorporating measures that are sensitive to cross-cultural variations in social-emotional skills (Darling-Churchill & Lippman, 2016).

Since social-emotional skills develop with increasing age and show different characteristics over time, measurements should consider the age and developmental stages of children (Edmunds & Stewart-Brown, 2003). Importantly, some preceding aspects of social-emotional skills have not fully emerged in young children (Campbell et al., 2016). For example, theory of mind (ToM), the ability to understand other people's perspectives and predict their actions, has shown to facilitate children's prosocial behaviour including cooperating, helping, and comforting (Imuta, Henry, Slaughter, Selcuk, & Ruffman, 2016). The expressive language skills, which are essential to the development of social competence, have also been shown to be significantly linked to ToM (Imuta et al., 2016; Hughes & Ensor, 2007). These capacities, however, expand gradually during the course of early childhood and are not fully developed in young children (Campbell et al., 2016). Consequently, many of the behaviours that are viewed as problematic in middle childhood may be developmentally normative in early childhood due to premature social-emotional skills (Carter, Briggs-Gowan, & Davis, 2004; Phillips & Lonigan, 2010). Therefore, specific developmental characteristics in different phases of childhood should be accounted for when measuring social-emotional skills of young children.

Another issue to consider is that the majority of social-emotional assessment tools including the Social Skills Rating Scale (SSRS; Gresham & Elliot, 1990) and the Child Behaviour Checklist (CBCL; Achenbach, 1991) generally focuses on identifying a range of problem behaviours (Rudolph & Epstein, 2007). Although these instruments have strong psychometric properties and are well validated to identify social-emotional dysfunctioning, they may place unnecessary emphasis on negative behaviour and fail to distinguish children with mild problems due to floor effects (Edmunds & Stewart-Brown, 2003). Humphrey et al. (2011) also argue that more well-established instruments are only concerned with social skills as opposed to both the social and emotional dimensions. As a result, strength-based assessments such as the Social-Emotional Assets and Resiliency Scale (SEARS; Merrell, 2011) that encompass both the social and emotional components can be useful to assess children's strengths and competencies. This, in turn, helps teachers and parents to establish positive expectations for a child rather than focusing on problems, thus empowering him/her (Rudolph & Epstein, 2007).

Social-emotional skills are best reflected in social interactions (Campbell et al., 2016). Consequently, naturalistic observations can complement rating measures to capture a child's usual behaviour in a relatively unbiased and ecological way (Wolcott & Williford, 2015; Jones, Zaslow, Darling-Churchill, & Halle, 2016). This highlights importance of utilising a multi-method approach including rating scales and direct observations in order to understand a comprehensive profile of a child. Research, however, has indicated low to moderate correlations between report measures and observations. For example, Thomas, Shapiro, DuPaul, Lutz, and Kern (2011) examined the relationship between indirect and direct measurements of preschoolers' social skills. The teacher-ratings on 137 children ages 3-5 who were at risk for attention deficit hyperactivity disorder (ADHD) were collected to assess social competencies including cooperation and attention. Direct observations were also conducted during free play to assess positive social interactions. Consistent with previous studies, the result suggested that there was a low level of association between teacher-rated social skills and observed social play ($r = -.17$). Such low agreements between informant reports and direct observations indicate that 1) each measurement targets different aspects of social skills of children; and 2) children in fact behave differently according to diverse settings (e.g., outdoor free play vs. classroom activity) and relational contexts (Kerr, Lunkenheimer, & Olson, 2007).

Direct observations are more time consuming and costly and normally require special training, all of which often make them impractical (Thomas et al., 2011; Wolcott & Williford, 2015). By contrast, parent and teacher rating scales are efficient with respect to time and cost and are more suitable for everyday use (Thomas et al., 2011). The rating measures are also useful to detect low-frequency behaviour that may be clinically significant yet are hard to capture by time-sampling observations (Halle & Darling-Churchill, 2016; Wolcott & Williford, 2015).

Together, these results suggest that the utility of multiple measures that tap into a particular latent construct is essential to provide a more comprehensive profile of a child's EF and social-emotional skills. Both indirect and direct measurements should take into account 1) predictive utility; 2) ecological validity; 3) rater bias; 4) practicality; and 5) developmental appropriateness. Failing to employ adequate measuring instruments or heavily relying on one method in isolation may add bias and error variance to the findings and lack validity. For these reasons, the present study employed 1) well-established instruments followed by statistical analysis procedures; and 2) rating scales with multiple respondents including parents and teachers combined with direct assessments to ensure reliability and validity. The following two sections will outline the procedures and measurement tools used in the current study.

4.9 Data collection procedures

Observation training. In order to remain objective to what is taking place within classrooms and thereby reduce observer bias, rigorous reliability training is necessary. This, in turn, helps ensure coherence and comparability between different studies, especially those in which the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008) is used. Prior to conducting observation, the researcher undertook a 14-hour online Teachstone's Training programme to become a CLASS observer. The two-day training included pre-reading and viewing of video-clips, concentrated attendance in the online workshop guided by the CLASS trainers in the US, individual training materials (20-minute video clips) to practise coding against standard codes provided by the trainers, and the opportunity to take an online rater-reliability test. The rater-reliability test consisted of five 15-20 minute clips and required over 80% accuracy against the master codes up to three rounds (Pianta et al., 2008). The researcher obtained certification as a CLASS observer by achieving an inter-rater reliability of 94% in 2014. As annual recertification is required for continued accurate use of the CLASS instrument, the researcher undertook the reliability tests in 2015 and 2016 and achieved over 90% accuracy both times.

When conducting observation, observer biases can occur due to potential observer drift and expectancy effects (Hersen, 2004; Little, 2013). Observer drift is a change in interpretation of the original behavioural definitions (McKay, 2008). This implicit shift in code definition can be derived from various reasons such as rater fatigue, ambiguous behavioural codes, or shifting in the coding scheme (Hersen, 2004). The expectancy effects refer to a tendency for a rater to obtain results based on their expectation-congruent judgements (Rosenthal & Rubin, 1978), which can be influenced by prior knowledge and experiences (Little, 2013). In order to eliminate the possibility of such observer bias, having clear behavioural codes, intentional training, and rigorous observation procedure such as in CLASS is essential.

Construct	Measure	Who?			Time points	
		Researcher	Teacher	Parents	Autumn (2015)	Spring (2016)
Classroom quality	Classroom Assessment Scoring System (CLASS)	✓			✓	
Intellectual functioning	Picture Similarities from British Ability Scales Third Edition (BAS3)	✓			✓	
Executive function (direct assessment)	Peg Tapping (inhibitory control)	✓			✓	✓
	Digit Span backwards (working memory)	✓			✓	✓
	Dimensional Change Card Sorting (DCCS) (cognitive flexibility)	✓			✓	✓
Executive function (questionnaire)	Behavioural Rating Inventory of Executive Function – Preschool Version (BRIEF-P)		✓	✓	✓	✓
Relationship quality	Child Parent Relationship Scale (CPRS)			✓	✓	✓
	Student Teacher Relationship Scale (STRS)		✓		✓	✓
Social/emotional skills	Social-Emotional Assets and Resiliency Scales (SEARS)		✓	✓	✓	✓
Pre-academic competence	Naming Vocabulary from BAS3	✓			✓	✓
	Early Number Concepts from BAS3					

Table 4.9-1. Data collection instruments and research timetable

When assigning scores, the observer is required to strictly adhere to four distinct coding rules as a part of the CLASS observation procedure (Pianta et al., 2008). Firstly, the observer needs to remain objective; the ratings should not be influenced by initial impressions of teachers or external explanations. Only behaviours observed are considered in coding in accordance with the detailed descriptions of the dimensions within the CLASS manual without taking the perspectives of the teacher. Secondly, each observation cycle must be treated independently without expecting a change or stability so that ratings can capture behaviour as it occurs in the real-life setting. Thirdly, ratings should be based on frequency, duration, and intensity such that a single occurrence will not dictate an overall rating. The teacher behaviour during the entire observation segment is evaluated and reviewed prior to assigning scores. Lastly, each dimension should be rated independently. Although a single incident often taps into several dimensions simultaneously, it is critical that the observer does not adjust the codes based on expectations of stability across dimensions.

Direct observation. Observation using the CLASS was conducted in the autumn of 2015. One cycle involved 20-minute observation and 10-minute rating; four cycles (2 hours) in a single observation were conducted in each classroom as advised in the CLASS manual in order to obtain quality data of teacher-child interactions. The researcher sat in a classroom corner to take notes and moved if needed to record interactions particularly teachers' behaviour without interruption. The CLASS manual was consistently referred to throughout the coding processes. Methodological limitations of observation in the current study should be mentioned. Firstly, observation was carried out only once a year in the autumn due to practical reasons such as limited time and budget restrictions. However, teachers' interactional quality or styles might drift during the course of school year (Casabianca, Lockwood, & McCaffrey, 2015). This is because 1) there will be more familiarity between teachers and children over time; 2) activities and materials might become different according to the changing developmental needs of the children; and 3) external factors such as holidays or teacher fatigue might also have an impact on teacher and child behaviour (Meyer, Cash, & Mashburn, 2011). Therefore, care should be taken when understanding the associations between the CLASS domains and the development of school readiness skills in the current study. As a single time-point observation makes it difficult to capture the teaching trends in the classroom over time and their potential influences on child outcomes (Casabianca et al., 2015), scorings may have yielded different findings if observations were conducted continuously throughout the year. Secondly, although having a second observer would have been preferable to evaluate the extent to which the same ratings would be obtained by different raters and thereby establish inter-rater reliability, it was not feasible for the same practical reasons above such as limited time and budget and unavailability of qualified CLASS observers in the region. As such, observations were carried out with the upmost care while keeping in mind all the aforementioned observation coding rules to minimise observer bias.

Direct assessments. Children were also assessed individually in a corner of the classroom and administered a series of EF, vocabulary, and numeracy attainment tasks at the beginning and end of the school year. Fluid intelligence was measured only once at the beginning of the school year as a covariate. A series of tasks were presented in a fixed order so as to provide the same experience to all children: Picture Similarities from British Ability Scale-3 (BAS3; Elliot & Smith, 2011), Early Vocabulary from BAS3, Early Number Concepts (BAS3), Peg Tapping (Diamond & Taylor, 1996), Digit Span backwards (DSB; Wechsler, 2003), and Dimensional Card Change Sorting (DCCS; Zelazo, 2006). The whole assessment took approximately 30 minutes per child depending on ability levels.

Parent and teacher questionnaires. Both teachers and parents were provided with a packet of questionnaires at the beginning and end of the school year (Appendix A). Teachers completed the questionnaires on children's daily EF (Behavioural Rating Inventory of Executive Function – Preschool Version – BRIEF-P; Gioia, Espy, & Isquith, 2003); their relationship with each child (Student Teacher Relationship Scale – STRS; Pianta, 2001); their perspectives of the child's social and emotional skills (Social-Emotional Assets and Resiliency Scale – SEARS; Merrell, 2011); and their social and academic expectations (National Household Education Survey – NHES; National Centre for Education Statistics, 2016). Parents completed questionnaires on family demographics (e.g., household income, parental education); their child's daily EF (BRIEF-P); their relationships with their child (Child Teacher Relationship Scale – CTRS; Pianta, 1992); their perspectives of the child's social and emotional skills (SEARS); and their social and academic expectations (NHES). The majority of parents who completed the questionnaire (97%) were mothers. The questionnaires required approximately 10 minutes to complete. A list of measurements and time points for data collection is shown in Table 4.9-1. The following section will describe in detail the selected measurements in the current study.

4.10 Measurements

A variety of direct and indirect measurements were used to collect data on children, teachers, families, and classroom quality. Direct measurements such as systematic observation and performance-based assessments examined behaviour and achievement at the time of occurrence, whereas indirect measurements such as rating scales provided information about informants' perceptions on specific behaviour of a child in his/her naturalistic environments (Thomas et al., 2011).

Classroom quality

a) The Classroom Assessment Scoring System (CLASS)

The CLASS (Pianta et al., 2008) is a standardised instrument for observing and assessing the quality of teacher-child interactions in classrooms. It is organised into three domains

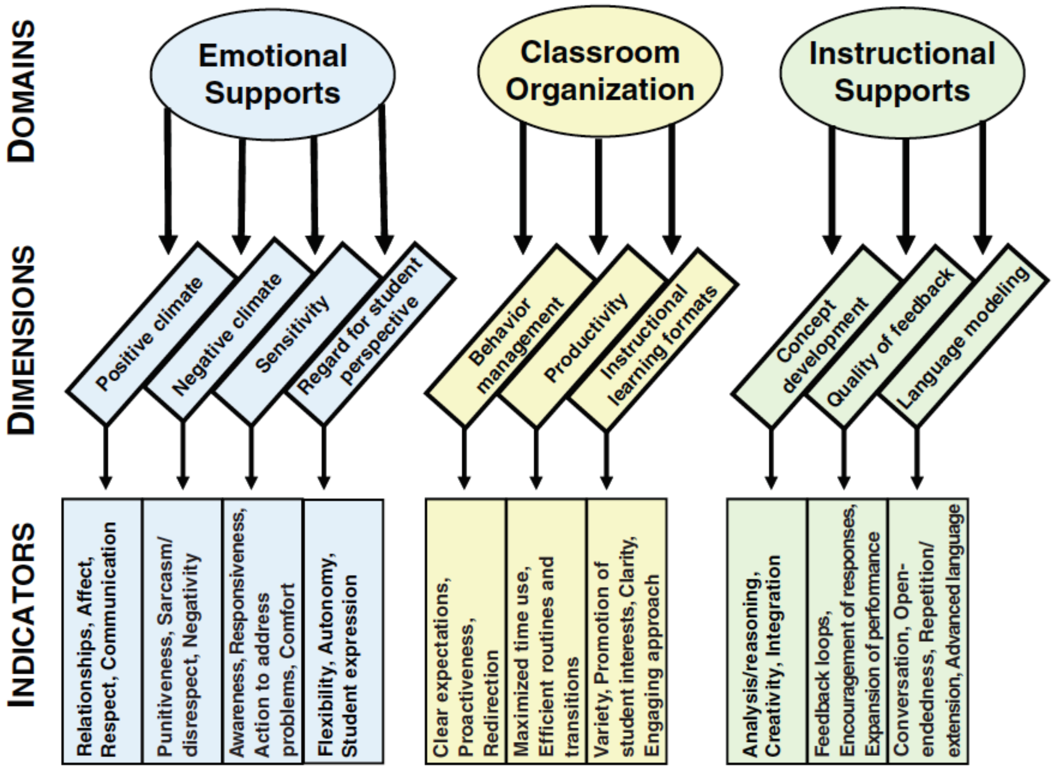

Figure 4.10-1. Overview of CLASS domains and dimensions (Pianta & Hamre, 2009, p. 111)

(Emotional Support, Classroom Organisation, Instructional Support) with 10 dimensions (Positive Climate, Negative Climate, Teacher Sensitivity, Regard for Student Perspectives, Behaviour Management, Productivity, Instructional Learning Formats, Concept Development, Quality of Feedback, Language Modeling) (Figure 4.10-1).

Emotional Support. The Emotional Support domain reflects on children's "social and emotional functioning in the classroom" (Pianta & Hamre, 2009, p. 113) and includes four subscales: Positive Climate, Negative Climate, Teacher Sensitivity, and Regard for Student Perspectives. Positive Climate focuses on the level of an emotional connection between children and the teacher and amongst peers. Negative Climate encompasses the overall level of negative affect (e.g., irritability, anger) expressed through verbal and/or physical interactions between children and the teachers or amongst peers. Teacher Sensitivity reflects the level of the teacher's awareness of, and responsiveness to, individual children, especially when they have academic, social, or behaviour problems. Regard for Student Perspectives measures the degree to which the teacher places importance on children's autonomy and leadership and how classroom activities are reflected on children's ideas, motivation and curiosity.

Classroom Organisation. The Classroom Organisation domain captures the degree to which classrooms have effective management methods, instructional time and routine structures, and engaging classroom/learning activities. This domain considers Behaviour Management, Productivity, and Instructional Learning Formats. Behaviour Management reflects a teacher's ability to provide clear behavioural expectations and use effective strategies to prevent and redirect problem behaviour. Productivity encompasses the teacher's skill to use efficient approaches to manage their instructional time thereby maximising children's engagement in learning activities. Productivity ratings are not meant to measure the quality of instruction or children's level of engagement (Pianta et al., 2008). Instructional Learning Formats reflects the way in which the teacher delivers activities and lessons to facilitate children's participation and involvement.

Instructional Support. The Instructional Support domain considers the degree to which a teacher promotes children's cognitive and language development. This domain encompasses three subscales: Concept Development, Quality Feedback, and Language Modeling. Concept Development reflects how the teacher employs instructional discussions and activities that enhance children's higher order thinking skills. Quality Feedback measures the degree to which the teacher expands children's learning and understanding and encourages their active participation through more individualised and specific feedback. Language Modeling considers the quality and amount of the language stimulation and facilitation used by the teacher so that children are given more opportunities for language use.

Each dimension was rated on a 7-point scale ranging from 1-2 (low), 3-5 (mid) to 6-7 (high). Negative Climate of the CLASS data were reverse-coded following the CLASS manual for the analyses. The average of individual cycle scores for each dimension formed a composite score across number of cycles of observations. After calculating the average dimension scores, the individual composite domain score for Emotional Support, Classroom Organisation, and Instructional Support was obtained.

Table 4.10-2 presents the CLASS descriptive information that was obtained from 19 classrooms across the three school types. The mean, standard deviation, range, skewness, kurtosis, and the Cronbach's alpha values are included in the table. The four cycles (2 hours) of observation were carried out in each classroom and 76 cycles of observation (38 hours) were conducted as a total. Internal consistencies in the current study ranged from .60 to .96.

To determine the normality of the data collected, the skewness and kurtosis values were examined. As seen in the table, most of variables were within a range of ± 1.96 indicating there were not significant differences from a normal distribution at $p < .05$ (Field, 2013). Negative Climate in particular showed problematic kurtosis and skewness values; however, other studies have also demonstrated non-normal distributions in this dimension (e.g., Malmberg, Hagger, Burn, Mutton, & Colls, 2010; Sandilos, DiPerna, & Family Life Project Key Investigators, 2014). This was taken into account in the analysis and interpretation of the data.

Indicator	*M*	*SD*	Range	Skewness	Kurtosis	Cronbach's alpha
Emotional Support	5.89	0.54	4.7-6.8	-0.578	-0.198	
Positive Climate	5.96	0.60	5−7	-0.512	-0.415	.86
Negative Climate	1.12	0.26	1−2	2.710	7.958	.79
Regard for Student Perspectives	5.38	1.05	3−7	1.052	0.698	.94
Teacher Sensitivity	5.36	0.74	4−7	-0.061	-0.348	.81
Classroom Organisation	5.16	0.95	3.4-6.6	-0.374	-1.081	
Behaviour Management	5.67	0.90	4−7	0.000	0.127	.91
Productivity	5.21	0.52	5−6	-2.000	4.000	.66
Instructional Learning Format	4.79	1.53	2−7	-0.773	-0.491	.96
Instructional Support	2.56	0.82	1.4-4.6	0.785	0.432	
Concept Development	2.05	0.58	1−3	-0.104	0.336	.60
Quality Feedback	2.64	0.98	1−5	0.695	-0.595	.94
Language Modeling	2.62	0.80	1−4	0.560	-0.542	.82

Table 4.10-2. Descriptive of the CLASS
Note. Scale ranged from 1-7 (1,2-low; 3,4,5-medium; 6-7-high).

Fluid intelligence

a) Picture Similarities (British Ability Scales Third Edition–BAS-3)

The BAS-3 (Elliot & Smith, 2011) is a standardised test to measure a variety of cognitive strengths and weaknesses of children ages 3-17, and it has been widely accepted in the UK and US (Elliot, 2001). Picture Similarities in Early Years Battery (up to age 7:11) was used to assess the non-verbal reasoning ability of children. A child was shown a row of four different pictures or patterns and asked to match a fifth card with the most relevant one. The items became increasingly difficult and required children to perceive and analyse visual information appropriately based on a common element or concept. Speech was not required to complete a task and most of the contents of the items are not abstract but rather representational. A child received a score of 1 for the correct answer and 0 for an incorrect answer. The total number of items named correctly was added and recorded as a final score; the possible set of scores ranged between 0 and 35. A higher score indicated a greater level of the child's inductive reasoning abilities. According to the National Household Survey (Statistics Canada, 2013), 40% of the total population in the Metro Vancouver areas are foreign-born immigrants. The non-verbal reasoning task was selected so that children who may be learning English as a second language would not be disadvantaged. According to the BAS-3 technical manual (Elliot & Smith, 2011), the average internal consistency for early years was .76; the test-retest reliability was .64.

Table 4.10-3 presents the descriptive information of the Picture Similarities task for the whole sample. The mean, standard deviation, range, skewness, and kurtosis are included in the table. The skewness and kurtosis values were within the acceptable range of ± 1.96.

M	SD	Min	Max	Skewness	Kurtosis
20.33	5.77	4	30	-0.468	-0.018

Table 4.10-3. Descriptive statistics of the Picture Similarities (N = 119)

A one-way ANOVA was also conducted to examine whether there was a group difference in the fluid intelligence scores measured by the Picture Similarities from the BAS-3. Table 4.10-4 presents the means, standard deviations, range, and the results of the Levene's test and a one-way ANOVA.

	Programme type			Levene's test	One-way ANOVA	
	Montessori	Reggio Emilia	BCELF		*F (df)*	Sig.
M	22.3	18.29	20.1			
SD	5.18	5.65	6.00	0.04	5.71 (2,116)**	.004
Range	14−30	4−28	5−30			

Table 4.10-4. Mean, standard deviation, stability, and consistency of the fluid intelligence score
Note. Scale ranged from 0-35; *df* = degree of freedom. ***p* < .01.

The Levene's test was used to examine whether the variance in scores was equal for each of the three school types. The significance value was greater than .05, and thus showed that the assumption of the homogeneity of variance was not violated (Pallant, 2016). A one-way ANOVA revealed that there was a statistically significant difference at the $p < .05$ level in the fluid intelligence scores for the three school types, $F(2,116) = 5.74$, $p = .01$. Post-hoc comparisons using the Tukey test indicated that the mean score for Montessori children ($M = 22.3$, $SD = 5.18$) was significantly higher than Reggio Emilia children ($M = 18.29$, $SD = 5.65$). There was no statistically significant difference between Montessori and BCELF children ($M = 20.1$, $SD = 6.00$) or Reggio Emilia and BCELF children. As such, it was deemed appropriate to include fluid intelligence scores as a covariate to control for in the main analyses.

Direct assessment of executive function

Executive function (EF) was assessed by well-known tasks according to three core executive functioning skills (inhibitory control, working memory, and attention/shift) (Diamond et al., 2007): Peg Tapping, Digit Span backwards, and Dimensional Change Card Sorting (DCCS). The researcher followed the administering instructions and scoring provided by Meador, Turner, Lipsey, & Farran (2013).

a) Peg Tapping

Peg Tapping (Diamond & Taylor, 1996) intends to measure children's inhibitory control by asking them to tap with a peg twice when an experimenter taps once and vice versa. Children are required to restrain a natural tendency to follow the action of the experimenter while holding the rule in mind in order to respond correctly. After two practice trials with feedback, children proceeded to practise eight more times. If children demonstrated understanding during these practice trials, they then had 16 test trials with no feedback. Otherwise, the task was terminated and those who did not perform the test trials received a score of -1. Children who successfully performed the test trials were given a score of 0 for an incorrect response and 1 for correct responses. The total of correct responses were recorded as a final score and the score ranged from -1 to 16. A higher score indicated a greater level of inhibitory control. The internal consistency was .82 in preschool (Blair & Razza, 2007); the test-retest reliability was .80 in preschool (Lipsey et al., 2014). As Diamond and Taylor (1996) pointed out in their study, children in the current study also demonstrated three common errors: 1) following only one set of instructions by always tapping once, or always tapping twice; 2) tapping many times irrespectively; and 3) imitating what the experimenter did instead of doing the opposite.

Table 4.10-5 presents the descriptive information of Peg Tapping. The mean, standard deviation, range, skewness, and kurtosis are included in the table. The skewness and kurtosis values were in the marginally acceptable range.

		Programme type			Total	Skewness	Kurtosis
		Montessori	Reggio Emilia	BCELF			
Time1	*M*	10.25	8.19	10.97	9.7	-0.421	-1.080
	SD	5.11	4.67	4.28	4.86		
	Range	0−16	0−15	2−16	0−16		
Time2	*M*	14.15	13.12	14.24	13.81	-2.004	4.718
	SD	2.38	3.26	2.21	2.71		
	Range	6−16	1−16	6−16	1−16		

Table 4.10-5. Descriptive statistics of Peg Tapping (N = 119)

b) Digit Span backwards (DSB)

The Digit Span backwards (DSB) task from Digit Span (Wechsler, 2003) measures children's working memory and requires a central executive system as opposed to short-term memory (Hale, Hoeppner, & Fiorello, 2002; Reynolds, 1997; St Clair-Thompson, 2010). The examiner asks children to repeat the numbers that they hear in the reverse order for DSB. The memory demands increase as the sets of numbers get larger. After two 2-digits practice trials with feedback, the test trials were administered with an increasing number of digits. Children were given two test trials for each sequence length. The task was terminated if children consecutively failed to recall the same digit span length for two trials. Children received a score of 1 for each trial recalled successfully. The total number of items recalled correctly was added and recorded as a final score. A higher score indicated a greater level of the child's working memory. According to the Wechsler Intelligence Scale for Children manual (2003), the internal consistency was .84; the test-retest reliability was .76 for DSB.

Table 4.10-6 presents the descriptive information of DSB. The mean, standard deviation, range, skewness, and kurtosis are included in the table. The skewness and kurtosis values were within the acceptable range of ± 3.29.

		Programme type			Total	Skewness	Kurtosis
		Montessori	Reggio Emilia	BCELF			
Time1	*M*	0.33	0.05	0.00	0.15	3.251	8.716
	SD	0.75	0.31	0.00	2.12		
	Range	0−2	0−2	0−0	0−2		
Time2	*M*	1.33	0.55	0.76	0.92	0.865	-0.410
	SD	1.16	0.99	1.27	0.53		
	Range	0−4	0−4	0−4	0−4		

Table 4.10-6. Descriptive statistics of Digit Span backwards (N = 119)

c) Dimensional Change Card Sorting (DCCS)

The DCCS (Zelazo, 2006) is a categorisation task for assessing attention. Children are required to sort a set of cards according to different sorting criteria such colour, shape, and a mixture of colour and shape. Children had six trials for each dimension. The task was terminated if children failed to sort out five cards correctly. If children successfully sorted cards by colour and shape in succession, they then proceeded to sort cards depending on a border rule. With this rule, children were instructed to sort cards with a black border by colour and without it by shape and they had twelve trials. Children received a score of 0 if they failed to pass the initial colour sorting, a score of 1 if they only completed the initial colour sorting but not the subsequent shape sorting, a score of 2 if they successfully completed both colour and shape sorting but not the subsequent border soring, and a score of 3 if they successfully completed the colour and shape sorting as well as at least nine out of the twelve border sorting trials. A higher score indicated a greater level of the child's cognitive flexibility. Schmitt et al. (2014) have demonstrated high internal consistency, with alpha coefficients of .84 for time point one and .77 for time point two. The overall test-retest reliability was .75 (Beck, Schaefer, Pang, & Carson, 2011).

Table 4.10-7 presents the descriptive information of the DCCS task. The mean, standard deviation, range, skewness, and kurtosis are included in the table. The skewness and kurtosis values were within the acceptable range.

		Programme type			Total	Skewness	Kurtosis
		Montessori	Reggio Emilia	BCELF			
Time1	*M*	1.81	1.50	1.76	1.69	-1.313	1.208
	SD	0.53	0.77	0.79	0.70		
	Range	0−3	0−2	0−3	0−3		
Time2	*M*	2.17	1.95	2.03	2.06	-0.305	4.578
	SD	0.52	0.38	0.42	0.46		
	Range	0−3	1−3	1−3	0−3		

Table 4.10-7. Descriptive statistics of Dimensional Change Card Sorting (N = 119)

<u>Indirect assessment of executive function</u>

a) Behavioural Rating Inventory of Executive Function – Preschool Version (BRIEF-P)

The BRIEF-P (Gioia et al., 2003) is a parent- and teacher-completed standardised rating scale with a focus on ecological validity to capture problems related to everyday executive function behaviours of preschool children ages 2-5. The BRIEF-P represents a componential view of EF and contains 63 items within five executive domains as follows: Inhibit, Working Memory, Shift, Emotional Control, and Plan/Organise. As specific domains of EF concerning inhibitory control, working memory, and shift were the main focus of the current study, 43 items from these three scales were extracted in the administered questionnaires. There were 16 items for Inhibit (IC), 17 items for Working Memory (WM), and 10 items for Cognitive Flexibility (CF). The inhibit dimension considers the child's ability to control and resist impulses. The items concerning inhibit include "Acts too wild or out of control" and "Is impulsive". The working memory dimension measures the child's capacity to hold and operate information in order to complete a given task or make a response. The items concerning working memory include "Cannot stay on the same topic when talking" and "Has trouble remembering something, even after a brief period of time". The shift dimension considers the child's level of efficacy, creativity, and mental flexibility in solving problems or moving beyond one situation. The items concerning shift include "Is upset by a change in plans or routine" and "Becomes upset with new situations". The measurement employs a 3-point Likert-type scale: 1 (never), 2 (sometimes), and 3 (often/always). All items were scored on a scale of 1, 2, and 3 and reverse coded. For the descriptive analysis, ratings within each scale were summed; the range of possible total score was 16-48 for IC, 17-51 for WM, and 10-30 for CF. A higher score reflected higher EF skills.

Reliability. The questionnaire has previously shown good reliability, with alpha coefficients ranging from .85 to .90 for parents (N = 460) and .90 to .94 for teachers (N = 302) (Gioia et al., 2003). In the manual, inter-rater agreement between parent and teacher ratings was generally low to modest (average r = .06 to .28) with stronger correlations for Inhibit (r = .25) and Shift (r = .28) (Gioia et al., 2003). Parents consistently rated children as having more problems than did teachers. The test-retest reliability studies were also described in the manual. For the parent sample, test-retest coefficients were adequate (average r = .81) over an average interval of 4.5-week period. For the teacher sample, a similar magnitude emerged (average r = .87) over a 4.2-week period. These results of test-retest reliability demonstrate the sufficient temporal stability of the BRIEF-P for repeated use over short periods of time.

Validity. Evidence supporting validity was demonstrated based on the convergence with other rating scales including the Child Behaviour Checklist (CBCL; Achenbach & Rescorla, 2000) and factor analysis (e.g., Duku & Vaillancourt, 2014; Gioia et al., 2003; Skogan et al., 2016). Gioia et al. (2003) in their manual examined convergent validity by comparing the parent-rated BRIEF-P (N = 137) with the existing CBCL. The CBCL assesses behavioural and emotional problems of children. The correlations between the two measures were all positive and statistically significant ($p < .001$), highlighting conceptually logical and coherent associations. For example, the BRIEF-P Working Memory scale was moderately correlated with the Attention Problems subscale of the CBCL (r = .58). The BRIEF-P Inhibit scale was strongly correlated with the Attention Problems (r = .69) and Aggressive Behaviour (r = .58) subscales of CBCL. The BRIEF-P Shift scale was strongly correlated with the internalising items of the CBCL such as Emotional Reactive (r = .52) and Anxious/Depressed (r = .51) subscales. Duke and Vaillancourt (2014) also examined the convergent validity of the BRIEF-P against the CBCL with a sample of Canadian preschool children (N = 625). The results showed a similar magnitude and pattern with correlations ranging from .63 to .82 at a significant level ($p < .01$). Together, the strength of the correlations provides evidence for supporting convergent validity that these two measures tap a relatively similar construct of the everyday behaviour of children.

The construct validity was also demonstrated using common factor analysis in several studies. Gioia et al. (2003) conducted exploratory factor analysis (EFA) in the normative samples of preschool children and found that a three-factor solution (Inhibitory self-control, Flexibility, and Meta-cognition) best fit data which accounted for 87% and 92% of the variance in the parent and teacher groups, respectively. In a confirmatory factor analysis (CFA) of the factor structure of the BRIEF-P with a sample of three-year-old Norwegian children (N = 1134), Skogan et al. (2016) also found that the originally proposed three-factor model fits to data better than two alternative one-factor models and supported a multicomponential view of EF even in early preschool years. Together, the results of the EFA and CFA provide evidence for supporting the structural validity of the BRIEF-P.

Descriptive statistics. The data were tested for distributional assumptions of normality based on measures of skewness and kurtosis values. The mean, standard deviation, skewness, and kurtosis values of each item for the whole sample are presented in Table C-1/C-2 (Appendix C). Although two items concerning IC and CF showed problematic skewness and kurtosis values outside ± 3.29 for the parent sample across two time points, most of the skewness and kurtosis values were within the acceptable range. For the teacher sample, most of the values were within a range of ± 2.58 for both time points.

Internal consistency in the present sample was high for all three subscales, with alpha coefficients ranging from .84 to .93 for parents and .88 to .96 for teachers at both time points (Tables 4.10-8 & 4.10-9).

		Programme type			Total	Cronbach's alpha
		Montessori	Reggio Emilia	BCELF		
Parent-rated Inhibitory control						
	M	39.45	38.48	41.23	39.64	
T1	*SD*	4.63	6.74	4.45	5.37	.85
	Range	29−47	24−47	31−47	24−47	
	M	39.42	40.24	40.50	39.94	
T2	*SD*	7.01	6.37	5.00	6.34	.91
	Range	12−48	21−48	33−48	12−48	
Parent-rated Working memory						
	M	44.88	41.34	45.81	44.05	
T1	*SD*	5.71	6.41	4.98	5.98	.91
	Range	23−51	27−50	38−51	23−51	
	M	44.83	43.62	45.00	44.45	
T2	*SD*	5.25	8.10	4.13	6.17	.93
	Range	33−51	27−51	39−51	27−51	

Parent-rated Cognitive flexibility						
	M	25.73	24.24	25.27	25.15	
T1	*SD*	3.47	4.18	3.77	3.79	.84
	Range	17−30	15−30	20−30	15−30	
	M	24.72	25.34	25.22	25.05	
T2	*SD*	4.17	4.42	3.20	4.04	.85
	Range	12−30	14−30	20−30	12−30	

Table 4.10-8. Descriptive statistics of parent-rated BRIEF-P (N = 87)

		Programme type			Total	Cronbach's alpha
		Montessori	Reggio Emilia	BCELF		
Teacher-rated Inhibitory control						
	M	40.17	41.10	43.00	41.17	
T1	*SD*	8.80	8.25	6.92	8.20	.96
	Range	20−48	21−49	17−49	17−49	
	M	39.38	40.07	41.21	40.06	
T2	*SD*	8.01	8.54	7.77	8.11	.95
	Range	18−48	19−48	18−48	18−48	
Teacher-rated Working memory						
	M	42.15	45.81	45.25	44.19	
T1	*SD*	9.31	7.33	8.94	8.66	.96
	Range	18−51	21−51	11−52	11−52	
	M	42.35	45.00	43.57	43.58	
T2	*SD*	9.08	8.42	7.05	8.41	.96
	Range	18−51	19−51	30−51	18−51	
Teacher-rated Cognitive flexibility						
	M	26.48	26.88	26.14	26.54	
T1	*SD*	4.07	3.54	3.82	3.81	.88
	Range	13−30	17−30	17−30	13−30	
	M	25.77	25.86	26.36	25.94	
T2	*SD*	4.90	4.12	3.73	4.35	.89
	Range	13−30	15−30	16−30	13−30	

Table 4.10-9. Descriptive statistics of teacher-rated BRIEF-P (N = 119)

Relationship quality

a) Child Parent Relationship Scale (CPRS)

The CPRS (Pianta, 1992) measures parents' perceptions of the relationship quality with their child in terms of conflict, closeness and dependency. Considering limited time and the burden imposed on parents, a short form was used in the current study. It is a 15-item self-report questionnaire capturing two dimensions of the parent-child relationships: conflict and closeness. The seven items measure closeness reflecting a parent's perception on the degree to which the relationship is characterised by warmth, affection, and positive interactions (e.g., "I share an affectionate, warm relationship with this child"). The eight items measure conflict reflecting a parent's perception on the degree to which the relationship is characterised by aggression and negativity (e.g., "This child and I always seem to be struggling with each other"). Each item was rated on a 5-point Likert-type scale ranging from 1 (definitely does not apply) to 5 (definitely applies). For the descriptive analysis, ratings within each scale were summed; the range of possible total score was 7-35 for Closeness and 8-40 for Conflict. While a higher Closeness score indicated higher levels of warm and supportive parent-child relationships, a higher Conflict score indicated higher levels of parent-perceived negativity and confrontation with his/her child.

Reliability. Driscoll and Pianta (2011) demonstrated acceptable to high ranges of internal consistency of the CPRS, with alpha coefficients .69 for maternal closeness and .72 for paternal closeness at 54 months, and .84 for maternal conflict and .80 for paternal conflict at 54 months (N = 563).

Validity. Evidence supporting predictive validity was demonstrated based on the correlations with other rating scales including the Social Skills Ratings System (SSRS; Elliott, Gresham, Freeman, & McCloskey, 1988). The SSRS assesses social skills and problem behaviours of children. The CPRS Closeness and Conflict ratings at 54 months (N = 563) were compared with the SSRS using mother ratings (Driscoll & Pianta, 2011). The correlations between the CPRS and SSRS were all statistically significant ($p < .01$) in expected directions, highlighting conceptually logical and coherent associations. For example, the SSRS Competence scale was positively correlated with the Closeness ($r = .35$) and was negatively correlated with the Conflict ($r = -.45$) subscales of the CPRS. The SSRS Problem Behaviour scale was negatively correlated with the Closeness ($r = -.18$) and was strongly positively correlated with the Conflict ($r = .51$) subscales of the CPRS. Together, the moderate concurrent relationships provide evidence for supporting predictive validity of the CPRS.

b) Student Teacher Relationship Scale (STRS)

The STRS (Pianta, 2001) measures the quality of teacher-child relationships in terms of conflict and closeness and is designed to be as parallel as possible with the CPRS. It is a standardised and widely validated measurement instrument for assessing teachers' perceptions of their relationships with a particular child in the class. Considering limited time and the burden imposed on teachers, a short form was also used in the current study to measure conflict and closeness. The correlations between the short form (15 items) and long form (28 items) have been shown to be strong (r = .69 to .76 for Closeness, r = .59 to .74 for Conflict) (Settanni, Longobardi, Sclavo, Fraire, & Prino, 2015), reflecting that the short forms generally measure the same construct as the full-length versions. The short version has 15 items and employs a 5-point Likert-type scale ranging from 1 (definitely does not apply) to 5 (definitely applies). For the descriptive analysis, ratings within each scale were summed; the range of possible total score was 7-35 for Closeness and 8-40 for Conflict. A higher Closeness score indicated higher levels of warm and supportive child-teacher relationships, whereas a higher Conflict score indicated higher levels of teacher-perceived negativity and confrontation with a particular child.

Reliability. Pianta (2001) presented high ranges of internal consistency of the STRS, with alpha coefficients .86 for Closeness and .92 for Conflict (N = 1535). The short forms also showed good internal consistency with alpha coefficients .88 for Closeness and .86 for Conflict (N = 1256) (Settanni et al., 2015). The test-retest reliability studies were also presented in the manual. The test-retest coefficients were all adequate and statistically significant at $p < .05$ (.88 for Closeness and .92 for Conflict) over a four-week period.

Validity. Evidence supporting predictive validity was demonstrated based on the correlations with other ratings. The STRS for kindergarten children (N = 413) was compared with the Teacher Child Rating Scale (Hightower et al., 1986) that measures behavioural problems and competencies in the classroom. The correlations between the two measures were all statistically significant ($p < .01$) in expected directions, highlighting conceptually logical and coherent associations. For example, the STRS Conflict scale was positively correlated with the Behaviour Problems (r = .65) and was negatively correlated with Competence (r = -.60) subscales of the Teacher Child Rating Scale. The moderate degree of concurrent relationships provides evidence for supporting predictive validity of the STRS.

The construct validity was also demonstrated using common factor analysis in the manual. An EFA in the normative sample of primary school children (N = 1535) was conducted to examine the factorial structure, resulting in a three-factor solution (Closeness, Conflict, and Dependency) that accounted for approximately 49% of the variance of the final 28 items. Mi-young & Neuharth-Pritchett (2011) conducted the CFA to examine factorial validity with an

American sample of pre-K children, resulting in an adequate fit for the proposed three-factor model with 26 items. Together, the results of the EFA and CFA provide evidence for supporting the construct validity of the STRS.

Descriptive statistics. The data were tested for distributional assumptions of normality based on measures of skewness and kurtosis values. The mean, standard deviation, skewness, and kurtosis values of each item for the whole sample are presented in Table D-3/D-4 (Appendix D). For the parent sample, many items from the closeness subscale exhibited problematic skewness and kurtosis values outside ± 3.29 for both time points. For the teacher sample, most of the items showed the values within ± 3.29, although some items each at both time points exhibited problematic skewness and kurtosis values outside ± 3.29. This non-normal distribution was taken into account for the later analyses.

In the current study, internal consistency with the parent sample was .59 and .73 for closeness (T1 & T2 respectively) and .68 and .85 for conflict (T1 & T2 respectively) (Table 4.10-10). Teacher ratings showed higher internal consistency, with alpha coefficients of .85 and .87 for closeness (T1 & T2 respectively) and .85 for conflict (both T1 & T2) (Table 4.10-11). The discrepancy in internal consistency between parents and teachers might reflect a different nature of relationships that teachers and parents have with a child. The parent-child relationship can be less stable than the child-teacher relationship as the higher levels of parental emotional involvement might have a greater impact on the rating. Another explanation could be that halo effects, in which a child's particular type of behaviour shapes teachers' perceptions of other behaviours, might influence the teacher ratings to be more one-dimensional (Stone, Otten, Engels, Vermulst, & Janssens, 2010). For these reasons, the results should be treated with caution.

		Programme type			Total	Cronbach's alpha
		Montessori	Reggio Emilia	BCELF		
Parent-rated Closeness						
	M	33.09	31.77	32.81	32.62	
T1	*SD*	2.12	2.43	1.68	2.19	.59
	Range	26−35	26−35	29−35	26−35	
	M	32.82	31.91	32.75	32.52	
T2	*SD*	2.57	3.52	2.21	2.82	.73
	Range	24−35	22−35	29−35	22−35	
Parent-rated Conflict						
	M	16.58	16.58	16.58	16.97	
T1	*SD*	5.66	5.66	5.66	5.36	.68
	Range	8−34	9−30	9−34	8−34	
	M	17.24	17.27	16.63	17.11	
T2	*SD*	5.47	6.06	6.03	5.70	.85
	Range	8−36	9−33	9−31	8−36	

Table 4.10-10. Descriptive statistics of CPRS (N = 87)

		Programme type			Total	Cronbach's alpha
		Montessori	Reggio Emilia	BCELF		
Teacher-rated Closeness						
	M	28.24	31.14	31.13	29.79	
T1	*SD*	5.57	4.12	3.44	4.89	.85
	Range	15−35	21−35	26−35	15−35	
	M	29.00	32.95	32.13	30.93	
T2	*SD*	4.81	3.15	4.06	4.52	.87
	Range	15−35	24−35	21−35	15−35	
Teacher-rated Conflict						
	M	15.18	11.95	12.00	13.46	
T1	*SD*	6.13	3.92	4.52	5.36	.85
	Range	8−34	8−20	8−24	8−34	
	M	15.42	11.59	11.19	13.28	
T2	*SD*	7.75	5.38	5.78	6.88	.85
	Range	8−37	8−26	8−26	8−37	

Table 4.10-11. Descriptive statistics of STRS (N = 119)

Social and emotional skills

a) Social-Emotional Assets and Resiliency Scale (SEARS)

The SEARS (Merrell, 2011) is a multi-informant assessment for identifying social-emotional skills of children ages 5-18. It employs a strength-based assessment system and all the items are phrased positively to reflect desirable characteristics, which is supportive of the positive psychology movement that aims to focus on positive qualities and attributes instead of the negatives (Merrell, 2011; Nese et al., 2012). Given the limited time that teachers and parents had, the short version of the SEARS was employed in the current study. The correlations between the short form (12 items) and long form (41 items) have been shown to be very strong (.97 and .98 for SEARS for parents and SEARS for teachers respectively) reflecting that the short form generally measures the same construct as the full-length versions (Nese et al., 2012). The SEARS short forms consisted of 12 items: three items for Social competence (e.g., "Is comfortable talking to many different people" and "Makes friends easily"), three items for Empathy (e.g., "Understands how other people feel" and "Cares what happens to other people"), and six items for Responsibility (e.g., "Is dependable" and "Accepts responsibility when she/he needs to"). Each item was rated on a 4-point scale ranging from 1 (Never) to 4 (Always). For the descriptive analysis, ratings within each scale were summed; the range of possible total score was 3-12 for Social competence and Empathy and 6-24 for Responsibility. The total scores for each programme type were also generated for a general interpretation. The SEARS proposes a three-tiered model for interpretation of the total scores. In this model, the scores from about the 21st to the 99th percentile (approximately 80% of cases from the normative sample) indicate average to high functions; scores from about 6th to 20th percentile (approximately 15% of cases from the normative sample) indicate that children in this range are at risk for emerging social-emotional deficits; and scores at or below 5th percentile (approximately 5% of cases from the normative sample) indicate that children in this range are at high risk for significant deficits in social-emotional skills (Merrell, 2011). A higher score indicated higher perceived levels of social-emotional skills.

Reliability. Merrell (2011) demonstrated high ranges of internal consistency of the SEARS using the normative samples. For the parent sample (N = 649), the alpha coefficients were .89 for Social competence, .87 for Empathy, and .95 for Self-regulation/responsibility. For the teacher sample (N = 747), the alpha coefficients were .94 for Social competence, .91 for Empathy, and .95 for Self-regulation/responsibility. Similarly, the internal consistency coefficients were high for the short form (.89 for parent ratings and .93 for teacher ratings). The test-retest reliability studies for the long and short forms were also described in the manual. For the parent long form, the test-retest coefficients ranged from .88 to .93 over a two-week period. For the teacher long form, a similar magnitude emerged with test-retest coefficients ranging from .84 to .94 over a two-week period. Similarly, the test-retest coefficients for the total score of the short form were sufficient at a two-week interval (.92 for parent ratings and .90 for teacher ratings). These results of the test-retest reliability indicate the sufficient temporal stability of the measurement over a short period of time.

Validity. Evidence supporting validity was demonstrated based on the convergence with other rating scales including the Social Skills Rating Scale (SSRS; Gresham & Elliott, 1990) and factor analysis. Merrell (2011) in the manual demonstrated convergent validity by comparing the SEARS long and short form (Grades K-6) with the parent and teacher ratings of the SSRS (Elliott et al., 1988). Overall, the correlations between the two measures were all positive and statistically significant ($p < .01$) for the both parent ($r = .40$ to .74) and teacher ($r = .39$ to .82) long form, highlighting conceptually logical and coherent associations. Similarly, the correlations between the parent and teacher SEARS short form scores and the SSRS subscales were moderate to strong, ranging from .40 to .79. Together, the strength of the correlations provides evidence for supporting convergent validity that these two measures tap a relatively similar construct of social-emotional skills.

Merrell (2011) also demonstrated the construct validity using common factor analysis in the manual. For the parent ratings, an EFA in the normative sample (N = 1011) was conducted to examine the factorial structure, resulting in a three-factor solution (Responsibility/Self-regulation, Social Competence, and Empathy) that accounted for 49% of the variance. A subsequent CFA showed marginal fit statistics and supported the proposed three-factor model. For the teacher ratings, an EFA in the normative sample (N = 836) found that a four-factor solution (Responsibility, Social Competence, Self-Regulation, and Empathy) best fit data, which accounted for 63% of the variance. A subsequent CFA also supported the proposed four-factor model with strong fit statistics. Together, the results of the EFA and CFA provide evidence for supporting the construct validity of the SEARS.

Descriptive statistics. The data were tested for distributional assumptions of normality based on measures of skewness and kurtosis values. The mean, standard deviation, skewness, and kurtosis values of each item for the whole sample are presented in Table E-5/E-6 (Appendix E). All the skewness and kurtosis values for both the parent and teacher samples ranged ± 1.96 at both time points. In the current study, internal consistency was high for each subscale, with alpha coefficients ranging from .73 to .86 for parents (Table 4.10-12) and .84 to .93 for teachers across two time points (Table 4.10-13). Total scores across the three programme types in the current sample were higher than 20, which were above the 47th percentile, indicating average to excellent perceived levels of social-emotional skills.

		Programme type			Total	Cronbach's alpha
		Montessori	Reggio Emilia	BCELF		
Parent-rated Social competence						
	M	6.48	5.66	5.96	6.08	
T1	*SD*	1.88	1.84	1.56	1.80	.73
	Range	2−9	2−8	4−8	2−9	
	M	6.25	5.75	6.72	6.18	
T2	*SD*	1.63	1.78	1.45	1.66	.73
	Range	3−9	2−9	4−9	2−9	
Parent-rated Empathy						
	M	5.85	4.97	5.96	5.61	
T1	*SD*	1.84	1.38	1.66	1.70	.74
	Range	3−9	2−7	3−9	2−9	
	M	5.61	5.46	6.11	5.67	
T2	*SD*	2.10	1.53	1.75	1.84	.83
	Range	3−9	3−9	3−9	3−9	
Parent-rated Responsibility						
	M	11.38	9.59	10.38	10.56	
T1	*SD*	3.30	2.89	2.04	2.95	.80
	Range	4−18	5−13	6−14	4−18	
	M	11.17	9.64	11.06	10.62	
T2	*SD*	2.79	3.02	2.51	2.87	.86
	Range	6−17	6−14	7−18	6−18	

Table 4.10-12. Descriptive statistics of parent-rated SEARS (N = 87)

		Programme type			Total	Cronbach's alpha
		Montessori	Reggio Emilia	BCELF		
Teacher-rated Social competence						
	M	6.33	5.64	6.00	6.01	
T1	*SD*	2.17	2.06	2.34	2.17	.84
	Range	2−9	1−9	2−9	1−9	
	M	6.11	6.46	6.78	6.38	
T2	*SD*	2.34	2.01	2.37	2.25	.85
	Range	2−9	0−9	3−9	0−9	
Teacher-rated Empathy						
	M	5.88	5.52	5.82	5.74	
T1	*SD*	2.59	2.00	2.00	2.25	.90
	Range	0−9	3−9	3−9	0−9	
	M	6.31	6.11	6.72	6.33	
T2	*SD*	2.38	2.25	2.27	2.29	.93
	Range	0−9	0−9	2−9	0−9	

Teacher-rated Responsibility						
	M	10.54	11.19	12.50	11.24	
T1	*SD*	4.76	3.88	3.28	4.18	.92
	Range	1−18	4−18	6−18	1−18	
	M	11.31	12.11	14.00	12.17	
T2	*SD*	4.77	4.14	3.80	4.44	.92
	Range	1−18	0−18	6−18	0−18	

Table 4.10-13. Descriptive statistics of teacher-rated SEARS (N = 119)

<u>Pre-academic competence (Literacy and numeracy)</u>

a) Naming Vocabulary (BAS-3)

For a literacy assessment, Naming Vocabulary from BAS-3 (Elliot & Smith, 2011) was used to measure expressive language ability reflecting the child's previously acquired knowledge of nouns. A child was asked to name coloured pictures of different objects one at a time. There were 36 pictures in total, which were always presented in the same sequential order to every child. There were different starting and stopping points according to the child's age and performance. If a child failed more than three items at the stopping points, the task was terminated. The number of correct answers was summed and recorded as a final score. A higher score indicated a higher level of attainment for early literacy. According to the BAS-3 technical manual (Elliot & Smith, 2011), the internal consistency for early years (4:06-4:11) was .70; the test-retest reliability was .92.

Table 4.10-14 presents the descriptive information of the Naming Vocabulary task for both time points. The mean, standard deviation, range, skewness, and kurtosis are included in the table. The skewness and kurtosis values were within the acceptable range of ± 1.96.

		Programme type			Total	Skewness	Kurtosis
		Montessori	Reggio Emilia	BCELF			
	M	23.50	23.10	24.41	23.58		
Time1	*SD*	3.67	3.18	3.35	3.44	-0.050	-0.206
	Range	13−32	18−30	18−30	13−32		
	M	27.63	25.83	27.86	27.05		
Time2	*SD*	3.38	3.95	3.82	3.78	-0.425	-0.340
	Range	20−33	18−33	19−34	18−34		

Table 4.10-14. Descriptive statistics of Naming Vocabulary (N = 119)

b) Early Number Concepts (BAS-3)

For a numeracy assessment, Early Number Concepts from BAS-3 (Elliot & Smith, 2011) was used to measure children's knowledge of quantitative, numerical and pre-numerical concepts, and their application of them. The tasks included matching and classifying according to numerical attributes and by number, recognising ordinal relationships, and solving basic word problems concerning addition and subtraction. The child was shown different pictures and asked to answer a number of questions for each picture. There were 30 questions in total, which were always presented in the same sequential order to every child. There were different starting and stopping points according to each child's age and performance. If a child failed more than three items at the stopping points, the task was terminated. The number of correct responses was summed and recorded as a final score. A higher score indicated a higher level of attainment for emergent numeracy skills. According to the BAS-3 technical manual (Elliot & Smith, 2011), the internal consistency for early years (4:06-4:11) was .96; the test-retest reliability was .77.

Table 4.10-15 presents the descriptive information of the Early Number Concepts for both time points. The mean, standard deviation, range, skewness, and kurtosis are included in the table. The skewness and kurtosis values were within the acceptable range of ± 1.96.

		Programme type			Total	Skewness	Kurtosis
		Montessori	Reggio Emilia	BCELF			
Time1	*M*	16.88	14.14	15.28	15.52	-0.297	-1.152
	SD	5.80	6.19	5.98	6.05		
	Range	7−25	2−24	2−25	2−25		
Time2	*M*	25.63	21.36	22.59	23.38	-0.537	1.151
	SD	3.81	4.02	3.39	4.22		
	Range	16−34	8−27	15−28	8−34		

Table 4.10-15. Descriptive statistics of the Early Number Concepts (N = 119)

4.11 Factor structure

Confirmatory Factor Analysis (CFA) and Exploratory Structural Equation Model (ESEM) were conducted to evaluate the proposed factor structure of each questionnaire at each time point. Since CFA and ESEM would be useful to examine the relations amongst multifactorial latent constructs (Jackson, Gillaspy, & Purc-Stephenson, 2009), structural validity for binary data from direct assessments in which there was either a right or wrong answer was not estimated in the current study. All analyses were performed using Mplus 7.0 (Muthén & Muthén, 2012) with the robust variance-adjusted weighted least squares estimator (WLSMV) for ordered categorical variables. This estimation was also selected as a treatment for non-normal ordered categorical variables (Muthén & Muthén, 2007; Zhao, 2015).

CFA and ESEM. CFA is a form of structural equation modeling (SEM) that is particularly useful for construct validation (Brown, 2014). It is theory-driven, in which a strong conceptual foundation determines the specification of the factor model and estimates the relationships and covariation amongst the latent constructs in that hypothesised model (Brown, 2014; Schreiber, Nora, Stage, Barlow, & King, 2006). Along with CFA, which accounts for measurement error and transforms non-normal items into normally distributed latent variables (Marsh, Morin, Parker, & Kaur, 2014), an ESEM approach was also employed in the analyses. ESEM is an integrative model of both Exploratory Factor Analysis (EFA) and CFA within the general SEM (Marsh et al., 2014). While ESEM examines relations between latent variables, a priori factor structures, and multi-group measurement invariance such as in CFA, it also estimates all cross-loadings between indicators and latent variables with more flexibility such as in EFA (Myers, 2013). CFA traditionally sets non-target factor loadings to be zero to highlight the impact of target factors, thus is more restrictive compared to EFA (Asparouhov & Muthén, 2010). Such strict zero-loading restrictions often lead to a poor model fit with inflated factor correlations and subsequent extensive modification of models (Asparouhov & Muthén, 2010; Marsh et al., 2014). Behavioural measurement instruments such as those used in the current study, however, often contain items that are associated with multiple determinants (Marsh et al., 2014).

Therefore, the use of ESEM that allows the free estimation of cross loadings of conceptually related constructs is more preferable (Asparouhov & Muthén, 2010). Another substantial advantage of the ESEM approach is that it estimates the measurement and structural model at the same time. This simpler approach overcomes the challenges of traditional EFA-CFA conversions and may result in more accurate estimations compared to an EFA-based CFA model (Asparouhov & Muthén, 2010).

Model fit indices. For CFA and ESEM analyses, several indicators were employed to evaluate model-data fit of the measurement. Because the chi-square (χ^2) value is sensitive to sample size and is rather adjusted for a correct *p* value (Asparouhov & Muthén, 2010), fit indexes that are independent of sample size – such as the comparative fit index (CFI), Tucker-Lewis index (TLI) in a combination with the root mean square error of approximation (RMSEA) – were used. By convention, the model was considered acceptable when CFI and TLI value was greater than .90 (Bentler & Bonett, 1980) and good when CFI and TLI value was greater than .95 (Hu & Bentler, 1999). RMSEA values smaller than .08 indicated adequate fit (Hu & Bentler, 1999).

4.11.1 CFA and ESEM results

a) Behavioural Rating Inventory of Executive Function (BRIEF-P)

The results of CFA and ESEM for the three-factor model (Working Memory, Inhibitory control, and Cognitive flexibility) for the parent sample are presented in Table 4.11.1-1. CFA for the parent sample resulted in CFI values (.904 and .898 for T1 and T2 respectively) and TLI values (.898 and .893 for T1 and T2 respectively) at the limited acceptability, and RMSEA values within the acceptable range (.052 and .070 for T1 and T2 respectively). ESEM exhibited a better model fit, resulting in CFI values (.979 and .977 for T1 and T2 respectively), TLI values (.974 and .973 for T1 and T2 respectively), and RMSEA values (.026 and .035 for T1 and T2 respectively). Factor loadings from CFA are presented in Table F-1 (Appendix F).

Model		$\chi 2$ (df)	CFI	TLI	RMSEA
CFA	Time1	1073.013 (857)	.904	.898	.052
	Time2	1207.916 (857)	.898	.893	.070
ESEM	Time1	784.613 (737)	.979	.974	.026
	Time2	858.114 (777)	.977	.973	.035

Table 4.11.1-1. Indices of three-factor CFA and ESEM models for the parent-rated BRIEF-P

The results of CFA and ESEM for the three-factor model for the teacher sample are presented in Table 4.11.1-2. CFA for the teacher sample exhibited a good model fit, resulting in CFI values (.971 and .964 for T1 and T2 respectively), TLI values (.970 and .963 for T1 and T2 respectively), and RMSEA values (.058 and .065 for T1 and T2 respectively). Although both models exhibited a good model fit, the ESEM for the parent sample exhibited a better model fit, resulting in CFI values (.989 and .984 for T1 and T2 respectively), TLI values (.987 and

.981 for T1 and T2 respectively), and RMSEA values (.038 and .045 for T1 and T2 respectively). Factor loadings from CFA are presented in Table F-2 (Appendix F).

Model		$\chi2$ (df)	CFI	TLI	RMSEA
CFA	Time1	1193.626 (857)	.971	.970	.058
	Time2	1371.561 (857)	.964	.963	.065
ESEM	Time1	910.124 (777)	.989	.987	.038
	Time2	963.665 (777)	.984	.981	.045

Table 4.11.1-2. Indices of three-factor CFA and ESEM models for the teacher-rated BRIEF-P

For both parents and teachers, the CFA and ESEM approaches corroborated the goodness of fit of the three-factor structure and supported a multifactorial view of EF suggested by Miyake et al. (2000) in which WM, IC, and CF are three distinct but interrelated facets.

b) Child Parent Relationship Scale (CPRS)

Although many items from the closeness subscale exhibited problematic skewness and kurtosis values outside ± 3.29 for both time points, all the items were kept as the WLSMV estimator has been shown to perform well under a non-normal distribution (Bryne, 2013; DiStefano & Morgan, 2014).

The results of CFA and ESEM for the two-factor model (Closeness and Conflict) for the parent sample are presented in Table 4.11.1-3. CFA showed a poor model fit, resulting in CFI values (.863 and .919 for T1 and T2 respectively), TLI values (.841 and .905 for T1 and T2 respectively), and RMSEA values (.101 and .094 for T1 and T2 respectively). The ESEM exhibited a better model fit, resulting in CFI values (.973 and .933 for T1 and T2 respectively), TLI values (.962 and .907 for T1 and T2 respectively), and RMSEA values (.052 and .093 for T1 and T2 respectively). Factor loadings from CFA are presented in Table G-1 (Appendix G).

The ESEM approach corroborated the adequate fit of the two-factor structure of the CPRS for both time points, with most of the values meeting conventionally acceptable levels of good fit.

Model		χ2 (df)	CFI	TLI	RMSEA
CFA	T1	206.570 (104)	.863	.841	.101
	T2	153.793 (89)	.919	.905	.094
ESEM	T1	95.970 (76)	.973	.962	.052
	T2	130.061 (76)	.933	.907	.093

Table 4.11.1-3. Indices of two-factor CFA and ESEM models for CPRS

c) Student Teacher Relationship Scale (STRS)

The results of CFA and ESEM for the two-factor model (Closeness and Conflict) for the teacher sample are presented in Table 4.11.1-4. CFA showed a poor model fit, resulting in CFI values (.921 and .939 for T1 and T2 respectively), TLI values (.906 and .928 for T1 and T2 respectively), and RMSEA values (.124 and .129 for T1 and T2 respectively). ESEM exhibited a better model fit, resulting in CFI values (.976 for both time points), TLI values (.966 and .967 for T1 and T2 respectively), and RMSEA values (.074 and .087 for T1 and T2 respectively). Factor loadings from CFA are presented in Table G-2 (Appendix G).

The ESEM approach corroborated the adequate fit of the two-factor structure of the STRS for both time points, with most of the values meeting conventionally acceptable levels of good fit.

Model		χ2 (df)	CFI	TLI	RMSEA
CFA	T1	250.218 (89)	.921	.906	.124
	T2	264.434 (89)	.939	.928	.129
ESEM	T1	125.450 (76)	.976	.966	.074
	T2	143.884 (76)	.976	.967	.087

Table 4.11.1-4. Indices of two-factor CFA and ESEM models for STRS

d) Social-Emotional Assets and Resiliency Scale (SEARS)

The results of CFA and ESEM for the three-factor model (Social competence, Empathy, and Responsibility) for the parent sample are presented in Table 4.11.1-5. CFA for the parent sample exhibited an acceptable model fit for T1 and good model fit at T2, resulting in CFI values (.947 and .989 for T1 and T2 respectively), TLI values (.932 and .986 for T1 and T2 respectively), and RMSEA values (.088 and .052 for T1 and T2 respectively). ESEM exhibited a better model fit, resulting in CFI values (.987 and .985 for T1 and T2 respectively), TLI values (.974 and .970 for T1 and T2 respectively), and RMSEA values

(.055 and .076 for T1 and T2 respectively). Factor loadings from CFA are presented in Table H-1 (Appendix H).

Model		χ2 (df)	CFI	TLI	RMSEA
CFA	Time1	88.633 (51)	.947	.932	.088
	Time2	62.456 (51)	.989	.986	.052
ESEM	Time1	42.406 (33)	.987	.974	.055
	Time2	48.493 (33)	.985	.970	.076

Table 4.11.1-5. Indices of three-factor CFA and ESEM models for the parent-rated SEARS

The results of CFA and ESEM for the three-factor model for the teacher sample are presented in Table 3.11.1-6. CFA exhibited a poor fit, resulting in CFI values (.982 and .981 for T1 and T2 respectively), TLI values (.976 for both time points), and RMSEA values (.102 and .130 for T1 and T2 respectively). Although the RMSEA value at T2 did not meet conventionally acceptable levels of good fit, the ESEM exhibited an overall better model fit, resulting in CFI values (.994 and .992 for T1 and T2 respectively), TLI values (.988 and .985 for T1 and T2 respectively), and RMSEA values (.073 and .103 for T1 and T2 respectively). Factor loadings from CFA are presented in Table H-2 (Appendix H).

For both parent and teacher samples, the ESEM approach corroborated the goodness of fit of the three-factor structure of the SEARS suggested by Merrell et al. (2010).

Model		χ2 (df)	CFI	TLI	RMSEA
CFA	Time1	114.183 (51)	.982	.976	.102
	Time2	154.213 (51)	.981	.976	.130
ESEM	Time1	54.005 (33)	.994	.988	.073
	Time2	74.669 (33)	.992	.985	.103

Table 4.11.1-6. Indices of three-factor CFA and ESEM models for the teacher-rated SEARS

4.11.2 Testing measurement invariance

After a best-fitting model was determined, measurement invariance (configural invariance, weak invariance, and strong invariance) was examined to establish longitudinal consistency of measurements. It was particularly important to examine if the indicators were measuring the same underlying construct in the same way across time because latent constructs were not observed directly and children's data were collected at two time points (Marsh, Nagengast, &

Morin, 2013; Meredith & Tisak, 1990). Measurement noninvariance would suggest item bias across time and lead to biased estimates of regression parameter, thus posing a threat to the validity of the results concerning change over time (Dimitrov, 2006; Kim & Willson, 2014). Three levels of measurement invariance (configural invariance, weak invariance, and strong invariance) were evaluated. Firstly, configural invariance freely estimated factor loadings and intercepts of each item to identify a baseline model (Meredith & Tisak, 1990). Secondly, weak invariance constrained factor loadings to be equal across time and tested whether items were related to the latent construct of interest in the same way across time (Dimitrov, 2010; Fuhs & Day, 2011). If weak invariance did not hold, a one-unit change across two time points would not be equal, and hence group comparisons would be likely invalid (Meredith & Teresi, 2006; Marsh et al., 2013). Thirdly, strong invariance constrained factor loadings and intercepts across time and tested whether factor means were equal over time (Dimitrov, 2010). If strong invariance did not hold, observed differences would not be explained by the latent construct alone, but would be influenced by item bias (Meredith & Teresi, 2006). Consequently, the comparison of factor means across time would not be legitimate.
Tables below (4.11.2-1, 4.11.2-2, 4.11.2-3) present the configural, weak, and strong invariance model fit indices for BRIEF-P, CPRS, STRS, and SEARS. Although the relationship quality scales (CPRS & STRS) indicated a worse model fit at a marginal level, the data fit was reasonable enough by nearly meeting conventionally acceptable levels of adequate model fit. The measurement invariance models for other measurements showed an overall good fit to the data. Therefore, the results adequately supported measurement invariance across two time points for each construct used in the current study, thus indicating the readiness of the data for the future analyses. For all subsequent analyses, constraints for weak invariance and strong invariance were retained.

	$\chi2$ (df)	CFI	TLI	RMSEA
Parents				
Configural	3986.282 (3511)	.902	.898	.036
Weak	4027.272 (3556)	.903	.900	.035
Strong	4072.825 (3596)	.902	.900	.035
Teachers				
Configural	4229.427 (3514)	.958	.956	.041
Weak	4330.473 (3559)	.954	.953	.043
Strong	4369.097 (3599)	.954	.954	.042

Table 4.11.2-1. Measurement invariance results for the BRIEF-P

	$\chi2$ (df)	CFI	TLI	RMSEA
Parents				
Configural	521.430 (385)	.916	.906	.057
Weak	580.218 (397)	.888	.877	.065
Strong	594.082 (412)	.888	.882	.064
Teachers				
Configural	697.472 (384)	.925	.915	.083
Weak	706.905 (397)	.926	.919	.081
Strong	716.359 (413)	.928	.924	.079

Table 4.11.2-2. Measurement invariance results for the CPRS & STRS

	$\chi2$ (df)	CFI	TLI	RMSEA
Parents				
Configural	294.035 (225)	.957	.947	.054
Weak	297.380 (234)	.961	.954	.050
Strong	352.346 (246)	.934	.926	.064
Teachers				
Configural	406.763 (227)	.971	.965	.082
Weak	415.612 (235)	.971	.966	.080
Strong	419.334 (247)	.973	.969	.077

Table 4.11.2-3. Measurement invariance results for the SEARS

4.12 Statistical analysis plan

This section describes an overview of the statistical analysis methods employed in the current study. Analyses were conducted using SPSS Statistics 23 (2015) and Mplus 7.0 (Muthén & Muthén, 2012). Analytical procedures included one-way ANOVA, repeated measures ANOVA, and latent autoregressive modelling and latent autoregressive cross-lagged panel modelling in SEM.

Missing data treatment. From pre-test to post-test, five children left their respective schools. Since they were not tested on any of the measures at post-test, their pre-test data were excluded from the analyses. There were higher rates of missing data on parent reports at both time points, but this was expected as parents' response rates are typically low (Humphrey et al., 2011). In SPSS, missing items were coded as -9 and pairwise comparisons were employed for estimating variables with missing items. In Mplus, missing data were handled with the WLSMV estimator using full information maximum likelihood (Asparouhov & Muthén, 2010).

Pearson's correlation. Pearson's correlation coefficients were computed to explore the strength of the associations amongst all the variables. The correlation tables for parent and teacher samples as well as between parents and teachers are presented in Appendix I and J respectively.

Analysis of variance (ANOVA). One-way ANOVA was performed to examine the mean differences in classroom process quality of respective school programmes (RQ1). Post-hoc tests were followed to determine which of these programmes differed from each other. Repeated measures ANOVA was performed to examine changes in the mean scores of EF, social-emotional skills, and academic achievement across two time points, capturing the general trend of developmental changes. All the ANOVA tests were conducted using SPSS.

Structural equation modeling (SEM). Many of the complex psycho-educational constructs including social-emotional skills and EF are often influenced by underlying and unobservable forces, and thus are commonly measured using multiple manifest indicators (Bollen, 2002; Liem & Martin, 2013). As such, SEM provides a powerful framework in which unobserved hypothesised constructs (latent variables based on a set of indicators) can be examined (Dimitrov, 2006). The analysis of latent variables in SEM is more advantageous over traditional approaches using observed variables, such as a t-test and ANOVA, for two reasons. Firstly, SEM can deal with non-normal data well unlike classic parametric tests. Classic parametric tests face certain limitations, as real data do not often meet required statistical assumptions of normality and homogeneity of variance (Alessandri, Zuffianò, & Perinelli, 2017). Consequently, violation of these statistical assumptions when using observed variables approaches can inflate rates of type I and type II errors (Tabachnick & Fidell, 2013). In contrast, the estimation method in SEM such as WLSMV does not assume normal distribution (Brown, 2006) and performs well under non-normal data while minimising type I and type II errors (Asparouhov & Muthén, 2016; Yu, 2002). Secondly, SEM accounts for measurement error (Asparouhov & Muthén, 2016) by isolating the common variance amongst indicators of a latent construct from error variance caused by measurement error and other sources of variability (Alessandri et al., 2017; McCoach, Black, & O'Connell, 2007). In contrast, classic parametric tests cannot accommodate measurement error based on the assumption of error-free measurement even when that is not the case (Alessandri et al., 2017). For these reasons, SEM was used in the current study for the analysis of developmental change across time and predictive utility of both observed and latent variables.

Intra-class correlation (ICC). Before examining the associations between programme types and gains in EE, social-emotional skills, and academic achievement, ICC was run to examine the nesting effect. ICC refers to the degree of correlation within a cluster, capturing how much of the total variance can be explained by the grouping variables (Field, 2013). For example, ICC value was .029 for Peg tapping at time point one at a school level (Appendix K). This indicates that 2.9% of the variance in pre-test Peg Tapping scores was attributed to school differences, with the remaining variance attributable to differences amongst children in a school. Although there are no standard cut-off values for ICC, Koo and Li (2016) suggest that ICC values less than 0.5 indicate a lack of variability across subjects. This means that there are fewer variations of skill sets within a school. In the current study, although children nested within 14 schools nested within three programme types, the ICC values for the differences in each measure were low at most of the school levels, such that multilevel modelling approach was not employed in the analyses. For some variables that exhibited higher ICC values including the Digit Span backwards and Early Number Concepts scores, however, sensitivity analysis was conducted to account for non-independent observations which might be stemming from cluster sampling. This approach estimates not only the usual parameters but also computes standard errors so that the effect of the clustering can be investigated (Muthén & Muthén, 2007).

Latent autoregressive model (RQ2 & RQ3). A latent autoregressive model in a SEM framework was employed to 1) estimate the longitudinal effect of enrolling in particular programme type on change in the development of children's school readiness skills; and 2) estimate the effect of the CLASS domains on change in these skills. In the autoregressive model, the independent variable of interest is directly predicted by levels of the same variable and/or of other variables while taking into account the influence of the previous time point (Young, Furman, & Laursen, 2011). The primary purpose of applying the autoregressive model is to 1) estimate proportional change in covariance structures (Usami, Hayes, & McArdle, 2015); and 2) examine interrelations between and within variables across time (Kline, 2015).

Multiple-indicators multiple-causes (MIMIC) approach (Jöreskog & Goldberger, 1975) was combined with the autoregressive model to estimate the effect of the grouping variables. The advantage of using the MIMIC approach over traditional approaches such as ANCOVA and MANCOVA is that it accounts for the latent construct of interest with corrected measurement error and estimates a model fit to the data (Marsh, Tracey, & Craven, 2006; McArdle, 2009; Thompson & Green, 2006). Another power advantage of the MIMIC approach is that it does not require a multiple group approach and can apply to a single measurement model based on the full sample using dummy variables for groups as covariates (Dimitrov, 2006; Thompson & Green, 2006). Although it is desirable to establish measurement invariance separately for each group, this multiple-group approach is not always practical for stable parameter estimation when the sample sizes are small or unequal (Kaplan & George, 1995; Kim & Cao, 2015; Marsh et al., 2009) such as in the current study. In the autoregressive model with the MIMIC approach, which specifies a single CFA model, the latent score at time point two is regressed on that latent score at time point one along with exogenous covariates (e.g., groups) as predictors of the factor (Thompson & Green, 2006). As such, a significant direct effect of these covariates reflects variability across groups in relation to previous time point (Brown, 2014; Jöreskog & Goldberger, 1975; Marsh et al., 2013).

Figure 4.12-1 illustrates a latent autoregressive model with dummy variables. In the model, η_1 in an oval represents the repeated latent variables with multiple indicators: Ψ represents the factor variance; and ζ represents the disturbances. β_{21} represents the standardised autoregressive coefficients, whereas β_{2M} and β_{2R} represent the cross-lagged effects. In the current study, all variables from the three groups were combined together in a single data set. For the RQ2, the programme effect was explored by dummy variables for Montessori and Reggio Emilia against the BCELF group. Factor loadings for the repeated items were constrained to be equal over time, and correlated measurement residuals amongst repeated items over time were included in the model. The covariances amongst the independent variables (Ψ_{1R}, Ψ_{1M}, and Ψ_{MR}) as well as endogenous disturbance (ζ_1) were also incorporated in the model to account for any synchronous associations (Newsom, 2015). In order to capture the potential programme effect on unique variance in IC, for example, the level of IC at time point two (η_2) was regressed on the level of IC (η_1) at time point one as well as the dummy-coded group variables in a rectangle.

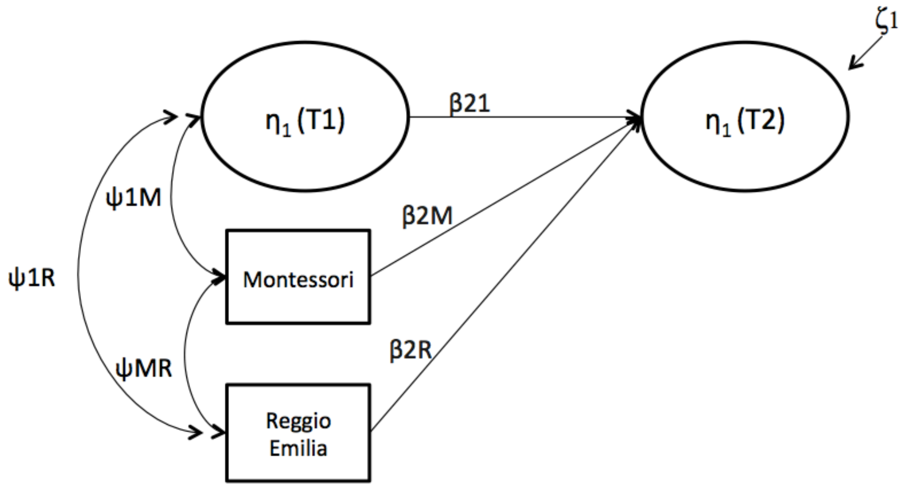

Figure 4.12-1. Latent autoregressive model with dummy variables

When dealing with dichotomous variables, measurement error was incorporated in the models by multiplying the variance of the observed variable of interest by 1 minus reliability coefficients and setting the loading equal to 1 (Newsom, 2015; Schumacker & Lomax, 2004) (Figure 4.12-2). The symbol ε represents measurement error, while x represents a repeated observed variable.

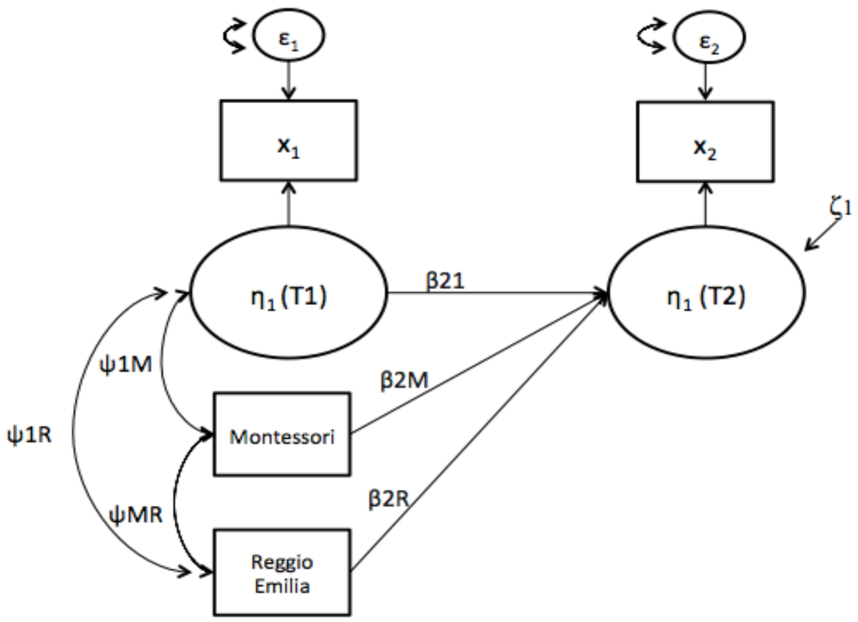

Figure 4.12-2. Latent autoregressive cross-lagged panel with measurement error

Latent autoregressive cross-lagged panel model (RQ4-7). Latent autoregressive cross-lagged model was employed to 1) examine the stability and associations amongst relationship quality, EF, social-emotional skills, and early emergent academic achievement over time; and 2) determine which of these variables is causally dominant.

Figure 4.12-3 illustrates a path diagram for a two-wave, latent autoregressive cross-lagged model with multiple indicators. In the model, η_1 and η_2 in an oval represent the repeated latent variables with multiple indicators (e.g., v_1, p_1); ε represents the residuals; Ψ represents the factor variance; and ζ represents the disturbances. B_{11} and β_{22} represent the standardised autoregressive coefficients, whereas β_{21} and β_{12} represent the cross-lagged path coefficients. Ψ_{12} represents the covariance between the two independent variables. In the current study, factor loadings (e.g., a) for the repeated items (e.g., v_1) were constrained to be equal over time, and correlated measurement residuals amongst repeated items over time (e.g., ε_1 and ε_4) were included in the model. The covariance between the independent variables (Ψ_{12}) and the covariance between the disturbances ($\zeta_{1,2}$) were also incorporated in the model to account for any synchronous associations. In order to capture the potential effect of relationship quality on unique variance in inhibitory control, for example, the level of inhibitory control at time point two (η_1T2) was regressed on the level of inhibitory control (η_1T1) as well as relationship quality at time point one (η_2T1) while controlling for the influence of the early time point. In order to examine a reciprocal influence of the level of inhibitory control on variance in relationship quality, the level of relationship quality at time point two (η_2T2) was also regressed on relationship quality at time point one (η_2T1) and the level of inhibitory control (η_1T1). All the SEM analyses were performed using Mplus 7.0 (Muthén & Muthén) with the robust variance-adjusted weighted least squares estimator (WLSMV).

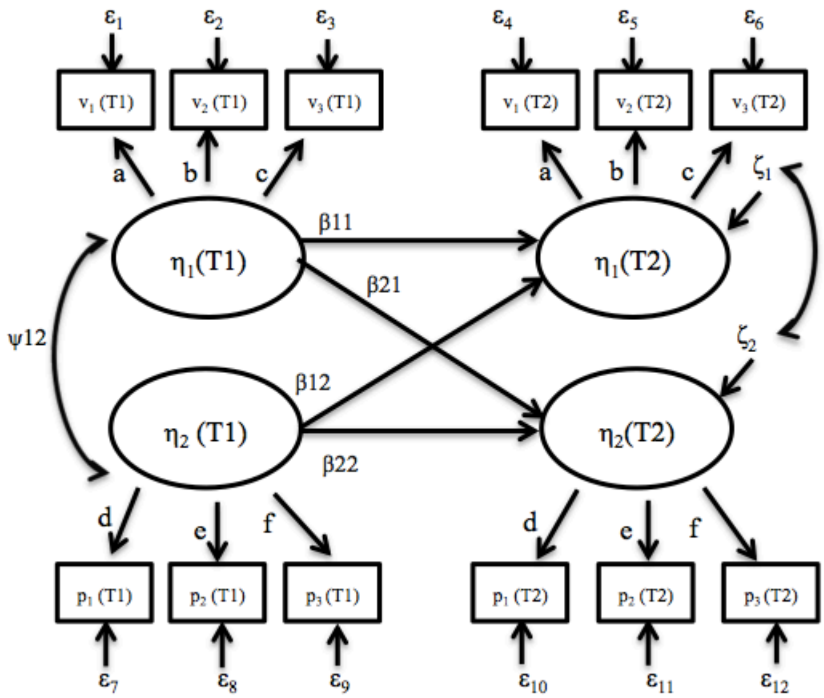

Figure 4.12-3. Latent autoregressive cross-lagged model with multiple indicators adapted from Longitudinal Structural Equation Modeling (p. 126), J.T. Newsom (2015).

4.13 Ethical considerations

Ethical issues were considered throughout the current research project. The study was reviewed by – and received ethical clearance through – the University of Oxford Central University Research Ethics Committee (Appendix L). The researcher also possessed Criminal Record Check clearance from Canada, which was presented to the head-teachers before commencing the study. The current study was carried out in adherence to the protocol for 'studies using non-invasive methods with children's and to the ethical guidelines set out by the British Educational Research Association (BERA, 2011) and the Social Sciences and Humanities Research Council of Canada (SSHRC, 2014).

Information letters and consent forms. The head-teachers were sent a letter and provided with comprehensive information about the study (Appendix M). The researcher ensured that the purpose and procedure of the study were clearly explained. Once they agreed to participate, an information sheet (Appendix N) and an opt-in consent form were sent to parents (Appendix O) and teachers (Appendix P). Consent was gained from the parents on behalf of their child/children as they were under the age of 16. The informed consent outlined research including its aim, methods, ethical considerations, handling of the data, contribution, and dissemination such that prospective participants could make an informed decision about participation in the study. The opt-in method of obtaining consent was used. As such, participation in this study was completely voluntary and the participants were informed in advance that they had the right to withdraw from the study at any stage by simply informing the researcher. This injunction was also explained to children verbally at each assessment. A child's right to end his/her involvement in the study at any time throughout the study was respected even if parental consent was given. The researcher provided contact details of herself and her supervisors; the prospective participants before proceeding with data collection and consented participants during the study were encouraged to contact the research team if they had any concerns and/or questions for clarification.

Data collection. All assessments were conducted in a regular classroom in the presence of a classroom teacher and/or an adult with a responsibility from a safety point of view and due to the consideration of the ecological context. It was explained to children before and during the assessments that they could leave an activity at any stage if they wished so that their right to withdraw from the study was continuously respected.

Secure data handling and storage. Printed documents collected for this project are securely stored in a locked filing cabinet and computerised data are password-protected. All data, including individual children and schools, were labelled with ID codes rather than names and were only accessible to the researcher and her supervisors. Confidentiality is about protecting the privacy of participants. The informed consent form contained the information on how the data would be used and stored. Confidentiality of records was taken care of; no reference to individuals was made within this project, and thus anonymity was upheld. This injunction will also apply to any future publications. A brief report of the overall findings would be sent to the participating schools and interested families at the end of the study.

4.14 Chapter summary

In summary, this chapter provided a detailed description of the current study's methodology including the research design, participants, data collection procedures, measurements, statistical plan, and ethical considerations. A longitudinal pre-test and post-test quasi-experimental design was employed 1) to illustrate the effectiveness of different types of preschools on the development of school readiness skills including EF, social-emotional skills, and pre-academic competence; and 2) examine the sources of influences in the child, family and school in relation to the development of these school readiness skills. The participants were 119 four-year-old children who attended Montessori, Reggio Emilia, or play-based schools in a Western Canadian city. The data collection was conducted through direct and indirect assessments at the beginning and end of one school year, all of which adhered to ethical guidelines established by the University of Oxford, BERA, and SSHRC. Given there were measurement challenges when assessing EF and social-emotional skills, reliability and validity of the selected measurements were examined through statistical procedures including Cronbach's alpha, CFA, ESEM, and measurement invariance. The results adequately demonstrated that all the constructs were prepared for further analyses.

The following chapter will discuss the findings regarding 1) the effectiveness of these preschool curricula (Montessori, Reggio Emilia, and BCELF programmes) in Western Canada on the development of children's school readiness including EF, social-emotional skills, and pre-academic competence; and 2) other sources of influences in the child, family and school in relation to the development of these school readiness skills.

Chapter 5: The main study findings

This chapter presents the results of the research questions. Quantitative data analyses based on classroom observations, direct assessments of executive function (EF) and pre-academic competence, and teacher-and-parent questionnaires for EF and social-emotional skills were conducted. The aim was 1) to determine the effectiveness of the three preschool programmes in Western Canada on the development of children's school readiness including EF, social-emotional skills, and pre-academic competence; and 2) to investigate the sources of influences in the child, family and school in relation to the development of these school readiness skills.

5.1 Research questions

RQ1: Are there any differences in classroom process quality by preschool types in Western Canada?
RQ2: Is enrolment in different preschool programmes associated with greater changes in EF, social-emotional skills, and pre-academic competence during one school year?
RQ3: Is any aspect of classroom process quality measured by the CLASS associated with changes in EF, social-emotional skills, and pre-academic competence?
RQ4: What are the associations between EF and pre-academic competence over time?
RQ5: What are the associations between social-emotional skills and pre-academic competence over time?
RQ6: What are the associations between EF and social-emotional skill over time?
RQ7: What are associations between teacher-child/parent-child relationship quality and school readiness skills over time?

5.2 Main findings

5.2.1 RQ1: Are there any differences in classroom process quality by preschool types (Montessori, Reggio Emilia, and BCELF programmes) in Western Canada?

This research question investigated classroom process quality of the three different school types, particularly focusing on the quality of teacher-child interactions using the Classroom

Assessment Scoring System (CLASS). Emotional Support reflects the ways in which teachers establish positive social and emotional functioning in the classroom through responsivity and autonomy support. Classroom Organisation reflects the degree to which teachers organise and manage students' time, behaviour, and motivation through the use of effective classroom routines, behavioural strategies, and learning materials/activities. Instructional Support reflects the degree to which teachers effectively promote cognitive and language development of the students through informative feedback, questioning, and language modelling.

Table 5.2.1-1 shows the means, standard deviations, and range for each of the three domains. Table 5.2.1-1 also includes the results of the Levene's test and one-way ANOVA including the F-ratio and the degrees of freedom across the three school types.

The mean score for Emotional Support fell in the high range for Montessori (*M* = 6.1, *SD* = 0.45) and Reggio Emilia (*M* = 6.0, *SD* = 0.28) and in the middle range for BCELF schools (*M* = 5.2, *SD* = 0.34). The mean score for Classroom Organisation fell in the high end of the middle range for Montessori (*M* = 5.8, *SD* = 0.58) and Reggio Emilia (*M* = 5.0, *SD* = 0.54) and in the low end of the middle range for BCELF schools (*M* = 3.8, *MD* = 0.38). The mean score for Instructional Support fell in the low range for all school types, Montessori (*M* = 2.6, *SD* = 0.60), Reggio Emilia (*M* = 2.7, *SD* = 0.62), and BCELF (*M* = 1.9, *SD* = 0.66).

Scale		Programme type			Levene's test	One-way ANOVA	
		Montessori	Reggio Emilia	BCELF		*F (df)*	Sig.
Emotional Support	*M*	6.1	6.0	5.2			
	SD	0.46	0.28	0.34	0.33	8.58 (2,16)**	.003
	Range	5.2−6.8	5.5−6.2	4.7−5.4			
Classroom Organisation	*M*	5.8	5.0	3.8			
	SD	0.58	0.54	0.38	0.38	20.21 (2,16)***	.001
	Range	4.6−6.6	4.3−5.7	3.4−4.3			
Instructional Support	*M*	2.6	2.7	1.9			
	SD	0.60	0.62	0.66	0.69	2.19 (2,16)	.14
	Range	1.9−3.6	2.1−3.6	1.4−2.8			

Table 5.2.1-1. Descriptive statistics of the CLASS domains across three programme types
Note. Scale ranged from 1-7 (1,2-low; 3,4,5-medium; 6,7-high); *M* = Mean; *SD* = Standard Deviation; *$p < .05$. **$p < .01$. ***$p < .001$.

The Levene's test showed that the assumption of the homogeneity of variance was not violated. A one-way ANOVA revealed that there was a statistically significant difference in Emotional Support at the $p < .01$ level and Classroom Organisation at the $p < .001$ level for the three school types; F (2,16) = 8.69, $p = .003$ and F (2,16) = 20.21, $p = .001$, respectively. There was no significant group difference in Instructional Support.

For the Emotional Support domain, post-hoc comparisons using the Tukey test indicated that the mean score for BCELF schools was significantly lower than both Montessori ($p = .002$) and Reggio Emilia schools ($p = .02$). Montessori and Reggio Emilia schools did not differ significantly from each other.

For the Classroom Organisation domain, post hoc comparisons using the Tukey test indicated that the mean score for BCELF schools was significantly lower than both Montessori ($p = .001$) and Reggio Emilia schools ($p = .016$). Montessori schools also differed significantly from Reggio Emilia schools ($p = .026$).

Table 5.2.1-2 presents the means, standard deviations, and range for each of the ten dimensions. The table also includes the results of the Levene's test and one-way ANOVA including the F-ratio and the degrees of freedom across three groups. The Levene's test showed that the assumption of the homogeneity of variance was not violated, except for Negative Climate. Robust tests of equality means are usually recommended for heterogeneous variances; however, these tests could not be performed as one group (Reggio Emilia) has 0 variance. Therefore, the results of parametric one-way ANOVA were consulted for inspecting the mean-level difference in this dimension.

There was a statistically significant difference in four dimensions amongst the three school types: Regard for Student Perspectives (F (2,16) = 26.96, $p = .001$), Teacher Sensitivity (F (2,16) = 5.42, $p = .016$), Instructional Learning Formats (F (2,16) = 45.40, $p = .001$), and Concept Development (F (2,16) = 10.66, $p = .001$). Post hoc comparisons using the Tukey test were performed to inspect specific mean-level differences. For Regard for Student Perspectives, BCELF schools ($M = 3.6$, $SD = 0.60$) scored significantly lower than Montessori ($M = 6.0$, $SD = 0.46$, $p = .001$) and Reggio Emilia schools ($M = 5.1$, $SD = 0.41$, $p = .004$). Montessori also differed significantly from Reggio Emilia schools ($p = .016$).

Scale		Programme type			Levene's test	One-way ANOVA	
		Montessori (N=10)	Reggio Emilia (N=5)	BCELF (N=4)		*F (df)*	Sig.
Positive Climate	*M*	6.0	6.3	5.5	0.94	1.96 (2,16)	.17
	SD	0.67	0.35	0.41			
	Range	5−7	6−7	5−6			
Negative Climate	*M*	1.2	1.0	1.1	4.03*	0.77 (2,16)	.48
	SD	0.33	0	0.14			
	Range	1−2	0−1	1−2			
Regard for Student Perspectives	*M*	6.0	5.1	3.6	0.93	26.96 (2,16)**	.001
	SD	0.46	0.41	0.60			
	Range	5−7	5−6	3−4			
Teacher Sensitivity	*M*	5.7	5.7	4.7	0.56	5.42 (2,16)*	.02
	SD	0.61	0.42	0.52			
	Range	5−7	4−6	4−5			
Behaviour Management	*M*	6.1	5.6	4.9	3.15	2.87 (2,16)	.09
	SD	1.02	0.45	0.32			
	Range	4−7	5−6	5−5			
Productivity	*M*	5.4	5.1	4.9	1.87	1.78 (2,16)	.20
	SD	0.49	0.63	0.25			
	Range	4−6	4−6	4−5			
Instructional Learning Formats	*M*	6.0	4.2	2.6	2.03	45.40 (2,16)**	.001
	SD	0.42	0.72	0.94			
	Range	5−7	3−5	2−4			
Concept Development	*M*	2.2	2.4	1.3	0.90	10.66 (2,16)**	.001
	SD	0.41	0.42	0.35			
	Range	2−6	2−5	1−2			
Quality Feedback	*M*	2.6	3.1	2.3	0.25	0.87 (2,16)	.44
	SD	0.93	1.10	1.02			
	Range	1−5	2−5	2−4			
Language Modeling	*M*	2.9	2.5	2.1	0.27	2.51 (2,16)	.11
	SD	0.78	0.74	0.72			
	Range	2−4	2−4	1−3			

Table 5.2.1-2. Mean, standard deviation, range, stability, and consistency in the CLASS scores
Note. Scale ranged from 1-7 (1,2- low, 3,4,5-medium, 6,7-high); *df* = degree of freedom. $*p < .05$. $**p < .01$.

For Teacher Sensitivity, BCELF schools ($M = 4.7$, $SD = 0.52$) scored significantly lower than Montessori ($M = 5.7$, $SD = 0.61$, $p = .015$) and Reggio Emilia schools ($M = 5.7$, $SD = 0.42$, $p = .046$). Montessori and Reggio Emilia schools did not differ significantly from each other.

For Instructional Learning Formats, Montessori schools ($M = 6.0$, $SD = 0.42$) scored significantly higher than Reggio Emilia ($M = 4.2$, $SD = 0.72$, $p = .001$) and BCELF schools ($M = 2.6$, $SD = 0.94$, $p = .001$). Reggio Emilia also significantly differed from BCELF schools ($p = .003$).

For Concept Development, BCELF schools (M = 1.3, SD = 0.35) scored significantly lower than Montessori (M = 2.2, SD = 0.41, p = .003) and Reggio Emilia schools (M = 2.4, SD = 0.42, p = .002), although the mean scores for all school types fell in the low range. Montessori and Reggio Emilia schools did not differ significantly from each other.

5.2.2 RQ2: Is enrolment in different preschool programmes associated with changes in EF, social-emotional skills, and academic achievement during one school year?

This research question investigated whether enrolling in different preschool programmes was associated with changes in children's EF, social-emotional skills, and pre-academic competence over one preschool year. Before examining the predictive effects of preschool programmes, progress in school readiness skills over time was explored using a mixed between-within subjects ANOVA (Table 5.2.2-1) (Appendix Q).

Scale	Mixed between-within subjects ANOVA		
	F (df)	Sig.	*ηp2*
Direct measure of EF			
Peg tapping (IC): T1→T2	101.87 (2,116)***	.001	.47
Digits backward (WM): T1→T2	53.492 (1,116)***	.001	.32
DCCS (CF): T1→T2	30.04 (1,116)***	.001	.21
Indirect measure of EF (BRIEF-P)			
Parent-rated IC: T1→T2	0.01 (1,68)	.93	.001
Parent-rated WM: T1→T2	0.18 (1,68)	.68	.003
Parent-rated CF: T1→T2	0.19 (1,68)	.67	.003
Teacher-rated IC: T1→T2	3.72 (1,115)	.06	.03
Teacher-rated WM: T1→T2	1.11 (1,115)	.29	.01
Teacher-rated CF: T1→T2	1.79 (1,115)	.18	.02
Indirect measure of social-emotional skills (SEARS)			
Parent-rated Social competence: T1→T2	1.23 (1,67)	.27	.02
Parent-rated Empathy: T1→T2	1.04 (1,67)	.31	.02
Parent-rated Responsibility: T1→T2	0.12 (1,67)	.72	.02
Teacher-rated Social competence: T1→T2	3.04 (1,115)	.08	.03
Teacher-rated Empathy: T1→T2	5.64 (1,115)**	.02	.05
Teacher-rated Responsibility: T1→T2	2.35 (1,115)	.13	.02
Pre-academic competence (BAS-3)			
Vocabulary: T1→T2	121.54 (1,116)***	.001	.51
Early Number Concepts: T1→T2	238.89 (2,116)***	.001	.67

Table 5.2.2-1. Main effects for time in a mixed between-within subjects ANOVA
Note. WM = Working memory; IC = Inhibitory control; CF = Cognitive flexibility; ηp^2 = partial eta-squared. $^{**}p < .01$, $^{***}p < .001$.

There was a substantial time effect on direct measurements, with all groups making a significant improvement in all aspects of performance-based EF and pre-academic competence. On the other hand, there was no time effect on indirect measures of EF and social-emotional skills except for teacher-rated empathy, with no groups making a significant improvement in most of teacher or parent ratings of EF and social-emotional skills.

In order to examine the predictive effects of the three preschool programmes, latent autoregressive analyses in a SEM framework were performed. Each component of EF, social-emotional skills, and pre-academic competence was investigated separately by regressing the latent construct (or observed variable) at post-test (T2) on the same latent construct (or observed variable) at previous point (T1) as well as dummy group variables (Montessori=1, Reggio Emilia=0). Fluid intelligence was accounted for and included in all the models. Covariates such as teachers' years of experience, educational levels, and expectations were eventually excluded from all the models since the inclusion of these covariates did not bring any significant changes in the parameter estimates. Constraints for weak and strong invariances were retained in the analyses. The correlations amongst baseline variables as well as endogenous disturbances were also estimated.

The standardised β coefficients are reported in each of the 17 autoregressive models so as to indicate how much unique variance in dependent variables is influenced by individual independent variables. For the purpose of simplification, factor loadings for multiple indicators are not reported in the subsequent figures.

a) Direct measure of executive function

Inhibitory Control (IC). IC was measured using the Peg Tapping task. The reliability for the scale was .82 (Blair & Razza, 2008); the standard deviation was 4.86 for T1 and 2.71 for T2. Therefore, the measurement variance was $4.25 = \sqrt{(1-.82)}\ 4.86\ (y)$ for T1 and $1.32 = \sqrt{(1-.82)}\ 2.71\ (y)$ for T2 and included in the model. The latent autoregressive model exhibited a marginally acceptable model fit (CFI = .985; TLI = .866; RMSEA = .09). Enrolment in a particular school type was not significantly associated with change in IC ($\beta = .028$, $p = .80$ for Montessori; $\beta = -.041$, $p = .72$ for Reggio Emilia) (Figure 5.2.2-a1).

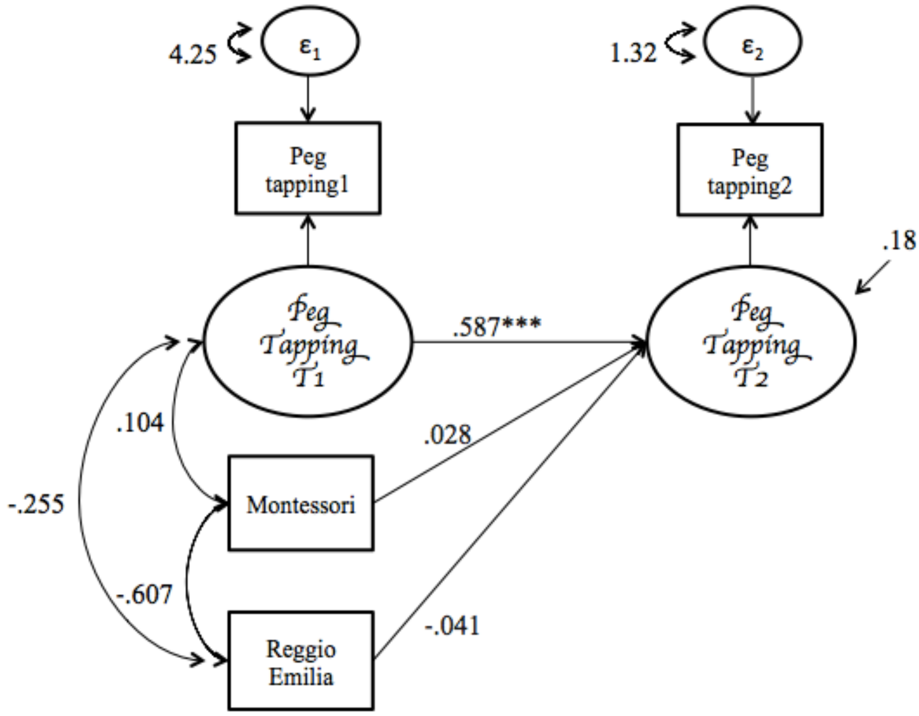

Figure 5.2.2-a1. Latent autoregressive model of different curricula and Peg tapping (N = 119)

Working Memory (WM). WM was measured using the Digit Span backwards (DSB) task from Digit Span. The reliability for the scale was .84. The standard deviation for DSB was 2.12 for T1 and .53 for T2. Therefore, the measurement variance for DSB was .81 = √(1−.84) 2.12 (y) for T1 and .05 = √(1−.84) .53(y) for T2. The correction for this measurement error, however, was not included in the model due to a terrible model fit. The subsequent autoregressive model with observed variables still exhibited a poor model fit (CFI = .932; TLI = .526; RMSEA = .14) such that the results should be interpreted with caution. Enrolment in a particular school type was not significantly associated with change in WM (β = .151, *p* = .16 for Montessori; β = -.099, *p* = .35 for Reggio Emilia) (Figure 5.2.2-a2). The result of the sensitivity analysis also supported the non-significant effects by showing similar standardised coefficients (β = .151, *p* =.17 for Montessori; β = -.099, *p* = .31 for Reggio Emilia).

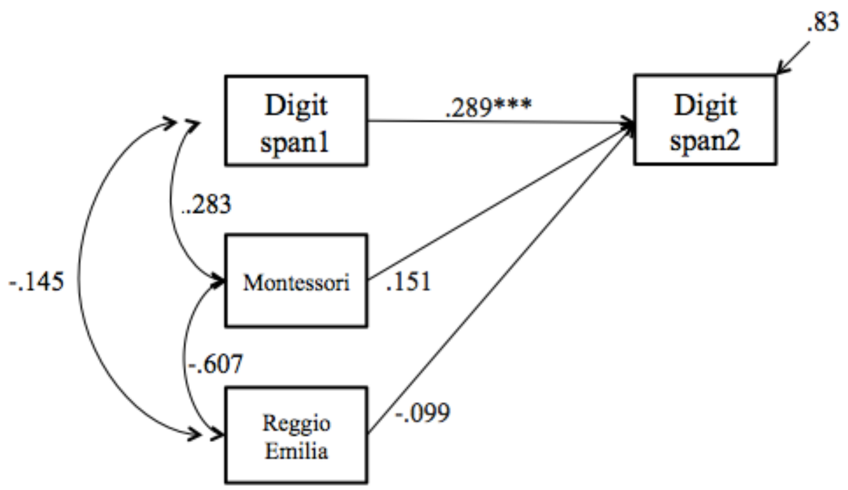

Figure 5.2.2-a2. Autoregressive model of different curricula and Digit Span backwards (N = 119)

Cognitive Flexibility (CF). CF was measured using the Dimensional Card Change Sorting task (DCCS). The reliability for the scale was .84 (McClelland et al., 2014); the standard deviation was .70 for T1 and .46 for T2. Therefore, the measurement variance was .08 = √(1−.84) .70 (y) for T1 and .03 = √(1−.84) .46 (y) for T2. The latent autoregressive model for DCCS exhibited a poor model fit (CFI = .897; TLI = .070; RMSEA = .17) such that the results should be interpreted with caution. Enrolment in a particular school type was not a significantly associated with change in CF (β = .139, *p* =.23 for Montessori; β = -.022, *p* = .85 for Reggio Emilia) (Figure 5.2.2-a3).

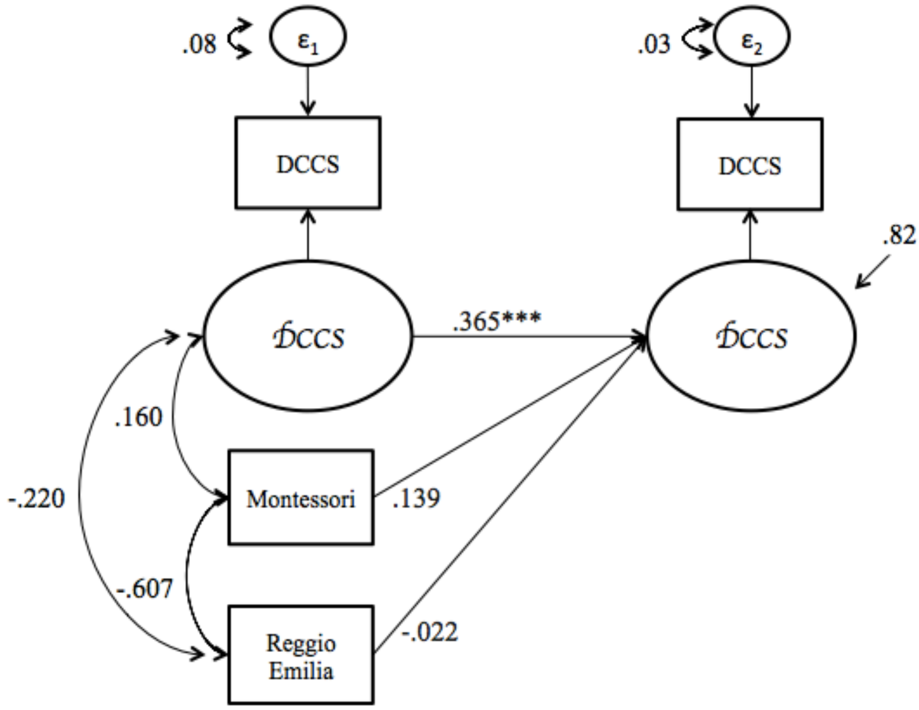

Figure 5.2.2-a3. Latent autoregressive model of different curricula and DCCS (N = 119)

b) Parent and teacher ratings of executive function (BRIEF-P)

Everyday executive function behaviours of children were rated by parents and teachers using the Behavioural Rating Inventory of Executive Function- Preschool Version (BRIEF-P).

Parent-reported Inhibitory Control (IC). The latent autoregressive model exhibited a good model fit (CFI = .957; TLI = .954; RMSEA = .04). Enrolment in a particular school type was not significantly associated with change in latent IC (β = .070, p = .39 for Montessori; β = .055, p = .52 for Reggio Emilia) (Figure 5.2.2-b1).

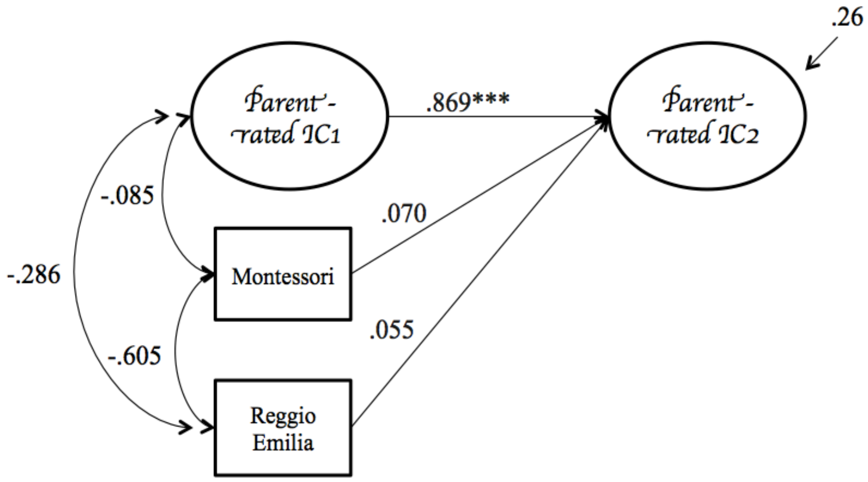

Figure 5.2.2-b1. Latent autoregressive model of different curricula and parent-rated IC (N = 87)

Parent-reported Working Memory (WM). The latent autoregressive model exhibited an excellent model fit (CFI = .984; TLI = .983; RMSEA = .03). Enrolment in a particular school type was not significantly associated with change in latent WM (β = .078, *p* = .32 for Montessori; β = .195, *p* = .06 for Reggio Emilia) (Figure 5.2.2-b2).

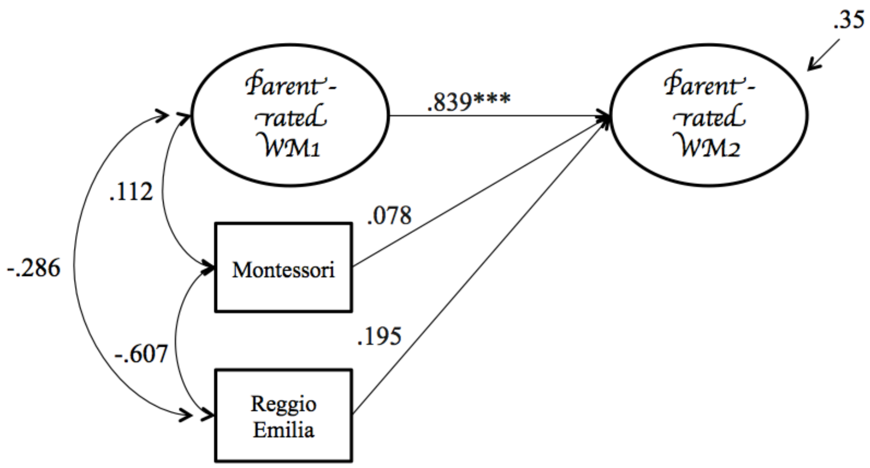

Figure 5.2.2-b2. Latent autoregressive model of different curricula and parent-rated WM (N = 87)

Parent-reported Cognitive Flexibility (CF). The latent autoregressive model exhibited a good model fit (CFI = .950; TLI = .946; RMSEA = .06). Enrolment in a particular school type was not significantly associated with change in latent CF (β = -.048, *p* = .59 for Montessori; β = .115, *p* = .20 for Reggio Emilia) (Figure 5.2.2-b3).

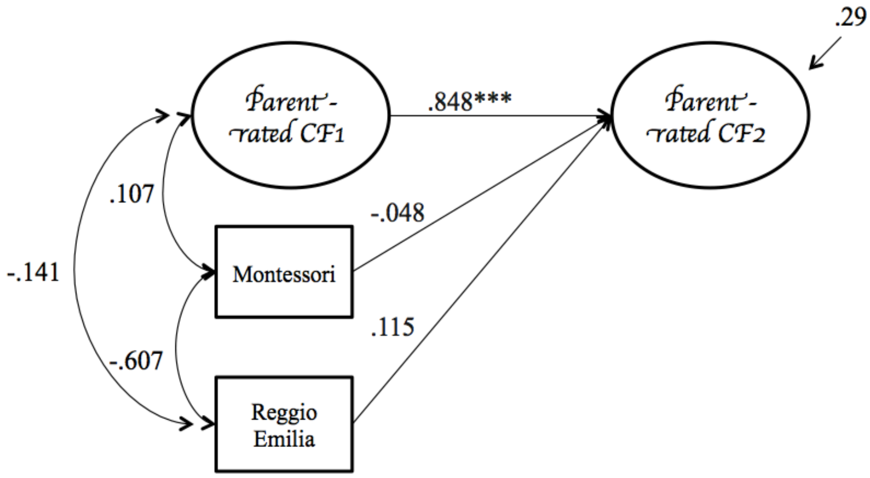

Figure 5.2.2-b3. Latent autoregressive model of different curricula and parent-rated CF (N = 87)

Teacher-reported Inhibitory Control (IC). The latent autoregressive model exhibited a good model fit (CFI=.991; TLI=.991; RMSEA=.04). Enrolment in a particular school type was not significantly associated with change in latent IC (β = .002, *p* = .75 for Montessori; β = .021, *p* = .75 for Reggio Emilia) (Figure 5.2.2-b4).

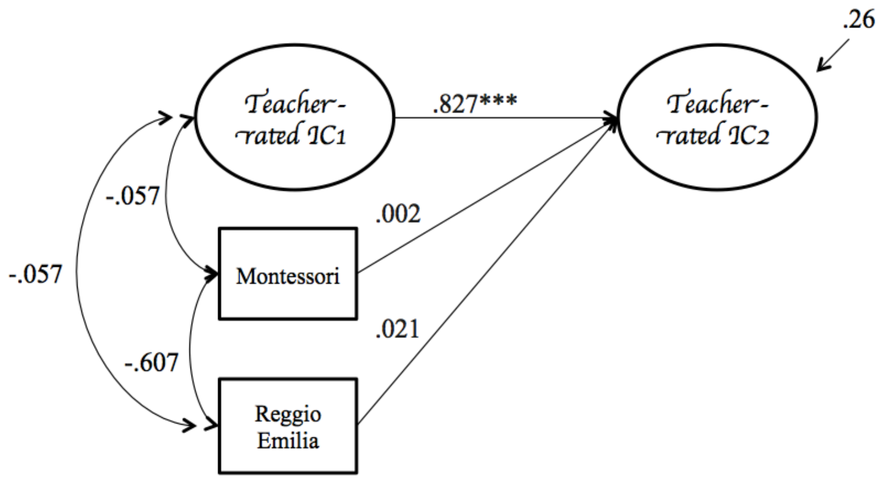

Figure 5.2.2-b4. Latent autoregressive model of different curricula and teacher-rated IC (N = 119)

Teacher-reported Working Memory (WM). The latent autoregressive model exhibited a good model fit (CFI = .985; TLI = .984; RMSEA = .05). Enrolment in a particular school type was not significantly associated with change in latent WM (β = .027, *p* = .68 for Montessori; *β* = .195, *p* = .06 for Reggio Emilia) (Figure 5.2.2-b5).

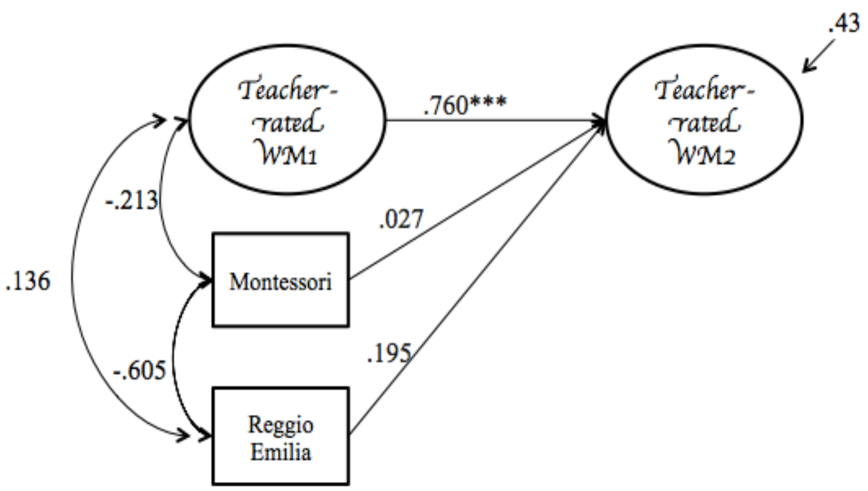

Figure 5.2.2-b5. Latent autoregressive model of different curricula and teacher-rated WM (N = 87)

Teacher-reported Cognitive Flexibility (CF). The latent autoregressive model exhibited a satisfactory model fit (CFI = .943; TLI = .938; RMSEA = .08). Enrolment in a particular school type was negatively associated with change in latent CF at a significant level (β = -.174, p = .03 for Montessori; β = -.218, p = .01 for Reggio Emilia), indicating that children in Montessori and Reggio Emilia schools showed significantly fewer improvements in teacher-rated CF than children in BCELF schools (Figure 5.2.2-b6).

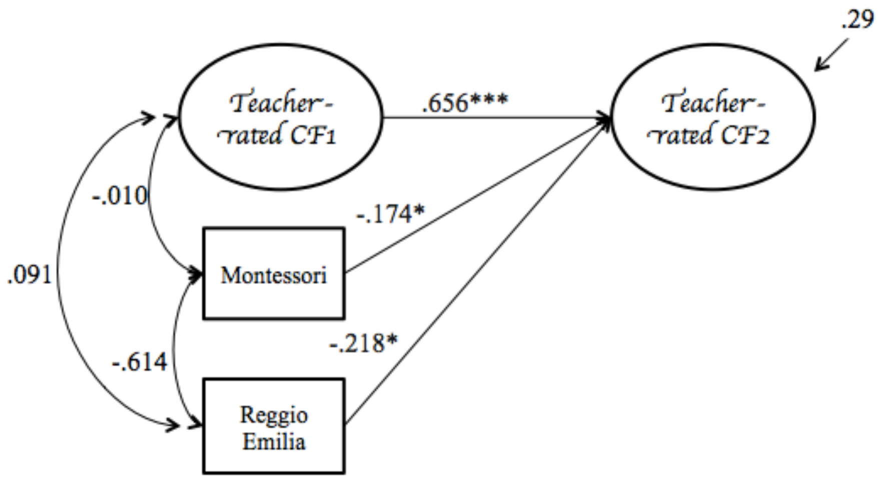

Figure 5.2.2-b6. Latent autoregressive model of different curricula and teacher-rated CF (N = 119)

c) Parent and teacher ratings of social-emotional skills

Social-emotional skills of children were measured by parents and teachers using the Social-Emotional Assets and Resiliency Scale (SEARS).

Parent-reported Social competence (SC). The latent autoregressive model exhibited a satisfactory model fit (CFI = .987; TLI = .980; RMSEA = .08). Enrolment in a particular school type was negatively associated with change in parent-rated social competence at a significant level (β = -.315, p = .01 for Montessori; β = -.285, p = .02 for Reggio Emilia), indicating that children in Montessori and Reggio Emilia schools made significantly fewer improvements in parent-rated social competence than children in BCELF schools (Figure 5.2.2-c1).

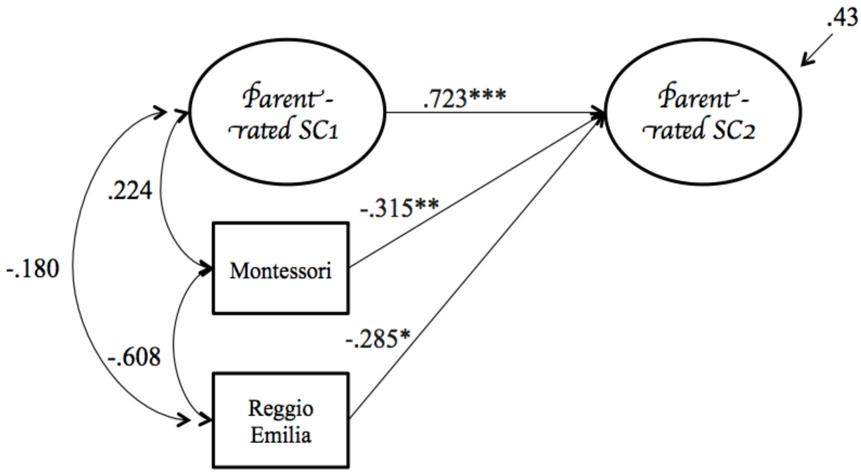

Figure 5.2.2-c1. Latent autoregressive model of different curricula and parent-rated SC (N = 119)

Parent-reported Empathy. The latent autoregressive model exhibited a marginally acceptable model fit (CFI = .989; TLI = .982; RMSEA = .09). Enrolment in a particular school type was negatively associated with change in empathy (β = -.289, p = .01 for Montessori; β = -.101, p = .29 for Reggio Emilia), indicating that only children in Montessori schools made significantly fewer improvements in parent-rated empathy than children in BCELF schools (Figure 5.2.2-c2).

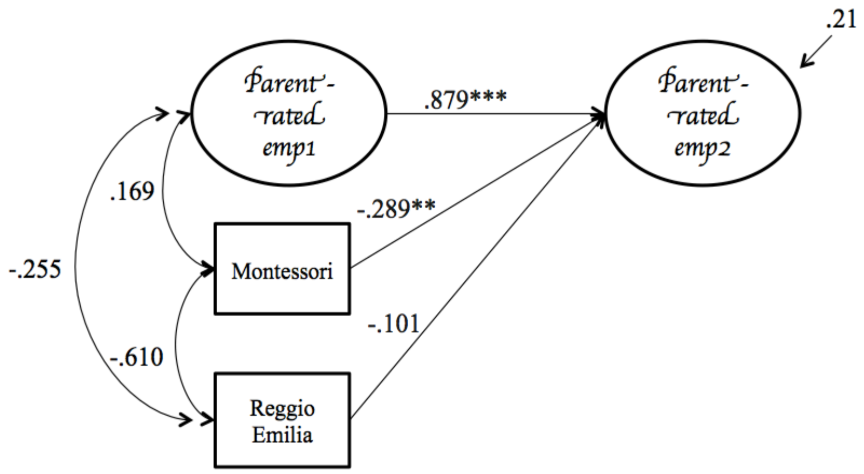

Figure 5.2.2-c2. Latent autoregressive model of different curricula and parent-rated empathy (N = 87)

Parent-reported Responsibility. The latent autoregressive model exhibited a satisfactory model fit (CFI = .952; TLI = .944; RMSEA = .08). Enrolment in a particular school type was not significantly associated with change in parent-rated responsibility (β = -.166, *p* = .24 for Montessori; β = -.268, *p* = .21 for Reggio Emilia) (Figure 5.2.2-c3).

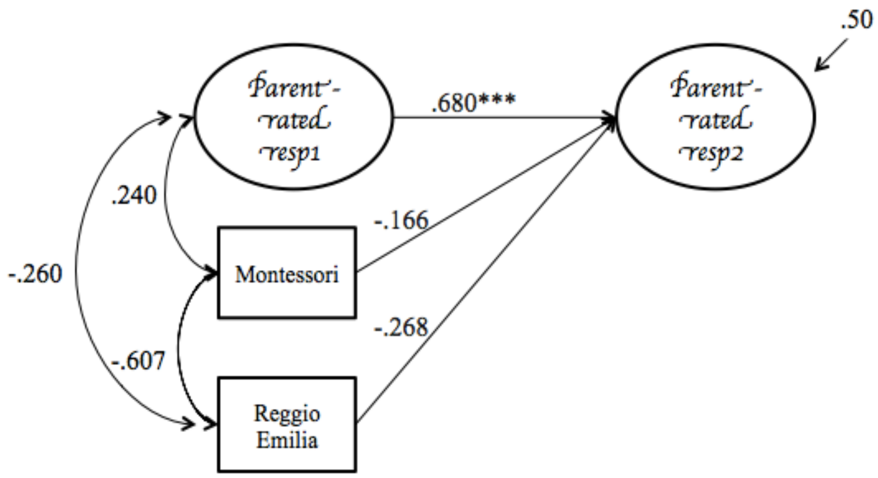

Figure 5.2.2-c3. Latent autoregressive model of different curricula and parent-rated responsibility (N = 87)

Teacher-reported Social competence (SC). The latent autoregressive model exhibited a rather poor model fit (CFI = .989; TLI = .982; RMSEA = .11) such that the results should be interpreted with caution. Enrolment in a particular school type was not significantly associated with change in latent teacher-rated social competence (β = -.154, *p* = .08 for Montessori; β = -.020, *p* = .80 for Reggio Emilia) (Figure 5.2.2-c4).

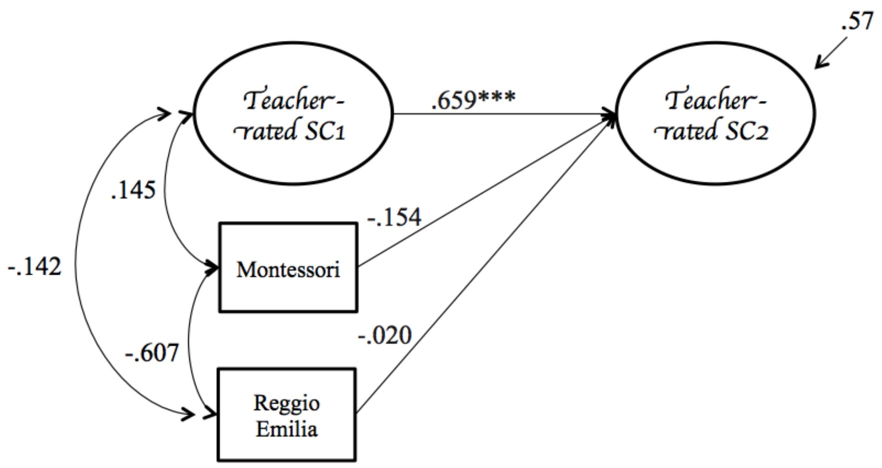

Figure 5.2.2-c4. Latent autoregressive model of different curricula and teacher-rated SC (N = 119)

Teacher-reported Empathy. The latent autoregressive model exhibited an excellent model fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). Enrolment in a particular school type was not significantly associated with change in latent teacher-rated empathy (β = -.076, *p* = .37 for Montessori; β = -.114, *p* = .29 for Reggio Emilia) (Figure 5.2.2-c5).

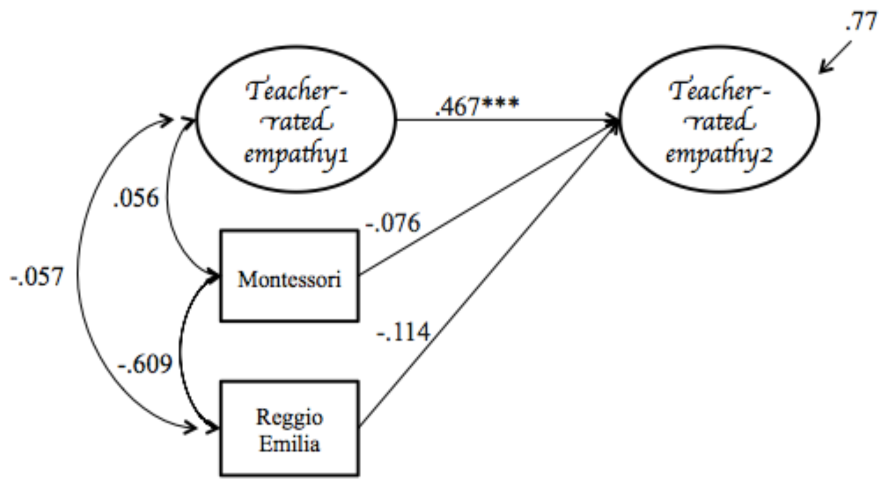

Figure 5.2.2-c5. Latent autoregressive model of different curricula and teacher-rated empathy (N = 119)

Teacher-reported Responsibility. The latent autoregressive model exhibited a marginally acceptable model fit (CFI = .982; TLI = .979; RMSEA = .09). Enrolment in a particular school type was not significantly associated with change in latent teacher-rated responsibility (β = -.046, *p* = .59 for Montessori; β = -.055, *p* = .58 for Reggio Emilia) (Figure 5.2.2-c6).

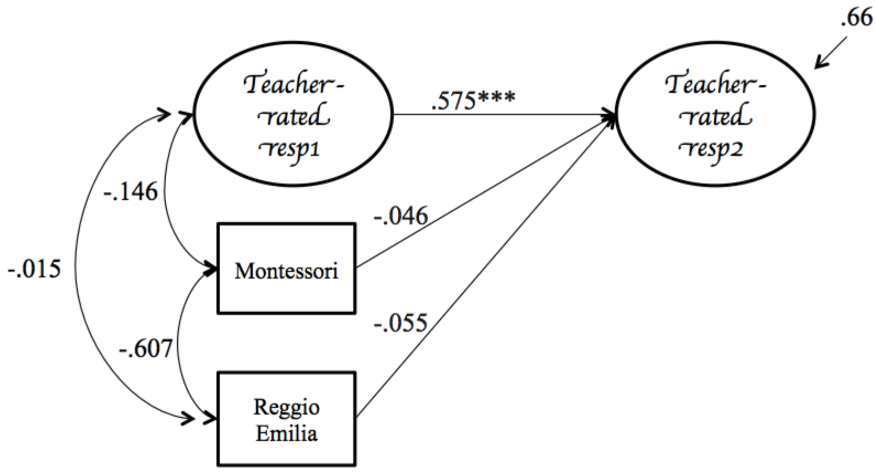

Figure 5.2.2-c6. Latent autoregressive model of different curricula and teacher-rated responsibility (N = 119)

d) Direct measure of pre-academic competence

Naming Vocabulary and Early Number Concepts from the BAS-3 were used to measure vocabulary and numeracy respectively.

Vocabulary. The reliability for the scale was .70 (Smith & Elliot, 2011); the standard deviation was 3.44 for T1 and 3.78 for T2. Therefore, the measurement variance was 3.55 = $\sqrt{(1-.70)}$ 3.44 (y) for T1 and 4.28 = $\sqrt{(1-.70)}$ 3.78 (y) for T2 and included in the model. The latent autoregressive model exhibited a good model fit (CFI = .990; TLI = .912; RMSEA = .07). Enrolment in a particular school type was not significantly associated with change in vocabulary (β = .093, *p* = .43 for Montessori; β = -.127, *p* = .28 for Reggio Emilia) (Figure 5.2-2-d1).

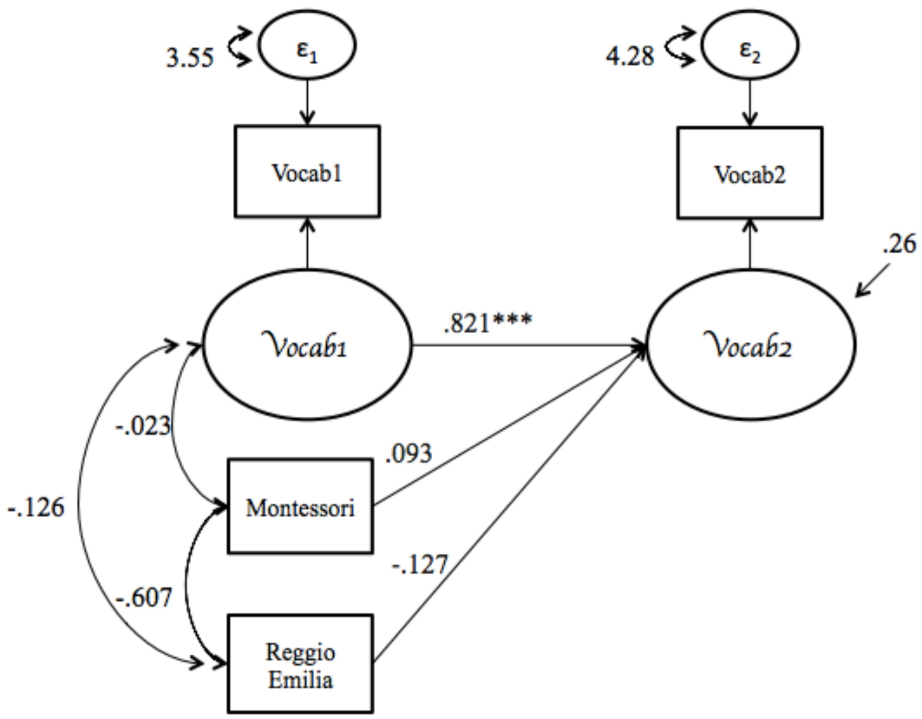

Figure 5.2.2-d1. Latent autoregressive model of different curricula and vocabulary (N = 119)

Numeracy. The reliability for the scale was .96 (Smith & Elliot, 2011); the standard deviation was 6.05 for T1 and 4.22 for T2. Therefore, the measurement variance was 1.46 = √(1 −.96) 6.05(y) for T1 and .71 = √(1−.96) 4.22 (y) for T2 and included in the model. The latent autoregressive model exhibited a poor model fit (CFI = .894; TLI = .042; RMSEA = .27). As parameter estimates did not show a significant change, fluid intelligence was removed from the model. The subsequent model showed an excellent model fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). Enrolment in a particular school type was significantly associated with change in early number concepts (β = .303, p = .001 for Montessori; β = -.102, p = .27 for Reggio Emilia), indicating that Montessori children made significantly greater improvements in early number concepts while Reggio Emilia children did not compared to BCELF school children (Figure 5.2.2-d2). The result of the sensitivity analysis also supported the significant effect of Montessori schools by showing similar standardised coefficients (β = .299, p = .03 for Montessori; β = -.169, p = .14 for Reggio Emilia).

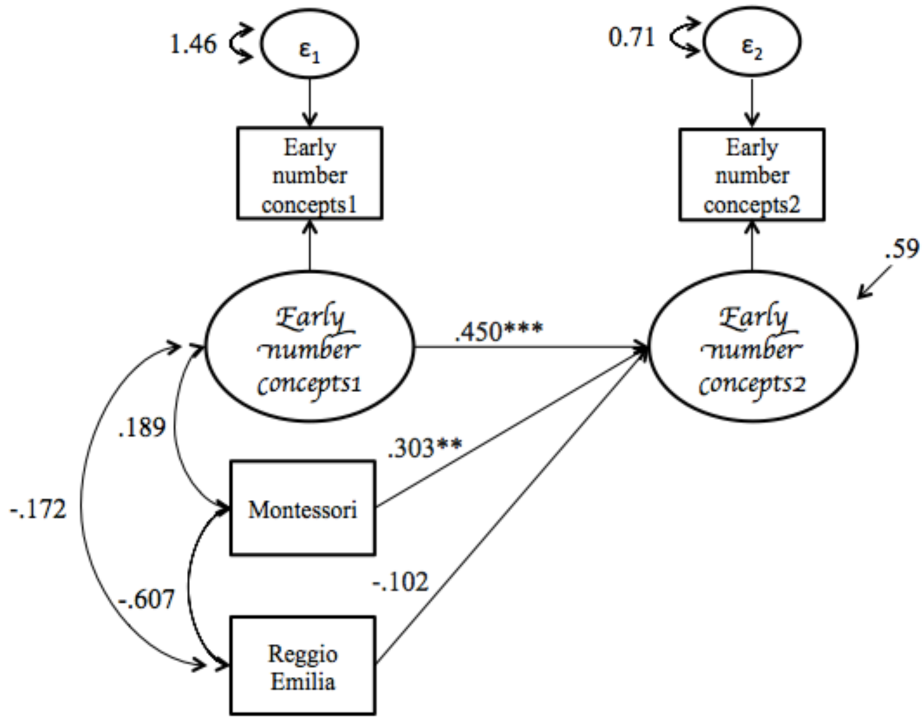

Figure 5.2.2-d2. Latent autoregressive model of different curricula and early number concepts (N = 119)

Table 5.2.2-2 represents parameter estimates between different programme types and outcome variables. In summary, enrolment in a particular school type was not associated with significant changes in most of the direct measures except for numeracy skills. Montessori children showed significantly greater improvements in numeracy skills while Reggio Emilia children did not compared to BCELF school children.

According to parents, both Montessori and Reggio Emilia children showed significantly fewer improvements in the Social Competence scale than BCELF school children. Montessori parents also described their children as showing significantly fewer improvements in empathy than did BCELF school parents. According to teachers, both Montessori and Reggio Emilia children showed significantly fewer improvements in CF compared to the BCELF children.

	Programme type			
	Montessori		Reggio Emilia	
Outcome variables	β	*p*	β	*p*
Direct measure of EF				
Peg tapping (Inhibitory control: IC)	.028	.80	-.041	.72
Digits backward (Working memory: WM)	.151	.16	-.099	.35
DCCS (Cognitive flexibility: CF)	.139	.23	-.022	.85
Indirect measure of EF (BRIEF-P)				
Parent-rated IC	.070	.39	.055	.52
Parent-rated WM	.078	.32	.195	.06
Parent-rated CF	-.048	.59	.115	.20
Teacher-rated IC	.002	.75	.021	.75
Teacher-rated WM	.027	.68	.195	.06
Teacher-rated CF	-.174	.03*	-.218	.01*
Indirect measure of social-emotional skills (SEARS)				
Parent-rated Social competence	-.315	.01*	-.285	.02*
Parent-rated Empathy	-.289	.01*	-.101	.29
Parent-rated Responsibility	-.166	.24	-.268	.21
Teacher-rated Social competence	-.154	.08	-.020	.80
Teacher-rated Empathy	-.076	.37	-.114	.29
Teacher-rated Responsibility	-.046	.59	-.055	.58
Direct measure of pre-academic competence (BAS-3)				
Vocabulary	.093	.43	-.127	.28
Early number Concepts	.303	.001**	-.102	.27

Table 5.2.2-2. Parameter estimates between programme types and changes in outcome measures
Note. βs represent standard coefficients. $*p < .05$. $**p < .01$.

5.2.3 RQ3: Is any aspect of classroom process quality measured by the CLASS associated with changes in EF, social-emotional skills, and pre-academic competence?

The latent autoregressive analyses in a SEM framework were computed to test the role of classroom process quality in facilitating school readiness skills including EF, social-emotional skills, and pre-academic competence. Because of the collinear nature of the scores, each CLASS domain (Emotional Support, Classroom Organisation, and Instructional Support) was run separately. Covariates such as fluid intelligence, teachers' years of experience, educational levels, and school types were eventually excluded from all the models since the inclusion of these covariates produced a poor model fit and did not bring any significant changes in the parameter estimates. Consequently, the result should be interpreted with caution. The correlation table for the CLASS domains and school readiness skills at both time points are presented in Appendix R.

a) CLASS and direct measures of EF

Emotional Support and IC (Peg Tapping). The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for IC was sizeable (β = .58, p = .001). Emotional Support was not significantly associated with change in IC (β = -.07, p = .42).

Emotional Support and WM (Digit Span backwards). Since incorporating correction for measurement error for WM failed to estimate both autoregressive and cross-lagged effects, the observed variables for backward memory span were used in the following model. Consequently, the result should be interpreted with caution. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for WM was sizeable (β = .33, p = .001). Emotional Support was not significantly associated with change in vocabulary (β = -.05, p = .54).

Emotional Support and CF (DCCS). The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for CF was sizeable (β = .38, p = .001). Emotional Support was not significantly associated with change in CF (β = .03, p = .77).

Classroom Organisation and IC (Peg Tapping). The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for IC was sizeable (β = .59, p = .001). Classroom Organisation was not significantly associated with change in CF (β = -.04, p = .70).

Classroom Organisation and WM (Digit Span backwards). Since incorporating correction for measurement error for DSB failed to estimate autoregressive effect, the observed variables for backward memory span were used in the following model. Consequently, the result should be interpreted with caution. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for WM was sizeable (β = .32, p = .001). Classroom Organisation was not significantly associated with change in WM (β = .09, p = .29).

Classroom Organisation and CF (DCCS). The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for CF was sizeable (β = .38, p =

.001). Classroom Organisation was not significantly associated with change in CF (β = .14, p = .13).

Instructional Support and IC (Peg Tapping). The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for IC was sizeable (β = .58, p = .001). Instructional Support was not significantly associated with change in CF (β = -.03, p = .74).

Instructional Support and WM (Digit Span backwards). Since incorporating correction for measurement error for WM failed to estimate autoregressive effect, the observed variables for backward memory span were used in the following model. Consequently, the result should be interpreted with caution. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for WM was sizeable (β = .34, p = .001). Instructional Support was not significantly associated with change in WM (β = -.05, p = .59).

Instructional Support and CF (DCCS). The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for CF was sizeable (β = .36, p = .001). Instructional Support was not significantly associated with change in CF (β = -.17, p = .07).

b) CLASS and teacher-rated EF (BRIEF-P)

Emotional Support and teacher-rated IC. The model exhibited an excellent fit (CFI = .99; TLI = .99; RMSEA = .04). The autoregressive effect for teacher-rated IC was sizeable (β = .83, p = .001). Emotional Support was not significantly associated with change in teacher-rated IC (β = -.001, p = .89).

Emotional Support and teacher-rated WM. The model exhibited an excellent fit (CFI = .97; TLI = .99; RMSEA = .05). The autoregressive effect for teacher-rated WM was sizeable (β = .76, p = .001). Emotional Support was not significantly associated with change in teacher-rated WM (β = -.003, p = .71).

Emotional Support and teacher-rated CF. The model exhibited an acceptable fit (CFI = .95; TLI = .94; RMSEA = .08). The autoregressive effect for CF was sizeable (β = .64, p = .001). Emotional Support was significantly negatively associated with change in CF (β = -.03, p = .01).

Classroom Organisation and teacher-rated IC. The model exhibited an excellent fit (CFI = .98; TLI = .98; RMSEA = .05). The autoregressive effect for teacher-rated IC was sizeable (β = .76, p = .001). Classroom Organisation was not significantly associated with change in IC (β = .001, p = .75).

Classroom Organisation and teacher-rated WM. The model exhibited an excellent fit (CFI = .98; TLI =. 98; RMSEA = .05). The autoregressive effect for teacher-rated WM was sizeable (β = .80, p = .001). Classroom Organisation was not significantly associated with change in WM (β = -.01, p = .98).

Classroom Organisation and teacher-rated CF. The model exhibited a good fit (CFI = .94; TLI = .94; RMSEA = .08). The autoregressive effect for teacher-rated CF was sizeable (β = .64, p = .001). Classroom Organisation was significantly negatively associated with change in CF (β = -.06, p = .02).

Instructional Support and teacher-rated IC. The model exhibited an excellent fit (CFI = .99; TLI = .99; RMSEA = .04). The autoregressive effect for teacher-rated WM was sizeable (β = .83, p = .001). Instructional Support was not significantly associated with change in teacher-rated IC (β = .01, p = .76).

Instructional Support and teacher-rated WM. The model exhibited an excellent fit (CFI=.98; TLI=.98; RMSEA=.05). The autoregressive effect for teacher-rated WM was sizeable (β = .76, p = .001). Instructional Support was not significantly associated with change in teacher-rated WM (β = .04, p = .20).

Instructional Support and teacher-rated CF. The model exhibited a marginally acceptable fit (CFI = .94; TLI = .93; RMSEA = .09). The autoregressive effect for teacher-rated CF was sizeable (β = .68, p = .001). Instructional Support was significantly negatively associated with change in teacher-rated CF (β = -.06, p = .02).

c) CLASS and teacher-rated social-emotional skills (SEARS)

Emotional Support and teacher-rated Social Competence. The model exhibited a rather poor fit (CFI = .99; TLI = .98; RMSEA = .11). This might be due to low correlations between items across time. Consequently, the result should be interpreted with caution. The autoregressive effect for teacher-rated Social Competence was sizeable (β = .64, p = .001). Emotional Support was not significantly associated with change in teacher-rated Social Competence (β = -.03, p = .07).

Emotional Support and teacher-rated Empathy. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for teacher-rated Empathy was sizeable (β = .47, p = .001). Emotional Support was not significantly associated with change in teacher-rated Empathy (β = -.02, p = .18).

Emotional Support and teacher-rated Responsibility. The model exhibited a marginally acceptable fit (CFI = .98; TLI = .98; RMSEA = .09). The autoregressive effect for teacher-rated Responsibility was sizeable (β = .58, p = .001). Emotional Support was not significantly associated with change in teacher-rated Responsibility (β = -.01, p = .57).

Classroom Organisation and teacher-rated Social Competence. The model exhibited a marginally acceptable fit (CFI = .99; TLI = .99; RMSEA = .09). The autoregressive effect for teacher-rated Social Competence was sizeable (β = .64, p = .001). Classroom Organisation was not significantly associated with change in teacher-rated Social Competence (β = -.05, p = .11).

Classroom Organisation and teacher-rated Empathy. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for teacher-rated Empathy was sizeable (β = .47, p = .001). Classroom Organisation was not significantly associated with change in teacher-rated Empathy (β = -.03, p = .32).

Classroom Organisation and teacher-rated Responsibility. The model exhibited a marginally acceptable fit (CFI = .98; TLI = .98; RMSEA = .09). The autoregressive effect for teacher-rated Responsibility was sizeable (β = .58, p = .001). Classroom Organisation was not significantly associated with change in teacher-rated Responsibility (β = -.02, p = .61).

Instructional Support and teacher-rated Social Competence. The model exhibited a marginally acceptable fit (CFI = .99; TLI = .99; RMSEA = .09). The autoregressive effect for teacher-rated Social Competence was sizeable (β = .64, p = .001). Instructional Support was not significantly associated with change in teacher-rated Social competence (β = -.01, *p* = .71).

Instructional Support and teacher-rated Empathy. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for teacher-rated Empathy was sizeable (β = .46, *p* = .001). Instructional Support was not significantly associated with change in teacher-rated Empathy (β = -.04, *p* = .42).

Instructional Support and teacher-rated Responsibility. The model exhibited a marginally acceptable fit (CFI = .98; TLI = .98; RMSEA = .09). The autoregressive effect for teacher-rated Responsibility was sizeable (β = .58, *p* = .001). Instructional Support was not significantly associated with change in teacher-rated Responsibility (β = -.03, *p* = .58).

d) CLASS and pre-academic competence (BAS)

Emotional Support and Vocabulary. The autoregressive model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for vocabulary was sizeable (β = .81, *p* = .001). Emotional Support was not significantly associated with change in vocabulary (β = -.08, *p* = .38).

Emotional Support and Numeracy. The autoregressive model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for numeracy was sizeable (β = .52, *p* = .001). Emotional Support was not significantly associated with change in vocabulary (β = .09, *p* = .39).

Classroom Organisation and Vocabulary. The autoregressive model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for vocabulary was sizeable (β = .82, *p* = .001). Classroom Organisation was not significantly associated with change in vocabulary (β = -.09, *p* = .39).

Classroom Organisation and Numeracy. The autoregressive model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for numeracy was sizeable (β = .47, *p* = .001). Classroom Organisation was significantly associated with change in vocabulary (β = .27, *p* = .001).

Instructional Support and Vocabulary. The autoregressive model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for vocabulary was sizeable (β = .80, p = .001). Instructional Support was not significantly associated with change in vocabulary (β = -.13, p = .20).

Instructional Support and Numeracy. The autoregressive model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effect for numeracy was sizeable (β = .52, p =.001). Instructional Support was not significantly associated with change in vocabulary (β = -.07, p = .40).

Table 5.2.3-1 shows standardised cross-lagged coefficients. In summary, all domains had a significant negative impact on teacher-rated CF, and the Classroom Organisation domain of the CLASS had a significant positive impact on change in numeracy skills. No other significant associations were found between the CLASS domains and the change in outcome measures. This suggests that children in classrooms where teachers provided higher quality of interactions tended to show a significant decrease in teacher-rated CF. On the other hand, children in classrooms where teachers offered higher organisational quality tended to make significantly greater gains in numeracy skills.

CLASS domains	Direct measures of EF			Teacher-rated EF (BRIEF-P)			Teacher-rated social-emotional skills (SEARS)			Pre-academic competence (BAS)	
	IC	WM	CF	IC	WM	CF	SC	Emp	Res	Vocab	Num
ES	-.07	.05	.03	-.001	-.003	-.03*	-.03	-.02	-.01	-.08	.07
CO	-.04	.09	.14	.001	-.01	-.06*	-.05	-.03	-.02	-.13	.27*
IS	-.03	-.05	-.17	.01	.04	-.06*	-.01	-.04	-.03	-.16	-.07

Table 5.2.3-1. Parameters between the CLASS domains and change in school readiness skills
Note. Cell values are standardised β coefficients. *p < .05; ES = Emotional support; CO = Classroom organisation; IS = Instructional support; IC = Inhibitory control; WM = Working memory; CF = Cognitive flexibility; SC = Social competence; Emp = Empathy; Res = Responsibility; Vocab = Vocabulary; Num = Numeracy.

5.2.4 RQ4: What are the associations between EF and pre-academic competence over time?

a) Direct measures of EF and pre-academic competence (BAS)

IC (Peg Tapping) and Vocabulary. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effects for both IC and vocabulary were sizeable (β = .564, p = .001; β = .816, p = .001, respectively). IC at T1 was not significantly associated with change in vocabulary (β = .010, p = .93); vocabulary at T1 was not significantly associated with change in IC either (β = .071, p = .54).

IC (Peg Tapping) and Numeracy. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effects for both IC and early number concepts were sizeable (β = .472, p = .001; β = .367, p = .001, respectively). IC at T1 was significantly associated with change in early number concepts (β = .254, p = .03), whereas early number concepts at T1 were not significantly associated with change in IC (β = .189, p = .12).

WM (Digit Span backwards) and Vocabulary. Since incorporating correction for measurement error for WM failed to estimate both autoregressive and cross-lagged effects, the observed variables for backward memory span were used in the following model. Consequently, the result should be interpreted with caution. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effects for both WM and vocabulary were sizeable (β = .335, p = .001; β = .835, p = .001, respectively). WM at T1 was not significantly associated with change in vocabulary (β = -.110, p = .24), whereas vocabulary at T1 was significantly associated with change in WM (β = .269, p = .005).

WM (Digit Span backwards) and Numeracy. Since incorporating correction for measurement error for WM failed to estimate both autoregressive and cross-lagged effects, the observed variables for WM were used in the following model. Consequently, the result should be interpreted with caution. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effects for both WM and early number concepts were sizeable (β = .294, p = .001; β = .487, p = .001, respectively). WM at T1 was significantly associated with change in early number concepts (β = .211, p = .01); early number concepts at T1 were also significantly associated with change in WM (β = .293, p = .001).

CF (DCCS) and Vocabulary. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effects for both CF and vocabulary were sizeable (β = .386, p = .001; β = .797, p = .001, respectively). CF at T1 was not significantly associated with change in vocabulary (β = .135, p = .19); vocabulary at T1 was not significantly associated with change in CF either (β = -.017, p = .89).

CF (DCCS) and Numeracy. The model exhibited an excellent fit (CFI = 1.00; TLI = 1.00; RMSEA = .00). The autoregressive effects for both CF and early number concepts were sizeable (β = .304, p = .004; β = .453, p = .001, respectively). CF at T1 was significantly associated with change in early number concepts (β = .191, p = .04); early number concepts at T1 were also significantly associated with change in CF (β = .210, p = .04).

Table 5.2.4-1 shows standardised cross-lagged coefficients. In summary, there were reciprocal relationships between direct measure of EF and pre-academic competence. Each direct measure of EF was significantly associated with change in early number concepts, indicating that children with higher initial levels of EF had greater improvements in numeracy skills. Conversely, vocabulary was significantly associated with WM, indicating that children with higher initial levels of vocabulary had greater improvements in WM. Early number concepts were significantly associated with WM and CF, indicating that children with higher initial levels of numeracy skills had greater improvements in WM and CF.

Paths	β	*p*
Peg tapping (IC) T1→BAS (Vocabulary) T2	.010	.93
BAS (Vocabulary) T1→Peg tapping (IC) T2	.071	.54
Digits backward (WM) T1→BAS (Vocabulary) T2	-.110	.24
BAS (Vocabulary) T1→Digits backwards (WM) T2	.269	.005**
DCCS (CF) T1→BAS (Vocabulary) T2	.135	.19
BAS (Vocabulary) T1→DCCS (CF) T2	-.017	.89
Peg tapping (IC) T1→BAS (Number Concepts) T2	.254	.03*
BAS (Number Concepts) T1→Peg tapping (IC) T2	.189	.12
Digits backward (WM) T1→BAS (Number Concepts) T2	.211	.01*
BAS (Number Concepts) T1→Digits backward (WM) T2	.293	.001**
DCCS (CF) T1→BAS (Number Concepts) T2	.191	.04*
BAS (Number Concepts) T1→DCCS (CF) T2	.210	.04*

Table 5.2.4-1. Parameter estimates between direct measure of EF and BAS
Note. BAS = British Ability Scales; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; T1 = Time point one; Time point two; βs represent standard coefficients.
*p < .05. **p < .01.

b) Indirect measures of EF (BRIEF-P) and pre-academic competence (BAS)

Parent-rated IC and Vocabulary. The model exhibited an excellent fit (CFI = .953; TLI = .951; RMSEA = .04). The autoregressive effects for both parent-rated IC and vocabulary were sizeable (β = .832, p = .001; β = .932, p = .001, respectively). Parent-rated IC at T1 was not significantly associated with change in vocabulary (β = -.155, p = .26), whereas vocabulary at T1 was marginally significantly associated with change in IC (β = .212, p = .05).

Parent-rated IC and Numeracy. The model exhibited an acceptable fit (CFI = .947; TLI = .944; RMSEA = .05). The autoregressive effects for both parent-rated IC and early number concepts were sizeable (β = .901, p = .001; β = .735, p = .001, respectively). Parent-rated IC at T1 was not significantly associated with change in early number concepts (β = .127, p = .18), whereas early number concepts at T1 were significantly associated with change in WM (β = .352, p = .001).

Parent-rated WM and Vocabulary. The model exhibited an excellent fit (CFI = .981; TLI = .980; RMSEA = .03). The autoregressive effects for both parent-rated WM and vocabulary were sizeable (β = .790, p = .001; β = .905, p = .001, respectively). Parent-rated WM at T1 was not significantly associated with change in vocabulary (β = -.015, p = .90); vocabulary at T1 was not significantly associated with change in WM either (β = .008, p = .95).

Parent-rated WM and Numeracy. Since incorporating correction for measurement error for early number concepts did not converge, the observed variables for early number concepts were used in the following model. Consequently, the result should be interpreted with caution. The model exhibited an excellent fit (CFI = .981; TLI = .980; RMSEA = .03). The autoregressive effects for both parent-rated WM and early number concepts were sizeable (β = .762, p = .001; β = .629, p = .001, respectively). Parent-rated WM at T1 was not significantly associated with change in early number concepts (β = .094, p = .24), whereas early number concepts at T1 were significantly associated with change in WM (β = .114, p = .02), though the effect size was small.

Parent-rated CF and Vocabulary. The model exhibited an acceptable fit (CFI = .919; TLI = .916; RMSEA = .07). The autoregressive effects for both parent-rated CF and vocabulary were sizeable (β = .897, p = .001; β = .910, p = .001, respectively). Parent-rated CF at T1 was not significantly associated with change in vocabulary (β = -.098, p = .46); vocabulary at T1 was not significantly associated with change in CF either (β = .160, p = .17).

Parent-rated CF and Numeracy. The model exhibited an acceptable fit (CFI = .918; TLI = .915; RMSEA = .07). The autoregressive effects for both parent-rated IC and early number concepts were sizeable (β = .891, p = .001; β = .730, p = .001, respectively). Parent-rated IC at T1 was not significantly associated with change in early number concepts (β = .023, p = .83); early number concepts at T1 were significantly associated with change in CF either (β = .119, p = .32).

Table 5.2.4-2 shows standardised cross-lagged coefficients. In summary, unidirectional paths between pre-academic competence and parent-rated EF were found. Parent-rated EF was not significantly associated with any pre-academic competence. On the other hand, early number concepts were significantly associated with parent-rated WM and IC, indicating that children with higher initial levels of numeracy skills had greater improvements in parent-rated IC and WM.

Paths	β	p
BRIEF-P (IC) T1→BAS (Vocabulary) T2	-.155	.26
BAS (Vocabulary) T1→BRIEF-P (IC) T2	.212	.05
BRIEF-P (WM) T1→BAS (Vocabulary) T2	-.015	.90
BAS (Vocabulary) T1→BRIEF-P (WM) T2	.008	.95
BRIEF-P (CF) T1→BAS (Vocabulary) T2	-.098	.46
BAS (Vocabulary) T1→BRIEF-P (CF) T2	.160	.17
BRIEF-P (IC) T1→BAS (Number Concepts) T2	.127	.18
BAS (Number Concepts) T1→BRIEF-P (IC) T2	.352	.001**
BRIEF-P (WM) T1→BAS (Number Concepts) T2	.094	.24
BAS (Number Concepts) T1→BRIEF-P (WM) T2	.114	.02*
BRIEF-P (CF) T1→BAS (Number Concepts) T2	.023	.83
BAS (Number Concepts) T1→BRIEF-P (CF) T2	.119	.32

Table 5.2.4-2. Parameter estimates between parent-rated EF and pre-academic competence
Note. BRIEF-P = Behavioural Rating Inventory of Executive Function-Preschool Version; BAS = British Ability Scales; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. *p < .05. **p < .01.

Teacher-rated IC and Vocabulary. The direct path between teacher ratings of IC and vocabulary was examined. One outlier indicator of BRIEF-P (Item 17) was removed due to an inflated correlation across time. The model exhibited an excellent fit (CFI = .993; TLI = .993; RMSEA = .04). The autoregressive effects for both teacher-rated IC and vocabulary were sizeable (β = .806, p = .001; β = .968, p = .001, respectively). Teacher-rated IC at T1 was significantly negatively associated with change in vocabulary (β = -.286, p = .02), whereas vocabulary at T1 was not significantly associated with change in IC (β = .057, p = .44).

Teacher-rated IC and Numeracy. The direct path between teacher ratings of IC and early number concepts was examined. One outlier indicator of BRIEF-P (Item 17) was removed due to an inflated correlation across time. The model exhibited an excellent fit (CFI = .993; TLI = .993; RMSEA = .03). The autoregressive effects for both teacher-rated IC and early number concepts were sizeable (β = .816, p = .001; β = .720, p = .001, respectively). Teacher-rated IC at T1 was not significantly associated with change in early number concepts (β = .129, p = .14); early number concepts at T1 were not significantly associated with change in IC either (β = .077, p = .27).

Teacher-rated WM and Vocabulary. The direct path between teacher ratings of WM and vocabulary was examined. One outlier indicator of BRIEF-P (Item 31) was removed due to an inflated correlation across time. The model exhibited an excellent fit (CFI = .986; TLI = .985; RMSEA = .05). The autoregressive effects for both teacher-rated WM and vocabulary were sizeable (β = .751, p = .001; β = .976, p = .001, respectively). Teacher-rated WM at T1 was significantly negatively associated with change in vocabulary (β = -.242, p = .05), whereas vocabulary at T1 was not significantly associated with change in WM (β = -.005, p = .95).

Teacher-rated WM and Numeracy. The direct path between teacher ratings of WM and early number concepts was examined. One outlier indicator of BRIEF-P (Item 31) was removed due to an inflated correlation across time. The model exhibited an excellent fit (CFI = .986; TLI = .986; RMSEA = .05). The autoregressive effects for both teacher-rated WM and early number concepts were sizeable (β = .740, p = .001; β = .733, p = .001, respectively). Teacher-rated WM at T1 was not significantly associated with change in early number concepts (β = -.016, p = .85); early number concepts at T1 were not significantly associated with change in WM either (β = .079, p = .44).

Teacher-rated CF and Vocabulary. The direct path between teacher ratings of CF and vocabulary was examined. The model exhibited an acceptable fit (CFI = .939; TLI = .931; RMSEA = .08). The autoregressive effects for both teacher-rated CF and vocabulary were sizeable (β = .639, p = .001; β = .915, p = .001, respectively). Teacher-rated CF at T1 was significantly negatively associated with change in vocabulary (β = -.213, p = .02), whereas vocabulary at T1 was not significantly associated with change in CF (β = -.028, p = .70).

Teacher-rated CF and Numeracy. The direct path between teacher ratings of CF and early number concepts was examined. The model exhibited an acceptable fit (CFI = .941; TLI = .934; RMSEA = .08). The autoregressive effects for both teacher-rated CF and early number concepts were sizeable (β = .641, p = .001; β = .724, p = .001, respectively). Teacher-rated CF at T1 was not significantly associated with change in early number concepts (β = -.084, p = .33); early number concepts at T1 were not significantly associated with change in CF either (β = .148, p = .08).

Table 5.2.4-3 shows standardised cross-lagged coefficients. In summary, unidirectional paths from teacher-rated EF to pre-academic competence were found. Each facet of teacher-rated EF was significantly negatively associated with change in vocabulary, but not early number concepts, indicating that children with higher initial teacher-rated EF had fewer improvements in vocabulary. Pre-academic competence was not significantly associated with change in any facets of teacher-rated EF. No other significant associations were found.

Paths	β	p
BRIEF-P (IC) T1→BAS (Vocabulary) T2	-.286	.02*
BAS (Vocabulary) T1→BRIEF-P (IC) T2	.057	.44
BRIEF-P (WM) T1→BAS (Vocabulary) T2	-.242	.05*
BAS (Vocabulary) T1→BRIEF-P (WM) T2	-.005	.95
BRIEF-P (CF) T1→BAS (Vocabulary) T2	-.213	.02*
BAS (Vocabulary) T1→BRIEF-P (CF) T2	-.028	.70
BRIEF-P (IC) T1→BAS (Number Concepts) T2	.129	.14
BAS (Number Concepts) T1→BRIEF-P (IC) T2	.077	.27
BRIEF-P (WM) T1→BAS (Number Concepts) T2	-.016	.85
BAS (Number Concepts) T1→BRIEF-P (WM) T2	.079	.44
BRIEF-P (CF) T1→BAS (Number Concepts) T2	-.084	.33
BAS (Number Concepts) T1→BRIEF-P (CF) T2	.148	.08

Table 5.2.4-3. Parameter estimates between teacher-rated EF and pre-academic competence
Note. BRIEF-P = Behavioural Rating Inventory of Executive Function-Preschool Version; BAS = British Ability Scales; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. *p < .05. **p < .01.

5.2.5 RQ5: What are the longitudinal associations between social-emotional skills and pre-academic competence?

a) Social-emotional skills (SEARS) and pre-academic competence (BAS)

Parent-rated Social Competence and Vocabulary. The direct path between parent ratings of social competence and vocabulary was examined. The latent autoregressive model exhibited a good fit (CFI = .969; TLI = .955; RMSEA = .06). The autoregressive effects for both parent-rated social competence and vocabulary were sizeable (β = .680, p = .001; β = .912, p = .001, respectively). Parent-rated social competence at T1 was not significantly associated with change in vocabulary (β = -.089, p = .55); vocabulary at T1 was not significantly associated with change in parent-rated social competence either (β = .193, p = .11).

Parent-rated Social Competence and Numeracy. The direct path between parent ratings of social competence and early number concepts was examined. The latent autoregressive model exhibited a good fit (CFI = .963; TLI = .947; RMSEA = .07). The autoregressive effects for both parent-rated social competence and early number concepts were sizeable (β = .698, p = .001; β = .731, p = .001, respectively). Parent-rated social competence at T1 was not significantly associated with change in early number concepts (β = -.051, p = .62); early number concepts at T1 were not significantly associated with change in parent-rated social competence either (β = .056, p = .70).

Parent-rated Empathy and Vocabulary. The direct path between parent ratings of empathy and vocabulary was examined. The model exhibited a good fit (CFI = .979; TLI = .969; RMSEA = .07). The autoregressive effects for both parent-rated empathy and vocabulary were sizeable (β = .846, p = .001; β = .908, p = .001, respectively). Parent-rated empathy at T1 was not significantly associated with change in vocabulary (β = -.006, p = .97); vocabulary at T1 was not significantly associated with change in parent-rated empathy either (β = .161, p = .11).

Parent-rated Empathy and Numeracy. The direct path between parent ratings of empathy and early number concepts was examined. The model exhibited an acceptable fit (CFI = .970; TLI = .956; RMSEA = .09). The autoregressive effects for both parent-rated empathy and early number concepts were sizeable (β = .868, p = .001; β = .736, p = .001, respectively). Parent-rated empathy at T1 was significantly associated with change in early number concepts (β = .219, p = .02), whereas early number concepts at T1 were not significantly associated with change in parent-rated empathy (β = .122, p = .34).

Parent-rated Responsibility and Vocabulary. The direct path between parent ratings of responsibility and vocabulary was examined. The model exhibited an acceptable fit (CFI = .919; TLI = .906; RMSEA = .07). The autoregressive effects for both parent-rated responsibility and vocabulary were sizeable (β = .726, p = .001; β = .913, p = .001, respectively). Parent-rated responsibility at T1 was not significantly associated with change in vocabulary (β = .017, p = .89), whereas vocabulary at T1 was marginally significantly associated with change in parent-rated responsibility either though reaching borderline significance (β = .213, p = .06).

Parent-rated Responsibility and Numeracy. The direct path between parent ratings of responsibility and early number concepts was examined. The model exhibited an acceptable fit (CFI = .915; TLI = .902; RMSEA = .08). The autoregressive effects for both parent-rated responsibility and early number concepts were sizeable (β = .686, p = .001; β = .728, p = .001, respectively). Parent-rated responsibility at T1 was significantly associated with change in early number concepts (β = .070, p = .39); early number concepts at T1 were not significantly associated with change in parent-rated responsibility (β = .112, p = .45).

Table 5.2.5-1 shows standardised cross-lagged coefficients. In summary, no significant associations were found except for a unidirectional path from parent-rated empathy to early number concepts. This suggests that children with higher initial levels of parent-rated empathy showed greater improvements in numeracy skills.

Paths	β	*p*
SEARS (SC) T1→BAS (Vocabulary) T2	-.089	.55
BAS (Vocabulary) T1→SEARS (SC) T2	.193	.11
SEARS (Empathy) T1→BAS (Vocabulary) T2	-.006	.97
BAS (Vocabulary) T1→SEARS (Empathy) T2	.161	.11
SEARS (Responsibility) T1→BAS (Vocabulary) T2	.017	.89
BAS (Vocabulary) T1→SEARS (Responsibility) T2	.213	.06
SEARS (SC) T1→ BAS (Number Concepts) T2	-.051	.62
BAS (Number Concepts) T1→SEARS (SC) T2	.056	.70
SEARS (Empathy) T1→BAS (Number Concepts) T2	.219	.02*
BAS (Number Concepts) T1→SEARS (Empathy) T2	.122	.34
SEARS (Responsibility) T1→BAS (Number Concepts) T2	.070	.39
BAS (Number Concepts) T1→SEARS (Responsibility) T2	.112	.45

Table 5.2.5-1. Parameter estimates between parent-rated social-emotional skills and pre-academic competence

Note. SEARS = Social-Emotional Assets and Resiliency Scale; SC = Social Competence; BAS = British Ability Scales; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. *$p < .05$.

Teacher-rated Social Competence and Vocabulary. The direct path between teacher ratings of social competence and vocabulary was examined. The model exhibited a good fit (CFI = .994; TLI = .991; RMSEA = .05). The autoregressive effects for both teacher-rated social competence and vocabulary were sizeable ($\beta = .642, p = .001$; $\beta = .911, p = .001$, respectively). Teacher-rated social competence at T1 was not significantly associated with change in vocabulary ($\beta = .075, p = .47$); vocabulary at T1 was not significantly associated with change in teacher-rated social competence either ($\beta = .007, p = .94$).

Teacher-rated Social Competence and Numeracy. The direct path between teacher ratings of social competence and early number concepts was examined. The model exhibited a good fit (CFI = .987; TLI = .981; RMSEA = .07). The autoregressive effects for both teacher-rated social competence and early number concepts were sizeable ($\beta = .625, p = .001$; $\beta = .727, p = .001$, respectively). Teacher-rated social competence at T1 was not significantly associated with change in early number concepts ($\beta = .057, p = .49$); early number concepts at T1 were not significantly associated with change in teacher-rated social competence either (β = .125, *p* = .22).

Teacher-rated Empathy and Vocabulary. The direct path between teacher ratings of empathy and vocabulary was examined. The model exhibited an acceptable fit (CFI = .991; TLI = .988; RMSEA = .09). The autoregressive effects for both teacher-rated empathy and vocabulary were sizeable (β = .466, *p* = .001; β = .922, *p* = .001, respectively). Teacher-rated empathy at T1 was not significantly associated with change in vocabulary (β = -.070, *p* = .55); vocabulary at T1 was not significantly associated with change in teacher-rated empathy either (β = .191, *p* = .09).

Teacher-rated Empathy and Numeracy. The direct path between teacher ratings of empathy and early number concepts was examined. The model exhibited a good fit (CFI = .992; TLI = .989; RMSEA = .08). The autoregressive effects for both teacher-rated empathy and early number concepts were sizeable (β = .438, *p* = .001; β = .700, *p* = .001, respectively). Teacher-rated empathy at T1 was significantly associated with change in early number concepts (β = .214, *p* = .03); early number concepts at T1 were also significantly associated with change in teacher-rated empathy (β = .228, *p* = .02).

Teacher-rated Responsibility and Vocabulary. The direct path between teacher ratings of responsibility and vocabulary was examined. One outlier indicator of SEARS (Item11) was removed due to an inflated correlation across time. The model exhibited an acceptable fit (CFI = .975; TLI = .970; RMSEA = .09). The autoregressive effects for both teacher-rated responsibility and vocabulary were sizeable (β = .501, *p* = .001; β = .942, *p* = .001, respectively). Teacher-rated responsibility at T1 was significantly negatively associated with change in vocabulary (β = -.239, *p* = .04); vocabulary at T1 was also significantly associated with change in teacher-rated responsibility (β = .233, *p* = .02).

Teacher-rated Responsibility and Numeracy. The direct path between teacher ratings of responsibility and early number concepts was examined. One outlier indicator of SEARS (Item11) was removed due to an inflated correlation across time. The model exhibited an acceptable fit (CFI = .976; TLI = .972; RMSEA = .09). The autoregressive effects for both teacher-rated responsibility and early number concepts were sizeable (β = .463, *p* = .001; β = .678, *p* = .001, respectively). Teacher-rated responsibility at T1 was not significantly associated with change in early number concepts (β = .028, p = .76), whereas early number concepts at T1 were significantly associated with change in teacher-rated responsibility (β = .258, p = .01).

Table 5.2.5-2 shows standardised cross-lagged coefficients. In summary, two facets of teacher-rated social-emotional skills were significantly associated with change in pre-academic competence. Children with higher initial levels of empathy showed greater improvements in early number concepts, whereas children with higher initial levels of responsibility showed fewer improvements in vocabulary. Reciprocally, initial early number concepts were significantly associated with change in empathy as well as responsibility, indicating that children with higher initial levels of numeracy skills showed greater improvements in empathy and responsibility. Vocabulary was also significantly associated with change in teacher-rated responsibility, indicating that children with higher initial levels of vocabulary showed greater improvements in teacher-rated responsibility.

Paths	β	*p*
SEARS (SC) T1→BAS (Vocabulary) T2	.075	.47
BAS (Vocabulary) T1→SEARS (SC) T2	.007	.94
SEARS (Empathy) T1→BAS (Vocabulary) T2	-.070	.55
BAS (Vocabulary) T1→SEARS (Empathy) T2	.191	.08
SEARS (Responsibility) T1→BAS (Vocabulary) T2	-.239	.04*
BAS (Vocabulary) T1→SEARS (Responsibility) T2	.233	.02*
SEARS (SC) T1→BAS (Number Concepts) T2	.057	.48
BAS (Number Concepts) T1→SEARS (SC) T2	.125	.22
SEARS (Empathy) T1→BAS (Number Concepts) T2	.214	.023*
BAS (Number Concepts) T1→SEARS (Empathy) T2	.228	.02*
SEARS (Responsibility) T1→BAS (Number Concepts) T2	.028	.76
BAS (Number Concepts) T1→SEARS (Responsibility) T2	.258	.01*

Table 5.2.5-2. Parameter estimates between teacher-rated social-emotional skills and pre-academic competence
Note. SEARS = Social-Emotional Assets and Resiliency Scale; SC = Social Competence; BAS = British Ability Scales; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. *p < .05.

5.2.6 RQ6: What are the associations between EF and social-emotional skills?

a) Direct measures of EF and social-emotional skills (SEARS)

IC (Peg Tapping) and parent-rated Social Competence. Since incorporating correction for measurement error for Peg Tapping failed to identify a model, the observed variables for IC were used in the following model. Consequently, the results should be interpreted with caution. The model exhibited a good fit (CFI = .966; TLI = .950; RMSEA = .07). The autoregressive effects for both IC and parent-rated social competence were sizeable (β = .609, p = .001; β = .743, p = .001, respectively). IC at T1 was not significantly associated with change in parent-rated social competence (β = -.061, p = .48); parent-rated social competence at T1 was not significantly associated with change in IC either (β = -.083, p = .42).

IC (Peg Tapping) and parent-rated Empathy. Since incorporating correction for measurement error for Peg Tapping failed to identify a model, the observed variables for IC were used in the following model. Consequently, the results should be interpreted with caution. The model exhibited a good fit (CFI = .974; TLI = .963; RMSEA = .08). The autoregressive effects for both IC and parent-rated empathy were sizeable (β = .637, p = .001; β = .904, p = .001, respectively). IC at T1 was not significantly associated with change in parent-rated empathy (β = -.071, p = .25); parent-rated empathy at T1 was not significantly associated with change in IC either, though reaching borderline significance (β = -.165, p = .07).

IC (Peg Tapping) and parent-rated Responsibility. Since incorporating correction for measurement error for Peg Tapping failed to identify a model, the observed variables for IC were used in the following model. Consequently, the results should be interpreted with caution. The model exhibited a marginally acceptable fit (CFI = .909; TLI = .896; RMSEA = .08). The autoregressive effects for both IC and parent-rated responsibility were sizeable (β = .610, p = .001; β = .696, p = .001, respectively). IC at T1 was not significantly associated with change in parent-rated responsibility (β = .044, p = .47); parent-rated responsibility at T1 was not significantly associated with change in IC either (β = -.149, p = .11).

WM (Digit Span backwards) and parent-rated Social Competence. The model exhibited a good fit (CFI = .974; TLI = .963; RMSEA = .06). The autoregressive effects for both WM and parent-rated social competence were sizeable (β = .485, p = .001; β = .726, p = .001, respectively). WM at T1 was not significantly associated with change in parent-rated social competence (β = -.112, p = .35); parent-rated social competence at T1 was not significantly associated with change in WM either (β = -.095, p = .36).

WM (Digit Span backwards) and parent-rated Empathy. The model exhibited a good fit (CFI = .973; TLI = .961; RMSEA = .08). The autoregressive effects for both WM and parent-rated empathy were sizeable (β = .458, p = .001; β = .859, p = .001, respectively). WM at T1 was not significantly associated with change in parent-rated empathy (β = .001, p = .99); parent-rated empathy at T1 was not significantly associated with change in WM either (β = .018, p = .87).

WM (Digit Span backwards) and parent-rated Responsibility. The model exhibited an acceptable fit (CFI = .918; TLI = .905; RMSEA = .08). The autoregressive effects for both WM and parent-rated responsibility were sizeable (β = .467, p = .001; β = .688, p = .001, respectively). WM at T1 was not significantly associated with change in parent-rated responsibility (β = .058, p = .59); parent-rated responsibility at T1 was not significantly associated with change in WM either (β = .050, p = .64).

CF (DCCS) and parent-rated Social Competence. The model exhibited an acceptable fit (CFI = .947; TLI = .924; RMSEA = .08). The autoregressive effects for both CF and parent-rated social competence were sizeable (β = .467, p = .001; β = .692, p = .001, respectively). CF at T1 was not significantly associated with change in parent-rated social competence (β = .096, p = .50); parent-rated social competence at T1 was not significantly associated with change in CF either (β = .023, p = .77).

CF (DCCS) and parent-rated Empathy. The model exhibited an acceptable fit (CFI = .969; TLI = .955; RMSEA = .09). The autoregressive effects for both CF and parent-rated empathy were sizeable (β = .482, p = .001; β = .865, p = .001, respectively). CF at T1 was not significantly associated with change in parent-rated empathy (β = .049, p = .72); parent-rated empathy at T1 was not significantly associated with change in CF either, though reaching borderline significance (β = .184, p = .07).

CF (DCCS) and parent-rated Responsibility. The model exhibited a marginally acceptable fit (CFI = .905; TLI = .891; RMSEA = .08). The autoregressive effects for both CF and parent-rated responsibility were sizeable (β = .500, p = .001; β = .704, p = .001, respectively). CF at T1 was not significantly associated with change in parent-rated responsibility (β = .117, p = .45), whereas parent-rated responsibility at T1 was significantly associated with change in CF (β = .370, p = .001).

Table 5.2.6-1 shows standardised cross-lagged coefficients. In summary, only one significant association was found between parent-rated responsibility and change in the direct measure of CF indicating that children with higher initial levels of responsibility made greater improvements in CF. No other significant associations were found.

Paths	β	*p*
Peg tapping (IC) T1→SEARS (SC) T2	-.061	.48
SEARS (SC) T1→Peg tapping (IC) T2	-.083	.42
Peg tapping (IC) T1→SEARS (Empathy) T2	-.071	.25
SEARS (Empathy) T1→Peg tapping (IC) T2	-.165	.07
Peg tapping (IC) T1→SEARS (Responsibility) T2	.044	.47
SEARS (Responsibility) T1→Peg tapping (IC) T2	-.149	.11
Digits backward (WM) T1→SEARS (SC) T2	-.112	.35
SEARS (SC) T1→Digits backward (WM) T2	-.095	.36
Digits backward (WM) T1→SEARS (Empathy) T2	.001	.99
SEARS (Empathy) T1→Digits backward (WM) T2	.018	.87
Digits backward (WM) T1→SEARS (Responsibility) T2	.058	.59
SEARS (Responsibility) T1→Digits backward (WM) T2	.050	.64
DCCS (CF) T1→SEARS (SC) T2	.096	.50
SEARS (SC) T1→DCCS (CF) T2	.023	.77
DCCS (CF) T1→SEARS (Empathy) T2	.049	.72
SEARS (Empathy) T1→DCCS (CF) T2	.184	.07
DCCS (CF) T1→SEARS (Responsibility) T2	.117	.45
SEARS (Responsibility) T1→DCCS (CF) T2	.370	.001**

Table 5.2.6-1. Parameter estimates between direct measure of EF and parent-rated social-emotional skills

Note. SEARS = Social-Emotional Assets and Resiliency Scale; SC = Social Competence; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; DCCS = Dimensional Change Card Sorting; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. $^{**}p < .01$.

IC (Peg Tapping) and teacher-rated Social Competence. Since incorporating correction for measurement error for Peg Tapping failed to identify a model, the observed variables for IC were used in the following model. Consequently, the result should be interpreted with caution. One outlier indicator of SEARS (Item2) was removed due to an inflated correlation across time. The model exhibited an excellent fit (CFI = .989; TLI = .978; RMSEA = .05). The autoregressive effects for both IC and teacher-rated social competence were sizeable (β = .636, p = .001; β = .638, p = .001, respectively). IC at T1 was not significantly associated with change in teacher-rated social competence (β = -.020, p = .79); teacher-rated social competence at T1 was not significantly associated with change in IC either (β = -.053, p = .53).

IC (Peg Tapping) and teacher-rated Empathy. Since incorporating correction for measurement error for Peg Tapping failed to identify a model, the observed variables for IC were used in the following model. Consequently, the result should be interpreted with caution. One outlier indicator of SEARS (Item11) was removed due to an inflated correlation across time. The model exhibited a marginally acceptable fit (CFI = .990; TLI = .986; RMSEA = .09). The autoregressive effects for both IC and teacher-rated empathy were sizeable (β = .535, p = .001; β = .424, p = .001, respectively). IC at T1 was not significantly associated with change in teacher-rated empathy (β = .121, p = .10); teacher-rated empathy at T1 was not significantly associated with change in IC either (β = .113, p = .16).

IC (Peg Tapping) and teacher-rated Responsibility. Since incorporating correction for measurement error for Peg Tapping failed to identify a model, the observed variables for IC were used in the following model. Consequently, the result should be interpreted with caution. The model exhibited a marginally acceptable fit (CFI = .975; TLI = .969; RMSEA = .09). The autoregressive effects for both IC and teacher-rated responsibility were sizeable (β = .531, p = .001; β = .466, p = .001, respectively). IC at T1 was significantly associated with change in teacher-rated responsibility (β = .182, p = .005), whereas teacher-rated responsibility at T1 was not significantly associated with change in IC either (β = .016, p = .82).

WM (Digit Span backwards) and teacher-rated Social Competence. The model exhibited a good fit (CFI = .988; TLI = .982; RMSEA = .07). The autoregressive effects for both WM and teacher-rated social competence were sizeable (β = .476, p = .001; β = .631, p = .001, respectively). WM at T1 was not significantly associated with change in teacher-rated social competence (β = .086, p = .37); teacher-rated social competence at T1 was not significantly associated with change in WM either (β = .022, p = .82).

WM (Digit Span backwards) and teacher-rated Empathy. The model exhibited an excellent fit (CFI = .995; TLI = .992; RMSEA = .07). The autoregressive effects for both WM and teacher-rated social empathy were sizeable (β = .520, p = .001; β = .313, p = .005, respectively). WM at T1 was significantly associated with change in teacher-rated empathy

(β = .351, p = .001), whereas teacher-rated empathy at T1 was not significantly associated with change in WM (β = .019, p = .87).

WM (Digit Span backwards) and teacher-rated Responsibility. The model exhibited a marginally acceptable fit (CFI = .979; TLI = .975; RMSEA = .90). The autoregressive effects for both WM and teacher-rated social responsibility were sizeable (β = .482, p = .001; β = .459, p = .001, respectively). WM at T1 was significantly associated with change in teacher-rated responsibility (β = .312, p = .001), whereas teacher-rated responsibility at T1 was not significantly associated with change in WM (β = .134, p = .20).

CF (DCCS) and teacher-rated Social Competence. The model exhibited a good fit (CFI = .985; TLI = .978; RMSEA = .08). The autoregressive effects for both CF and teacher-rated social competence were sizeable (β = .465, p = .001; β = .643, p = .001, respectively). CF at T1 was not significantly associated with change in teacher-rated social competence (β = -.048, p = .66); teacher-rated social competence at T1 was not significantly associated with change in CF either (β = -.008, p = .92).

CF (DCCS) and teacher-rated Empathy. The model exhibited a good fit (CFI = .994; TLI = .991; RMSEA = .08). The autoregressive effects for both CF and teacher-rated empathy were sizeable (β = .530, p = .001; β = .370, p = .001, respectively). CF at T1 was significantly associated with change in teacher-rated empathy (β = .303, p = .002), whereas teacher-rated empathy at T1 was not significantly associated with change in CF (β = .074, p = .50).

CF (DCCS) and teacher-rated Responsibility. The model exhibited a marginally acceptable fit (CFI = .976; TLI = .971; RMSEA = .09). The autoregressive effects for both CF and teacher-rated responsibility were sizeable (β = .551, p = .001; β = .425, p = .001, respectively). CF at T1 was significantly associated with change in teacher-rated responsibility (β = .298, p = .01), whereas teacher-rated responsibility at T1 was not significantly associated with change in CF (β = -.013, p = .90).

Table 5.2.6-2 shows standardised cross-lagged coefficients. In summary, each direct measure of EF except for WM was significantly associated with change in teacher-rated social-emotional skills. WM was significantly associated with change in teacher-rated empathy as well as responsibility while IC was significantly associated with change in teacher-rated responsibility. Similarly, CF was significantly associated with change in teacher-rated empathy as well as responsibility. No significant bidirectional associations were found; teacher-rated social-emotional skills were not significantly associated with change in any direct measures of EF.

Paths	β	*p*
Peg tapping (IC) T1→SEARS (SC) T2	-.020	.79
SEARS (SC) T1→Peg tapping (IC) T2	-.053	.53
Peg tapping (IC) T1→SEARS (Empathy) T2	.121	.10
SEARS (Empathy) T1→Peg tapping (IC) T2	.113	.16
Peg tapping (IC) T1→SEARS (Responsibility) T2	.182	.01*
SEARS (Responsibility) T1→Peg tapping (IC) T2	.016	.82
Digits backward (WM) T1→SEARS (SC) T2	.086	.37
SEARS (SC) T1→Digits backward (WM) T2	.022	.82
Digits backward (WM) T1→SEARS (Empathy) T2	.351	.001**
SEARS (Empathy) T1→Digits backward (WM) T2	.019	.87
Digits backward (WM) T1→SEARS (Responsibility) T2	.312	.001**
SEARS (Responsibility) T1→Digits backward (WM) T2	.134	.20
DCCS (CF) T1→SEARS (SC) T2	-.048	.66
SEARS (SC) T1→DCCS (CF) T2	-.008	.92
DCCS (CF) T1→SEARS (Empathy) T2	.303	.002**
SEARS (Empathy) T1→DCCS (CF) T2	.074	.50
DCCS (CF) T1→SEARS (Responsibility) T2	.298	.01*
SEARS (Responsibility) T1→DCCS (CF) T2	-.013	.89

Table 5.2.6-2. Parameter estimates between direct measure of EF and teacher-rated social-emotional skills

Note. SEARS = Social-Emotional Assets and Resiliency Scale; SC = Social Competence; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; DCCS = Dimensional Change Card Sorting; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. **p* < .05. ***p* < .01.

b) Indirect measures of EF (BRIEF-P) and social-emotional skills (SEARS)

Parent-rated IC and parent-rated Social Competence. One outlier indicator of BRIEF-P (Item 32) was removed due to an inflated correlation across time. The model exhibited an acceptable fit (CFI = .943; TLI = .941; RMSEA = .04). The autoregressive effects for both parent-rated IC and social competence were sizeable (β = .837, *p* = .001; β = .695, *p* = .001, respectively). IC at T1 was significantly associated with change in parent-rated social competence (β = .246, *p* = .02), whereas parent-rated social competence at T1 was not significantly associated with change in IC (β = .077, *p* = .43).

Parent-rated IC and parent-rated Empathy. One outlier indicator of BRIEF-P (Item 32) was removed due to an inflated correlation across time. The model exhibited an acceptable fit (CFI = .938; TLI = .935; RMSEA = .04). The autoregressive effects for both parent-rated IC and empathy were sizeable (β = .828, p = .001; β = .817, p = .001, respectively). IC at T1 was not significantly associated with change in parent-rated empathy (β = .132, p = .23); parent-rated empathy at T1 was not significantly associated with change in IC either (β = .017, p = .84).

Parent-rated IC and parent-rated Responsibility. One outlier indicator of BRIEF-P (Item 32) was removed due to an inflated correlation across time. The model exhibited an acceptable fit (CFI = .949; TLI = .947; RMSEA = .03). The autoregressive effects for both parent-rated IC and responsibility were sizeable (β = .797, p = .001; β = .612, p = .001, respectively). IC at T1 was significantly associated with change in parent-rated responsibility (β = .331, p = .001), whereas parent-rated responsibility at T1 was not significantly associated with change in IC (β = .139, p = .16).

Parent-rated WM and parent-rated Social Competence. One outlier indicator of BRIEF-P (Item 41) was removed due to an inflated correlation across time. The model exhibited a marginally acceptable fit (CFI = .899; TLI = .896; RMSEA = .05). The autoregressive effects for both parent-rated WM and social competence were sizeable (β = .800, p = .001; β = .621, p = .001, respectively). WM at T1 was not significantly associated with change in parent-rated social competence (β = .133, p = .26); parent-rated social competence at T1 was not significantly associated with change in WM either (β = -.119, p = .24).

Parent-rated WM and parent-rated Empathy. One outlier indicator of BRIEF-P (Item 41) was removed due to an inflated correlation across time. The model exhibited an acceptable fit (CFI = .914; TLI = .912; RMSEA = .05). The autoregressive effects for both parent-rated WM and empathy were sizeable (β = .728, p = .001; β = .881, p = .001, respectively). WM at T1 was not significantly associated with change in parent-rated empathy (β = -.056, p = .54); parent-rated empathy at T1 was not significantly associated with change in WM either (β = .094, p = .29).

Parent-rated WM and parent-rated Responsibility. One outlier indicator of BRIEF-P (Item 41) was removed due to an inflated correlation across time. The model exhibited an acceptable fit (CFI = .919; TLI = .917; RMSEA = .04). The autoregressive effects for both parent-rated WM and responsibility were sizeable (β = .788, p = .001; β = .615, p = .001, respectively). WM at T1 was not significantly associated with change in parent-rated responsibility (β = .178, p = .09); parent-rated responsibility at T1 was not significantly associated with change in WM either (β = -.077, p = .39).

Parent-rated CF and parent-rated Social Competence. The model exhibited an acceptable fit (CFI=.916; TLI=.913; RMSEA=.07). The autoregressive effects for both parent-rated CF and social competence were sizeable (β = .817, p =.001; β = .461, p = .01, respectively). CF at T1 was significantly associated with change in parent-rated social competence (β = .335, p = .03), whereas parent-rated social competence at T1 was not significantly associated with change in CF (β = .100, p = .47).

Parent-rated CF and parent-rated Empathy. The model exhibited an acceptable fit (CFI = .927; TLI = .924; RMSEA = .06). The autoregressive effects for both parent-rated CF and empathy were sizeable (β = .881, p = .001; β = .826, p = .001, respectively). CF at T1 was not significantly associated with change in parent-rated empathy (β = .128, p = .20); parent-rated empathy at T1 was not significantly associated with change in CF either (β = .044, p = .62).

Parent-rated CF and parent-rated Responsibility. The model exhibited an acceptable fit (CFI = .930; TLI = .928; RMSEA = .05). The autoregressive effects for both parent-rated CF and responsibility were sizeable (β = .905, p = .001; β = .625, p = .001, respectively). CF at T1 was significantly associated with change in parent-rated responsibility (β = .316, p = .001), whereas parent-rated responsibility at T1 was not significantly associated with change in CF (β = -.061, p = .45).

Table 5.2.6-3 shows standardised cross-lagged coefficients. In summary, two facets of parent-rated EF were significantly associated with change in parent-rated social-emotional skills. Parent-rated IC was significantly associated with increase in parent-rated social competence as well as responsibility. Similarly, parent-rated CF was significantly associated with an increase in parent-rated social competence as well as responsibility. This suggests that children with higher initial levels of IC and CF made greater improvements in parent-rated social competence and responsibility. No significant bidirectional associations were found; parent-rated social-emotional skills were not significantly associated with change in parent-rated EF.

Paths	β	*p*
BRIEF-P (IC) T1→SEARS (SC) T2	.246	.02*
SEARS (SC) T1→BRIEF-P (IC) T2	.077	.43
BRIEF-P (IC) T1→SEARS (Empathy) T2	.132	.23
SEARS (Empathy) T1→BRIEF-P (IC) T2	.017	.84
BRIEF-P (IC) T1→SEARS (Responsibility) T2	.331	.001**
SEARS (Responsibility) T1→BRIEF-P (IC) T2	.139	.16
BRIEF-P (WM) T1→SEARS (SC) T2	.133	.26
SEARS (SC) T1→BRIEF-P (WM) T2	-.119	.24
BRIEF-P (WM) T1→SEARS (Empathy) T2	-.056	.54
SEARS (Empathy) T1→BRIEF-P (WM) T2	.094	.29
BRIEF-P (WM) T1→SEARS (Responsibility) T2	.178	.09
SEARS (Responsibility) T1→BRIEF-P (WM) T2	-.077	.39
BRIEF-P (CF) T1→SEARS (SC) T2	.335	.03*
SEARS (SC) T1→BRIEF-P (CF) T2	.100	.47
BRIEF-P (CF) T1→SEARS (Empathy) T2	.128	.20
SEARS (Empathy) T1→BRIEF-P (CF) T2	.044	.62
BRIEF-P (CF) T1→SEARS (Responsibility) T2	.316	.001**
SEARS (Responsibility) T1→BRIEF-P (CF) T2	-.061	.45

Table 5.2.6-3. Parameter estimates between parent-rated EF and social-emotional skills
Note. BRIEF-P = Behavioural Rating Inventory of Executive Function-Preschool Version; SEARS = Social-Emotional Assets and Resiliency Scale; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. **p* < .05. ****p* < .01.

Teacher-rated IC and teacher-rated Social Competence. One outlier indicator of BRIEF-P (Item 17) was removed due to an inflated correlation across time. The model exhibited an excellent fit (CFI = .987; TLI = .987; RMSEA = .04). The autoregressive effects for both teacher-rated IC and social competence were sizeable (β = .815, *p* = .001; β = .624, *p* = .01, respectively). IC at T1 was not significantly associated with change in teacher-rated social competence (β = -.123, *p* = .10); teacher-rated social competence at T1 was not significantly associated with change in IC either (β = -.026, *p* = .68).

Teacher-rated IC and teacher-rated Empathy. One outlier item of BRIEF-P (Item17) was removed due to an inflated correlation across time. The model exhibited an excellent fit (CFI = . 992; TLI = .991; RMSEA = .04). The autoregressive effects for both teacher-rated IC and empathy were sizeable (β = .847, *p* = .001; β = .353, *p* = .001, respectively). IC at T1 was significantly associated with change in teacher-rated empathy (β = .276, *p* = .002), whereas teacher-rated empathy at T1 was not significantly associated with change in IC (β = -.050, *p* = .44).

Teacher-rated IC and teacher-rated Responsibility. One outlier indicator of BRIEF-P (Item17) and one outlier indicator of SEARS (Item 11) were removed due to inflated correlations across time. The model exhibited an excellent fit (CFI = .989; TLI = .989; RMSEA = .04). The autoregressive effects for both teacher-rated IC and responsibility were sizeable (β = .838, *p* = .001; β = .348, *p* = .001, respectively). IC at T1 was significantly associated with change in teacher-rated responsibility (β = .296, *p* = .003), whereas teacher-rated responsibility at T1 was not significantly associated with change in IC (β = -.033, *p* = .68).

Teacher-rated WM and teacher-rated Social Competence. Two outlier indicators of BRIEF-P (Item 4 & 31) and one outlier indicator of SEARS (Item 2) were removed due to inflated correlations across time. The model exhibited an excellent fit (CFI = .982; TLI = .981; RMSEA = .05). The autoregressive effects for both teacher-rated WM and social competence were sizeable (β = .757, *p* = .001; β = .548, *p* = .001, respectively). WM at T1 was not significantly associated with change in teacher-rated social competence (β = -.109, *p* = .23); teacher-rated social competence at T1 was not significantly associated with change in WM either (β = -.071, *p* = .35).

Teacher-rated WM and teacher-rated Empathy. One outlier indicator of BRIEF-P (Item 31) and one outlier indicator of SEARS (Item 6) were removed due to inflated correlations across time. The model exhibited an excellent fit (CFI = .987; TLI = .986; RMSEA = .04). The autoregressive effects for both teacher-rated WM and empathy were sizeable (β = .786, *p* = .001; β = .423, *p* = .001, respectively). WM at T1 was significantly associated with change in teacher-rated empathy (β = .180, *p* = .03), whereas teacher-rated empathy at T1 was not significantly associated with change in WM (β = -.132, *p* = .07).

Teacher-rated WM and teacher-rated Responsibility. One outlier indicator of BRIEF-P (Item 31) and two outlier indicators of SEARS (Item 9&11) were removed due to inflated correlations across time. The model exhibited an excellent fit (CFI = .983; TLI = .983; RMSEA = .04). The autoregressive effects for both teacher-rated WM and responsibility were sizeable (β = .831, *p* = .001; β = .325, *p* = .01, respectively). WM at T1 was significantly associated with change in teacher-rated responsibility (β = .335, *p* = .003), whereas teacher-rated responsibility at T1 was not significantly associated with change in WM (β = -.132, *p* = .23).

Teacher-rated CF and teacher-rated Social Competence. The model exhibited a rather poor fit (CFI = .912; TLI = .906; RMSEA = .09). The autoregressive effects for both teacher-rated CF and social competence were sizeable (β = .622, *p* = .001; β = .646, *p* = .01, respectively). CF at T1 was not significantly associated with change in teacher-rated social competence (β = .001, *p* = .99); teacher-rated social competence at T1 was not significantly associated with change in CF either (β = .043, *p* = .58).

Teacher-rated CF and teacher-rated Empathy. The model exhibited a good fit (CFI = .958; TLI = .956; RMSEA = .07). The autoregressive effects for both teacher-rated CF and empathy were sizeable (β = .641, *p* = .001; β = .460, *p* = .01, respectively). CF at T1 was not significantly associated with change in teacher-rated empathy, though reaching borderline significance (β = .155, *p* = .06); teacher-rated empathy at T1 was not significantly associated with change in CF either (β = -.062, *p* = .47).

Teacher-rated CF and teacher-rated Responsibility. One outlier indicator of SEARS (Item11) was removed due to an inflated correlation across time. The model exhibited an acceptable fit (CFI = .944; TLI = .941; RMSEA = .07). The autoregressive effects for both teacher-rated CF and responsibility were sizeable (β = .653, *p* = .001; β = .471 *p* = .01, respectively). CF at T1 was not significantly associated with change in teacher-rated responsibility, though reaching borderline significance (β = .175, *p* = .07); teacher-rated responsibility at T1 was not significantly associated with change in CF either (β = -.041, *p* = .64).

Table 5.2.6-4 shows standardised cross-lagged coefficients. In summary, two facets of teacher-rated EF were significantly associated with change in teacher-rated social-emotional skills. Both teacher-rated WM and IC were significantly associated with increase in teacher-rated empathy as well as responsibility. No significant bidirectional associations were found; no facets of teacher-rated social-emotional skills were significantly associated with change in teacher-rated EF.

Paths	β	p
BRIEF-P (IC) T1→SEARS (SC) T2	-.123	.10
SEARS (SC) T1→BRIEF-P (IC) T2	-.026	.68
BRIEF-P (IC) T1→SEARS (Empathy) T2	.276	.002**
SEARS (Empathy) T1→BRIEF-P (IC) T2	-.050	.44
BRIEF-P (IC) T1→SEARS (Responsibility) T2	.296	.003**
SEARS (Responsibility) T1→BRIEF-P (IC) T2	-.033	.68
BRIEF-P (WM) T1→SEARS (SC) T2	-.109	.23
SEARS (SC) T1→BRIEF-P (WM) T2	-.071	.35
BRIEF-P (WM) T1→SEARS (Empathy) T2	.180	.03*
SEARS (Empathy) T1→BRIEF-P (WM) T2	-.132	.07
BRIEF-P (WM) T1→SEARS (Responsibility) T2	.335	.003**
SEARS (Responsibility) T1→BRIEF-P (WM) T2	-.132	.23
BRIEF-P (CF) T1→SEARS (SC) T2	.001	.99
SEARS (SC) T1→BRIEF-P (CF) T2	.043	.58
BRIEF-P (CF) T1→SEARS (Empathy) T2	.155	.06
SEARS (Empathy) T1→BRIEF-P (CF) T2	-.062	.47
BRIEF-P (CF) T1→SEARS (Responsibility) T2	.175	.07
SEARS (Responsibility) T1→BRIEF-P (CF) T2	-.041	.64

Table 5.2.6-4. Parameter estimates between teacher-rated EF and social-emotional skills
Note. BRIEF-P = Behavioural Rating Inventory of Executive Function-Preschool Version; SEARS = Social-Emotional Assets and Resiliency Scale; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. *$p < .05$. **$p < .01$.

5.2.7 RQ7: What are the associations between teacher-child/parent-child relationship quality and school readiness skills over time?

The latent autoregressive cross-lagged panel analyses in a SEM framework were computed to test the reciprocal associations amongst relationship quality, EF, social-emotional skills, and pre-academic competence. The relationship quality was measured using the Student Teacher Relationships Scale (STRS) and the Child Parent Relationship Scale (CPRS). For all the analyses, two outlier indicators of CPRS (Item1 and 6) were removed due to their inflated correlations. The residuals of the outcome variables as well as exogenous predictor variable were allowed to correlate in all the models reported here. Fluid intelligence was also incorporated into all the models except for the ones testing associations between relationship quality and social-emotional skills due to a lack of substantive theories that link fluid intelligence to social-emotional skills.

a) Relationship quality and direct measures of EF

Parent-child Closeness and IC (Peg tapping). The direct path between parent-child closeness and IC was examined. The latent autoregressive model exhibited a poor fit (CFI = .874; TLI = .849; RMSEA = .07). The autoregressive effects for both Closeness and IC were sizeable (β =.670, p = .001; β = .693, p = .001, respectively). The level of parent-child closeness at T1 was not significantly associated with change in IC (β = -.100, p = .32); IC at T1 was not significantly associated with change in parent-child closeness either (β = .014, p = .91).

Parent-child Closeness and WM (Digit Span backwards). Since incorporating correction for measurement error for WM failed to estimate both autoregressive and cross-lagged coefficients, the observed variables were used in the following model. Consequently, the result should be interpreted with caution as potential unequal measurement error across two time points may lead to biased estimates (Newsom, 2015). The model exhibited a rather poor fit (CFI = .837; TLI = .804; RMSEA = .08). The autoregressive effects for both Closeness and WM were sizeable (β = .672, p =.001; β = .474, p = .001, respectively). Parent-child closeness at T1 was not significantly associated with change in WM (β = -.122, p = .31); WM at T1 was not significantly associated with change in the level of parent-child closeness either (β = .068, p = .49).

Parent-child Closeness and CF (DCCS). The direct path between parent-child closeness and CF was examined. The latent autoregressive model exhibited a rather poor fit (CFI = .862; TLI = .834; RMSEA = .07). The autoregressive effects for both Closeness and CF were sizeable (β = .697, p = .001; β = .472, p = .001, respectively). Parent-child closeness at T1 was not significantly associated with change in CF (β = .005, p = .97); CF at T1 was not significantly associated with change in parent-child closeness either (β = -.142, p = .30).

Parent-child Conflict and IC (Peg Tapping). The latent autoregressive model exhibited an acceptable model fit (CFI = .931; TLI = .924; RMSEA =.07). The autoregressive effects for both Conflict and IC were sizeable (β = .800, p = .001; β = .685, p = .001, respectively). Parent-child conflict at T1 (β = .175, p = .07) was not significantly associated with change in IC though approaching borderline significance; IC at T1 was not significantly associated with change in parent-child conflict either (β = -.169, p = .10).

Parent-child Conflict and WM (Digit Span backwards). Since incorporating correction for measurement error for WM failed to estimate both autoregressive and cross-lagged coefficients, the observed variables were used in the following model. Consequently, the result should be interpreted with caution. The latent autoregressive model exhibited an acceptable model fit (CFI = .932; TLI = .925; RMSEA = .08). The autoregressive effects for both Conflict and WM were sizeable ($\beta = .810$, $p = .001$; $\beta = .466$, $p = .001$, respectively). Parent-child conflict at T1 was not significantly associated with WM ($\beta = .034$, $p = .74$); WM at T1 was not significantly associated with change in parent-child conflict either ($\beta = -.040$, $p = .74$).

Parent-child Conflict and CF (DCCS). The latent autoregressive model exhibited an acceptable fit (CFI = .931; TLI = .924; RMSEA = .07). The autoregressive effects for both Conflict and CF were sizeable ($\beta = .815$, $p = .001$; $\beta = .470$, $p = .001$, respectively). Parent-child conflict at T1 ($\beta = -.137$, $p = .09$) was not significantly associated with change in CF; parent-rated CF at T1 was not significantly associated with change in parent-child conflict either ($\beta = -.090$, $p = .45$).

Table 5.2.7-1 shows standardised cross-lagged coefficients. In summary, no statistically significant associations were found between the parent-child relationship quality and direct measures of EF.

Paths	β	*p*
CPRS (Closeness) T1→Peg tapping (IC) T2	-.100	.32
Peg tapping (IC) T1→CPRS (Closeness) T2	.014	.91
CPRS (Closeness) T1→Digits backward (WM) T2	-.122	.31
Digits backward (WM) T1→CPRS (Closeness) T2	.068	.49
CPRS (Closeness) T1→DCCS (CF) T2	.005	.97
DCCS (CF) T1→CPRS (Closeness) T2	-.142	.30
CPRS (Conflict) T1→Peg tapping (IC) T2	.175	.07
Peg tapping (IC) T1→CPRS (Conflict) T2	-.169	.10
CPRS (Conflict) T1→Digits backward (WM) T2	.034	.74
Digits backward (WM) T1→CPRS (Conflict) T2	-.040	.74
CPRS (Conflict) T1→DCCS (CF) T2	-.137	.09
DCCS (CF) T1→CPRS (Conflict) T2	-.090	.45

Table 5.2.7-1. Parameter estimates between parent-child relationship and direct measure of EF
Note. CPRS = Child-Parent Relationship Scale; DCCS = Dimensional Change Card Sorting; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; T1 = Time point 1; T2 = Time point 2; βs represent standard coefficients.

Teacher-child Closeness and IC (Peg Tapping). The latent autoregressive model exhibited a good mode fit (CFI = .971; TLI =.967; RMSEA = .07). The autoregressive effects for both Closeness and IC were sizeable (β = .649, p = .001; β = .663, p = .001, respectively). Teacher-child closeness at T1 was not significantly associated with change in IC (β = .103, p = .19); IC at T1 was not significantly associated with change in teacher-child closeness either (β = .109, p = .26).

Teacher-child Closeness and WM (Digit Span backwards). Since incorporating correction for measurement error for WM failed to estimate both autoregressive and cross-lagged coefficients, the observed variables were used in the following model. Consequently, the result should be interpreted with caution. The latent autoregressive model exhibited a good model fit (CFI = .974; TLI = .971; RMSEA = .07). The autoregressive effects for both Closeness and DB were sizeable (β = .652, p = .001; β = .481, p = .001, respectively). Teacher-child closeness at T1 was not significantly associated with change in WM (β = -.034, p = .71); WM at T1 was not significantly associated with change in teacher-child closeness either (β = .105, p = .32).

Teacher-child Closeness and CF (DCCS). The latent autoregressive model exhibited a good model fit (CFI = .974; TLI = .970; RMSEA = .07). The autoregressive effects for both Closeness and CF were sizeable (β = .673, p = .001; β = .475, p = .001, respectively). Teacher-child closeness at T1 was not significantly associated with change in CF (β = -.015, p = .89); CF at T1 was not significantly associated with change in teacher-child closeness either (β = .080, p = .35).

Teacher-child Conflict and IC (Peg Tapping). The latent autoregressive model exhibited an excellent model fit (CFI = .994; TLI = .994; RMSEA = .03). The autoregressive effects for both Conflict and IC were sizeable (β = .640, p = .001; β = .675, p = .001, respectively). Teacher-child conflict at T1 was not significantly associated with change in IC (β = -.016, p = .85); IC at T1 was not significantly associated with change in teacher-child conflict either (β = .123, p = .19).

Teacher-child Conflict and WM (Digit Span backwards). Since incorporating correction for measurement error for WM failed to estimate both autoregressive and cross-lagged coefficients, the observed variables were used in the following model. Consequently, the result should be interpreted with caution. The latent autoregressive model exhibited a good model fit (CFI = .993 TLI = .992; RMSEA = .03). The autoregressive effects for both Conflict and WM were sizeable (β = .652, *p* = .001; β = 1.32, *p* = .03, respectively). Teacher-child conflict at T1 was not significantly associated with change in WM (β = -.178, *p* = .17); WM at T1 was not significantly associated with change in teacher-child conflict either (β = .016, *p* = .79).

Teacher-child Conflict and CF (DCCS). The latent autoregressive model exhibited an excellent model fit (CFI = .991; TLI = .990; RMSEA = .04). The autoregressive effects for both Conflict and CF were sizeable (β = .648, *p* = .001; β = .475, *p* = .001, respectively). Teacher-child conflict at T1 was not significantly associated with change in CF (β = -.020, *p* = .86); CF at T1 was not significantly associated with change in teacher-child conflict either (β = .018 *p* = .85).

Table 5.2.7-2 shows standardised cross-lagged coefficients. In summary, no statistically significant associations were found between the levels of teacher-child relationship quality and direct measure of EF.

Paths	β	*p*
STRS (Closeness) T1→Peg tapping (IC) T2	.103	.19
Peg tapping (IC) T1→STRS (Closeness) T2	.109	.26
STRS (Closeness) T1→Digits backward (WM) T2	-.034	.71
Digits backward (WM) T1→STRS (Closeness) T2	.105	.32
STRS (Closeness) T1→DCCS (CF) T2	-.015	.89
DCCS (CF) T1→STRS (Closeness) T2	.080	.35
STRS (Conflict) T1→Peg tapping (IC) T2	-.016	.85
Peg tapping (IC) T1→STRS (Conflict) T2	.123	.19
STRS (Conflict) T1→ Digits backward (WM) T2	-.178	.17
Digits backward (WM) T1→STRS (Conflict) T2	.016	.79
STRS (Conflict) T1→DCCS (CF) T2	-.020	.86
DCCS (CF) T1→STRS (Conflict) T2	.018	.85

Table 5.2.7-2. Parameter estimates between teacher-child relationship and direct measure of EF
Note. STRS = Student-Teacher Relationship Scale; DCCS = Dimensional Change Card Sorting; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; T1 = Time point 1; T2 = Time point 2; βs represent standard coefficients. **p* < .05.

b) Relationship quality and indirect measures of EF (BRIEF-P)

Parent-child Closeness and parent-reported IC. The latent autoregressive model exhibited a poor fit (CFI = .938; TLI = .934; RMSEA = .04). The autoregressive effects for both Closeness and parent-reported IC were sizeable (β = .498, *p* = .001; β = .827, *p* = .001, respectively). Parent-child closeness at T1 was not significantly associated with change in parent-rated IC (β = .103, *p* = .37), whereas parent-rated IC at T1 was marginally significantly associated with change in parent-child closeness (β = .207, *p* = .06).

Parent-child Closeness and parent-reported WM. The latent autoregressive model exhibited a good fit (CFI = .953; TLI = .952; RMSEA = .04). The autoregressive effects for both Closeness and parent-reported WM were sizeable (β = .627, *p* = .001; β = .699, *p* = .001, respectively). Parent-child closeness at T1 was not significantly associated with change in parent-rated WM though approaching borderline significance (β = .174, *p* = .07); parent-rated WM at T1 was not significantly associated with the change in parent-child closeness either (β = .062, p = .62).

Parent-child Closeness and parent-reported CF. The latent autoregressive model exhibited an acceptable fit (CFI = .918; TLI = .915; RMSEA = .05). The autoregressive effects for both Closeness and parent-reported CF were sizeable (β = .707, *p* = .001; β = .889, *p* = .001, respectively). Parent-child closeness at T1 was not significantly associated with change in parent-reported CF (β = .000, *p* = .99); parent-reported CF at T1 was not significantly associated with change in parent-child closeness either (β = .006, *p* = .97).

Parent-child Conflict and parent-reported IC. Two outlier indicators of BRIEF-P (Item 26 & 32) were removed due to inflated correlations across time. The latent autoregressive model exhibited an acceptable fit (CFI = .912; TLI = .909; RMSEA = .04). The autoregressive effects for both Conflict and parent-reported IC were sizeable (β = .720, *p* = .001; β = .829, *p* = .001, respectively). Parent-child conflict at T1 was not significantly associated with change in parent-reported IC (β = -.017, *p* = .86), whereas parent-reported IC at T1 was significantly negatively associated with change in parent-child conflict (β = -.216, *p* = .02).

Parent-child Conflict and parent-reported WM. One outlier indicator of BRIEF-P (Item 41) was removed due to an inflated correlation across time. The latent autoregressive model exhibited a good fit (CFI = .945; TLI = .944; RMSEA = .03). The autoregressive effects for both Conflict and parent-reported WM were sizeable (β = .758, p = .001; β = .886, p = .001, respectively). Parent-child conflict at T1 was not significantly associated with change in parent-rated WM (β = -.071, p = .41); WM at T1 was not significantly associated with change in parent-child conflict either (β = -.067, p = .36).

Parent-child Conflict and parent-reported CF. The latent autoregressive model exhibited an acceptable fit (CFI = .917; TLI = .913; RMSEA = .05). The autoregressive effects for both Conflict and parent-reported CF were sizeable (β = .727, p = .001; β = .871, p = .001, respectively). Parent-child conflict at T1 was not significantly associated with change in parent-rated CF (β = .115, p = .23), whereas parent-rated CF at T1 was significantly negatively associated with change in parent-child conflict (β = -.228, p = .02).

Table 5.2.7-3 shows standardised cross-lagged coefficients. In summary, the level of relationship quality was not significantly associated with change in any facets of parent-rated EFs, whereas parent-rated IC and CF at T1 were significantly negatively associated with change in the level of parent-child conflict. This suggests that the higher levels of initial EF, particularly IC and CF, predicted lower levels of parent-rated conflict later.

Paths	β	*p*
CPRS (Closeness) T1→BRIEF-P (IC) T2	.103	.37
BRIEF-P (IC) T1→CPRS (Closeness) T2	.207	.06
CPRS (Closeness) T1→BRIEF-P (WM) T2	.174	.07
BRIEF-P (WM) T1→CPRS (Closeness) T2	.062	.62
CPRS (Closeness) T1→BRIEF-P (CF) T2	.000	.99
BRIEF-P (CF) T1→CPRS (Closeness) T2	.006	.97
CPRS (Conflict) T1→BRIEF-P (IC) T2	-.017	.86
BRIEF-P (IC) T1→CPRS (Conflict) T2	-.216	.02*
CPRS (Conflict) T1→BRIEF-P (WM) T2	-.071	.41
BRIEF-P (WM) T1→CPRS (Conflict) T2	-.067	.36
CPRS (Conflict) T1→BRIEF-P (CF) T2	.115	.23
BRIEF-P (CF) T1→CPRS (Conflict) T2	-.228	.02*

Table 5.2.7-3. Parameter estimates between parent-child relationship and parent-rated EF
Note. CPRS = Child-Parent Relationship Scale; BRIEF-P = Behavioural Rating Inventory of Executive Function-Preschool Version; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. *p < .05.

Teacher-child closeness and teacher-reported IC. One outlier indicator of BRIEF-P (Item17) was removed due to an inflated correlation across time. The latent autoregressive model exhibited an excellent fit (CFI = .980; TLI = .979; RMSEA = .04). The autoregressive effects for both Closeness and teacher-reported IC were sizeable (β = .667, p = .001; β = .826, p = .001, respectively). Teacher-child closeness at T1 was not significantly associated with change in teacher-rated IC (β = -.006, p = .93); teacher-rated IC at T1 was not significantly associated with change in teacher-child closeness either (β = .032, p = .68).

Teacher-child Closeness and teacher-reported WM. One outlier indicator of BRIEF-P (Item 31) was removed due to an inflated correlation across time. The latent autoregressive model exhibited an excellent fit (CFI = .974; TLI = .973; RMSEA = .05). The autoregressive effects for both Closeness and teacher-reported WM were sizeable (β = .660, p = .001; β = .757, p = .001, respectively). Teacher-child closeness at T1 was not significantly associated with change in teacher-rated WM (β = -.051, p = .45); teacher-rated WM was not significantly associated with change in teacher-child closeness either (β = .012, p = .88).

Teacher-child Closeness and teacher-reported CF. The latent autoregressive model exhibited an acceptable fit (CFI = .930; TLI = .926; RMSEA = .06). The autoregressive effects for both Closeness and teacher-reported CF were sizeable (β = .681, p = .001; β = .647, p = .001, respectively). Teacher-child closeness at T1 was not significantly associated with change in teacher-rated WM (β = -.046, p = .57); teacher-rated CF at T1 was not significantly associated with teacher-child closeness either (β = -.040, p = .61).

Teacher-child Conflict and teacher-reported IC. One outlier indicator of BRIEF-P (Item17) was removed due to an inflated correlation across time. The latent autoregressive model exhibited an excellent fit (CFI = .990; TLI = .989; RMSEA = .03). The autoregressive effects for both Conflict and teacher-reported IC were sizeable (β = .454, p = .001; β = .821, p = .001, respectively). Teacher-child conflict at T1 was not significantly associated with change in teacher-reported IC (β = .005, p = .95), whereas teacher-rated IC at T1 was significantly negatively associated with change in teacher-child conflict (β = -.269, p = .02).

Teacher-child Conflict and teacher-reported WM. One outlier indicator of BRIEF-P (Item 31) was removed due to an inflated correlation across time. The latent autoregressive model exhibited a good fit (CFI = .958; TLI = .957; RMSEA = .06). The autoregressive effects for both Conflict and teacher-reported WM were sizeable (β = .414, *p* = .001; β = .750, *p* = .001, respectively). Teacher-child conflict at T1 was not significantly associated with change in teacher-reported WM (β = .015, *p* = .86), whereas teacher-rated WM at T1 was significantly negatively associated with change in teacher-child conflict (β = -.299, *p* = .001).

Teacher-child Conflict and teacher-reported CF. One outlier indicator of BRIEF-P (Item 18) was removed due to an inflated correlation across time. The latent autoregressive model exhibited a good fit (CFI = .947; TLI = .945; RMSEA = .057). The autoregressive effects for both Conflict and teacher-reported CF were sizeable (β = .508, *p* = .001; β = .666, *p* = .001, respectively). Teacher-child conflict at T1 was not significantly associated with change in teacher-reported CF (β = .052, *p* = .60), whereas teacher-rated CF at T1 was significantly negatively associated with change in teacher-child conflict (β = -.223, *p* = .04).

Table 5.2.7-4 shows standardised cross-lagged coefficients. In summary, the teacher-child relationship quality was not significantly associated with any facets of teacher-rated EF, whereas all facets of teacher-rated EF were significantly negatively associated with change in the level of teacher-child conflict. This suggests that the higher initial levels of EF predicted lower levels of teacher-rated conflict later.

Paths	β	*p*
STRS (Closeness) T1→BRIEF-P (IC) T2	-.006	.93
BRIEF-P (IC) T1→STRS (Closeness) T2	.032	.68
STRS (Closeness) T1→BRIEF-P (WM) T2	-.051	.45
BRIEF-P (WM) T1→STRS (Closeness) T2	.012	.88
STRS (Closeness) T1→BRIEF-P (CF) T2	-.046	.57
BRIEF-P (CF) T1→STRS (Closeness) T2	-.040	.61
STRS (Conflict) T1→BRIEF-P (IC) T2	.005	.95
BRIEF-P (IC) T1→STRS (Conflict) T2	-.269	.02*
STRS (Conflict) T1→BRIEF-P (WM) T2	.015	.86
BRIEF-P (WM) T1→STRS (Conflict) T2	-.299	.001***
STRS (Conflict) T1→BRIEF-P (CF) T2	.052	.60
BRIEF-P (CF) T1→STRS (Conflict) T2	-.223	.04*

Table 5.2.7-4. Parameter estimates between teacher-child relationship and teacher-rated EF
Note. STRS = Student-Teacher Relationship Scale; BRIEF-P = Behavioural Rating Inventory of Executive Function-Preschool Version; IC = Inhibitory Control; WM = Working Memory; CF = Cognitive Flexibility; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. *$p < .05$. ***$p < .001$.

c) Relationship quality and social-emotional skills (SEARS)

Parent-child Closeness and parent-rated Social Competence. The latent autoregressive model exhibited an acceptable fit (CFI = .933; TLI = .923; RMSEA = .06). The autoregressive effects for both Closeness and parent-rated Social competence were sizeable (β = .680, p = .001; β = .463, p = .002, respectively). Parent-child closeness at T1 was significantly associated with change in parent-reported social competence (β = .368, p = .01), whereas parent-rated social competence at T1 was not significantly associated with change in the level of parent-child closeness (β = .029, p = .86).

Parent-child Closeness and parent-rated Empathy. The latent autoregressive model exhibited a good fit (CFI = .952; TLI = .946; RMSEA = .06). The autoregressive effects for both Closeness and parent-reported empathy were sizeable (β = .578, p = .001; β = .745, p = .002, respectively). Parent-child closeness at T1 was not significantly associated with change in parent-rated empathy (β = .203, p = .09); parent-rated empathy was not significantly associated with change in parent-child closeness either (β = .152, p = .36).

Parent-child Closeness and parent-rated Responsibility. The latent autoregressive model exhibited a poor fit (CFI = .920; TLI = .913; RMSEA = .06). The autoregressive effects for both Closeness and parent-reported responsibility were sizeable (β = .673, p = .001; β = .500, p = .001, respectively). Parent-child closeness at T1 was significantly associated with change in parent-reported responsibility (β = .465, p = .001), whereas parent-reported responsibility T1 was not significantly associated with change in parent-child closeness (β = -.030, p = .81).

Parent-child Conflict and parent-rated Social Competence. The latent autoregressive model exhibited an acceptable fit (CFI = .929; TLI = .922; RMSEA = .07). The autoregressive effects for both Conflict and parent-reported social competence were sizeable (β = .716, p = .001; β = .704, p = .001, respectively). Parent-child conflict at T1 was not significantly associated with parent-reported social competence (β = .083, p = .44), whereas parent-reported social competence at T1 was significantly negatively associated with change in parent-child conflict (β = -.361, p = .001).

Parent-child Conflict and parent-rated Empathy. The latent autoregressive model exhibited an acceptable fit (CFI = .923; TLI = .916; RMSEA = .08). The autoregressive effects for both Conflict and parent-reported empathy were sizeable (β = .767, p = .001; β = .811, p = .001, respectively). Parent-child conflict at T1 was significantly negatively associated with change in parent-reported empathy (β = -.216, p = .01); parent-reported empathy at T1 was also significantly negatively associated with change in parent-child conflict (β = -.193, p = .03).

Parent-child Conflict and parent-rated Responsibility. The latent autoregressive model exhibited an acceptable fit (CFI = .935; TLI = .932; RMSEA = .06). The autoregressive effects for both Conflict and parent-reported responsibility were sizeable (β = .845, p = .001; β = .690, p = .001, respectively). Parent-child conflict at T1 was significantly negatively associated with change in parent-reported empathy (β = -.234, p = .02), whereas parent-reported empathy at T1 was not significantly associated with change in parent-child conflict (β = -.105, p = .22).

Table 5.2.7-5 shows standardised cross-lagged coefficients. In summary, the parent-child relationship quality including Closeness and Conflict was significantly associated with change in parent-rated social-emotional skills. Although any facets of parent-rated social-emotional skills were not significantly associated with change in parent-child closeness, parent-rated social competence and responsibility were significantly negatively associated with change in parent-child conflict.

Paths	β	*p*
CPRS (Closeness) T1→SEARS (SC) T2	.368	.01**
SEARS (SC) T1→CPRS (Closeness) T2	.029	.86
CPRS (Closeness) T1→SEARS (Empathy) T2	.203	.09
SEARS (Empathy) T1→CPRS (Closeness) T2	.152	.36
CPRS (Closeness) T1→SEARS (Responsibility) T2	.465	.001***
SEARS (Responsibility) T1→CPRS (Closeness) T2	-.030	.81
CPRS (Conflict) T1→SEARS (SC) T2	.083	.44
SEARS (SC) T1→CPRS (Conflict) T2	-.361	.001***
CPRS (Conflict) T1→SEARS (Empathy) T2	-.216	.01**
SEARS (Empathy) T1→CPRS (Conflict) T2	-.193	.03*
CPRS (Conflict) T1→SEARS (Responsibility) T2	-.234	.02**
SEARS (Responsibility) T1→CPRS (Conflict) T2	-.105	.22

Table 5.2.7-5. Parameter estimates between parent-child relationship and parent-rated social-emotional skills

Note. CPRS = Child-Parent Relationship Scale; SEARS = Social-Emotional Assets and Resiliency Scale; SC = Social Competence; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. *p < .05. **p < .01. ***p < .001.

Teacher-child Closeness and teacher-rated Social Competence. One outlier indicator of SEARS (Item2) was removed due to an inflated correlation across time. The latent autoregressive model exhibited a good fit (CFI = .967; TLI = .963; RMSEA = .08). The autoregressive effects for both Closeness and teacher-reported social competence were sizeable (β = .649, p = .001; β = .332, p = .03, respectively). Teacher-child closeness at T1 was significantly associated with change in teacher-reported social competence (β = .339, p = .01), whereas teacher-reported social competence at T1 was not significantly associated with change in teacher-child closeness (β = .039, p = .78).

Teacher-child Closeness and teacher-rated Empathy. One outlier indicator of SEARS (Item5) was removed due to an inflated correlation across time. The latent autoregressive model exhibited a good fit (CFI = .973; TLI = .970; RMSEA = .07). The autoregressive effects for both Closeness and teacher-reported empathy were sizeable (β = .699, p = .001; β = .489, p = .03, respectively). Teacher-child closeness at T1 was not significantly associated with change in teacher-reported empathy (β = .046, p = .70); teacher-reported empathy at T1 was not significantly associated with change in teacher-child closeness either (β = -.047, p = .69).

Teacher-child Closeness and teacher-rated Responsibility. One outlier indicator of SEARS (Item11) was removed due to an inflated correlation across time. The latent autoregressive model exhibited a good fit (CFI = .969; TLI = .967; RMSEA = .07). The autoregressive effects for both Conflict and teacher-reported responsibility were sizeable (β = .655, p = .001; β = .508, p = .001, respectively). Teacher-child closeness at T1 was not significantly associated with change in teacher-reported responsibility (β = .071, p = .45); teacher-reported responsibility at T1 was not significantly associated with change in teacher-child closeness either (β = .026, p = .76).

Teacher-child Conflict and teacher-rated Social Competence. One outlier indicator of SEARS (Item2) was removed due to an inflated correlation across time. The latent autoregressive model exhibited an excellent fit (CFI = .981; TLI = .980; RMSEA = .05). The autoregressive effects for both Conflict and teacher-reported social competence were sizeable (β = .651, p = .001; β = .539, p = .001, respectively). Teacher-child conflict at T1 was not significantly associated with change in teacher-reported social competence (β = .069, p =

.38); teacher-reported social competence at T1 was not significantly associated with change in teacher-reported social competence either (β = .048, p = .58).

Teacher-child Conflict and teacher-rated Empathy. The latent autoregressive model exhibited a good fit (CFI = .984; TLI = .982; RMSEA = .05). The autoregressive effects for both Conflict and teacher-reported empathy were sizeable (β = .649, p = .001; β = .419, p = .001, respectively). Teacher-child conflict at T1 was significantly negatively associated with change in teacher-reported empathy (β = -.175, p = .02), whereas teacher-reported empathy at T1 was not significantly associated with change in teacher-child conflict (β = -.004, p = .96).

Teacher-child Conflict and teacher-rated Responsibility. Two outlier indicators of SEARS (Item11&12) were removed due to an inflated correlation across time. The latent autoregressive model exhibited a marginally acceptable fit (CFI = .945; TLI = .942; RMSEA = .09). The autoregressive effects for both Conflict and teacher-reported responsibility were sizeable (β = .498, p = .001; β = .557, p = .001, respectively). Teacher-child conflict at T1 was not significantly associated with change in teacher-reported responsibility (β = .012, p = .91), whereas teacher-reported responsibility was significantly negatively associated with change in teacher-child conflict (β = -.193, p = .02).

Table 5.2.7-6 shows standardised cross-lagged coefficients. In summary, teacher-child closeness was significantly associated with change in teacher-rated social competence, whereas teacher-child conflict was significantly negatively associated with change in teacher-rated empathy. This suggests that children with higher initial levels of closeness made greater improvements in social competence; children with lower initial levels of conflict made greater improvements in teacher-rated empathy. Only one facet of social-emotional skills, responsibility, was significantly negatively associated with change in teacher-child conflict. This suggests that children with higher initial levels of responsibility had less conflict with their teachers later.

Paths	β	*p*
STRS (Closeness) T1→SEARS (SC) T2	.339	.01**
SEARS (SC) T1→STRS (Closeness) T2	.039	.78
STRS (Closeness) T1→SEARS (Empathy) T2	.046	.70
SEARS (Empathy) T1→STRS (Closeness) T2	-.047	.69
STRS (Closeness) T1→SEARS (Responsibility) T2	.071	.45
SEARS (Responsibility) T1→STRS (Closeness) T2	.026	.76
STRS (Conflict) T1→SEARS (SC) T2	.069	.38
SEARS (SC) T1→STRS (Conflict) T2	.048	.58
STRS (Conflict) T1→SEARS (Empathy) T2	-.175	.02*
SEARS (Empathy) T1→STRS (Conflict) T2	-.004	.96
STRS (Conflict) T1→SEARS (Responsibility) T2	.012	.91
SEARS (Responsibility) T1→STRS (Conflict) T2	-.193	.02*

Table 5.2.7-6. Parameter estimates between teacher-child relationship and teacher-rated social-emotional skills

Note. STRS = Student-Teacher Relationship Scale; SEARS = Social-Emotional Assets and Resiliency Scale; SC = Social Competence; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. *$p < .05$. **$p < .01$.

c) Relationship quality and pre-academic competence

Parent-child Closeness and Vocabulary. The latent autoregressive model exhibited a rather poor fit (CFI = .893; TLI = .871; RMSEA = .07) such that the results should be interpreted with caution. The autoregressive effects for both Closeness and Vocabulary were sizeable (β = .677, p = .001; β = .879, p = .001, respectively). Parent-child closeness at T1 was not significantly associated with change in vocabulary (β = -.328, p = .16); vocabulary at T1 was not significantly associated with change in parent-child closeness either (β = -.013, p = .94).

Parent-child Closeness and Numeracy. Since incorporating correction for measurement error for early number concepts failed to identify a model, the observed variables for early number concepts were used in the following model. Consequently, the result should be interpreted with caution. The latent autoregressive model exhibited a rather poor fit (CFI = .869; TLI = .842; RMSEA = .07). The autoregressive effects for both closeness and early number concepts were sizeable (β = .680, p = .001; β = .684, p = .001, respectively). Parent-child closeness at T1 was not significantly associated with change in early number concepts (β = .067, p = .33), whereas early number concepts at T1 were significantly negatively associated with change in parent-child closeness (β = -.185, p = .01).

Parent-child Conflict and Vocabulary. The latent autoregressive model exhibited an acceptable fit (CFI = .932; TLI = .925; RMSEA = .07). The autoregressive effects for both conflict and vocabulary were sizeable (β = .815, p = .001; β = .907, p = .001, respectively). Parent-child conflict at T1 was not significantly associated with change in vocabulary (β = .137, p = .33); vocabulary at T1 was not significantly associated with change in parent-child conflict either (β = -.115, p = .29).

Parent-child Conflict and Numeracy. The latent autoregressive model exhibited an acceptable fit (CFI = .929; TLI = .922; RMSEA = .07). The autoregressive effects for both conflict and early number concepts were sizeable (β = .825, p = .001; β = .733, p = .001, respectively). Parent-child conflict at T1 was not significantly associated with change in early number concepts (β = -.058, p = .53); early number concepts at T1 were not significantly associated with change in parent-child conflict either (β = -.091, p = .44).

Table 5.2.7-7 shows standardised cross-lagged coefficients. In summary, the parent-child relationship quality was not significantly associated with change in neither vocabulary nor early number concepts, whereas early number concepts were significantly negatively associated with change in parent-child closeness. This suggests that children with lower initial levels of numeracy skills were more likely to have closer relationships with their parents later.

Paths	β	*p*
CPRS (Closeness) T1→BAS (Vocabulary) T2	-.328	.16
BAS (Vocabulary) T1→CPRS (Closeness) T2	-.013	.94
CPRS (Closeness) T1→BAS (Number Concepts) T2	.067	.33
BAS (Number Concepts) T1→CPRS (Closeness) T2	-.185	.01**
CPRS (Conflict) T1→BAS (Vocabulary) T2	.137	.33
BAS (Vocabulary) T1→CPRS (Conflict) T2	-.115	.29
CPRS (Conflict) T1→BAS (Number Concepts) T2	-.058	.53
BAS (Number Concepts) T1→CPRS (Conflict) T2	-.091	.44

Table 5.2.7-7. Parameter estimates between parent-child relationship and pre-academic competence

Note. CPRS = Child-Parent Relationship Scale; BAS = British Ability Scale; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. **p < .01.

Teacher-child Closeness and Vocabulary. The latent autoregressive model exhibited a good fit (CFI = .971; TLI = .968; RMSEA = .07). The autoregressive effects for both Closeness and Vocabulary were sizeable (β = .662, p = .001; β = .921, p = .001, respectively). Teacher-child closeness at T1 was not significantly associated with change in vocabulary (β = -.152, p = .15); vocabulary at T1 was not significantly associated with change in teacher-child closeness either (β = .060, p = .57).

Teacher-child Closeness and Numeracy. The latent autoregressive model exhibited a good fit (CFI = .969; TLI = .965; RMSEA = .07). The autoregressive effects for both closeness and early number concepts were sizeable (β = .670, p = .001; β = .730, p =.001, respectively). Teacher-child closeness at T1 was not significantly associated with change in early number concepts (β = .090, p = .25); early number concepts at T1 were not significantly associated with change in teacher-child closeness either (β = .090, p = .32).

Teacher-child Conflict and Vocabulary. The latent autoregressive model exhibited an excellent fit (CFI = .994; TLI = .993; RMSEA = .03). The autoregressive effects for both conflict and vocabulary were sizeable (β = .642, p = .001; β = .935, p = .001, respectively). Teacher-child conflict at T1 was significantly negatively associated with change in vocabulary (β = .203, p = .04), whereas vocabulary at T1 was not significantly associated with change in teacher-child conflict (β = -.058, p = .58).

Teacher-child Conflict and Numeracy. The latent autoregressive model exhibited an excellent fit (CFI = .991; TLI = .991; RMSEA = .04). The autoregressive effects for both conflict and early number concepts were sizeable (β = .647, p = .001; β = .734, p = .001, respectively). Teacher-child conflict at T1 was not significantly associated with change in early number concepts (β = .025, p = .80); early number concepts at T1 were not significantly associated with change in teacher-child either (β = -.024, p = .82).

Table 5.2.7-8 shows standardised cross-lagged coefficients. In summary, parent-child conflict was significantly associated with change in vocabulary, whereas initial pre-academic competence was not significantly associated with change in relational quality. This suggests that 1) parent-child relationship quality made no difference in later pre-academic competence; and 2) children who had higher initial levels of conflict with their teacher were more likely to have greater improvements in vocabulary.

Paths	β	*p*
STRS (Closeness) T1→BAS (Vocabulary) T2	-.152	.15
BAS (Vocabulary) T1→STRS (Closeness) T2	.060	.57
STRS (Closeness) T1→BAS (Early Number Concept) T2	.090	.25
BAS (Number Concepts) T1→STRS (Closeness) T2	.090	.32
STRS (Conflict) T1→BAS (Vocabulary) T2	.203	.04*
BAS (Vocabulary) T1→STRS (Conflict) T2	-.058	.58
STRS (Conflict) T1→BAS (Number Concept) T2	.025	.80
BAS (Number Concepts) T1→STRS (Conflict) T2	-.024	.82

Table 5.2.7-8. Parameter estimates between teacher-child relationship and pre-academic competence

Note. STRS = Student-Teacher Relationship Scale; BAS = British Ability Scale; T1 = Time point one; T2 = Time point two; βs represent standard coefficients. **p* < .05.

5.3 Summary of key findings

Chapter five has presented the results of the analyses. This section summarises the key findings of each research question.

Research question 1: *Are there any differences in classroom process quality (Emotional Support, Classroom Organisation, and Instructional Support) by preschool types in Western Canada (Montessori, Reggio Emilia, and BCELF programmes)?*

RQ1 examined classroom process quality, particularly teacher-child interactions using the CLASS observation measure in the three programme types. Both Montessori and Reggio Emilia schools offered higher levels of emotionally and organisationally supportive interactions compared to BCELF schools, although the same general trend emerged across the three programme types with strengths in Emotional Support and weakness in Instructional Support. There were significant differences in four dimensions amongst programme types; overall Montessori and Reggio Emilia schools tended to exhibit higher scores on Regard for Student Perspectives, Teacher Sensitivity, Instructional Learning Formats, and Concept Development. Montessori schools exhibited the most effective interactions in two dimensions compared to Reggio Emilia and BCELF schools; Regard for Student Perspectives which focused on teachers' behaviours in promoting autonomy, interests, and points of view and Instructional Learning Formats which focused on teacher behaviour in promoting student engagement with learning materials and activities.

Research question 2*: Is enrolment in different preschool programmes associated with changes in EF, social-emotional skills, and pre-academic competence over one school year?*

RQ2 examined the effects of different programme types on the development of school readiness skills including EF, social-emotional skills, and pre-academic competence across time. As for pre-academic competence, enrolment in Montessori schools was the strongest predictor for positive gains in direct measure of numeracy skills. As for direct measures of EF, there was no statistically significant difference in change across the three school types. As for indirect measures of EF, teachers in Montessori and Reggio Emilia schools described their students as making significantly fewer improvements in CF than did teachers in BCELF schools. As for social-emotional skills, parents in both Montessori and Reggio Emilia schools described their children as showing significantly fewer improvements in social competence than did parents in BCELF schools. Parents in Montessori schools also described their children as showing significantly fewer improvements in empathy than did parents in BCELF schools. Overall, only four significant associations out of 17 outcome variables were found, indicating that no preschool programme stood out as notably more effective than any of the others.

Research question 3*: Is any aspect of classroom process quality measured by the CLASS associated with change in EF, social-emotional skills, and pre-academic competence?*

RQ3 examined the effects of classroom process quality on the development of school readiness skills. All three CLASS domains (Emotional Support, Classroom Organisation, and Instructional Support) were significantly negatively associated with change in teacher-rated CF, indicating that children in classrooms where teachers provided higher levels of emotional, organisational, and instructional support were more likely to decrease in teacher-rated CF. Classroom Organisation was significantly associated with change in numeracy skills, indicating that children in classrooms where teachers were effective in managing children's behaviour, promoting productivity, and facilitating children's learning engagement were more likely to improve numeracy skills. No other significant associations were found between classroom process quality and outcome measures.

Research question 4*: What are the associations between EF and pre-academic competence over time?*

RQ4 examined the directionality between EF and pre-academic competence. As with direct measures of EF, all three core components of EF (including WM, IC, and CF) were significantly associated with numeracy skills. This suggests that children with higher initial EF were likely to improve numeracy skills. Vocabulary was significantly associated with WM, whereas numeracy skills were significantly associated with WM and CF. This suggests that 1) children beginning with higher vocabulary were more likely to develop higher WM; and 2) children beginning with higher numeracy skills were more likely to develop higher WM and CF.

As for indirect measures of EF, parent-rated EF was not significantly associated with change in pre-academic competence. On the other hand, numeracy skills were significantly associated with change in parent-rated IC and WM and initial vocabulary was also marginally significantly associated with change in parent-rated IC. This suggests that 1) parent-rated EF at the beginning of the school year made no difference in later pre-academic competence; 2) children beginning with higher numeracy skills were more likely to develop higher parent-rated IC and WM; and 3) children beginning with higher vocabulary were more likely to develop higher parent-rated IC. For teacher ratings, teacher-rated IC, WM, and CF were significantly associated with change in vocabulary, whereas the initial pre-academic competence level was not significantly associated with any facets of teacher-rated EF. This suggests that 1) children beginning with higher EF were more likely to develop better vocabulary; and 2) initial pre-academic competence made no difference in later teacher-rated EF.

Research question 5*: What are associations between social-emotional skills and pre-academic competence over time?*

RQ5 examined the directionality between social-emotional skills and pre-academic competence. For parent ratings, parent-rated initial empathy was significantly associated with change in numeracy skills, whereas initial pre-academic competence was not significantly associated with any facets of parent-rated social-emotional skills. This suggests that 1) children beginning with higher parent-rated empathy were more likely to improve numeracy skills; and 2) initial pre-academic competence made no difference in later parent-rated social-emotional skills. For teacher ratings, teacher-rated initial empathy was significantly associated with change in numeracy skills. Teacher-rated initial responsibility was also significantly negatively associated with change in vocabulary. This suggests that 1) children beginning with higher teacher-rated empathy were more likely to improve numeracy skills; and 2) children beginning with lower teacher-rated responsibility were more likely to develop vocabulary. Initial numeracy skills were significantly associated with change in teacher-rated empathy and responsibility, and initial vocabulary was significantly associated with change in responsibility. This suggests that 1) children beginning with higher numeracy skills were more likely to develop higher empathy and responsibility; and 2) children beginning with higher vocabulary were more likely to develop a higher sense of responsibility.

Research question 6*: What are the associations between EF and social-emotional skill over time?*

RQ6 examined the directionality between EF and social-emotional skills. As for the role of EF, direct measures of IC, WM and CF were significantly associated with change in parent-rated responsibility. Direct measures of WM and CF were also significantly associated with change in parent-rated empathy. This suggests that 1) children beginning with higher IC, WM and/or CF were more likely to develop a stronger sense of parent-rated responsibility; and 2) children beginning with higher WM or CF were more likely to develop higher parent-rated empathy. As for the role of social-emotional skills, parent-rated initial responsibility was significantly associated with change in performance-based CF. This suggests that children beginning with a higher sense of parent-rated responsibility were more likely to develop higher CF, although no other significant associations were found. For teacher-rated social-emotional skills, direct measures of WM and CF were significantly associated with change in teacher-rated empathy. All aspects of performance-based EF were significantly associated with teacher-rated responsibility. No facets of teacher-rated social-emotional skills were significantly associated with change in direct measures of EF. This suggests that 1) children beginning with higher EF were more likely to develop a stronger sense of empathy and responsibility; and 2) teacher-rated initial social-emotional skills made no difference in later EF.

As for indirect measures of EF and social-emotional skills, both parent-rated IC and CF were significantly associated with change in social competence and responsibility. Parent-rated social-emotional skills were not significantly associated with any facets of parent-rated EF. This suggests that 1) children beginning with higher parent-rated IC and CF were more likely to develop higher empathy and responsibility; and 2) parent-rated initial social-emotional skills made no difference in later parent-rated EF. Teacher-rated social-emotional skills exhibited similar unidirectional association. Both teacher-rated IC and WM were significantly associated with change in empathy and responsivity, whereas teacher-rated social-emotional skills were not significantly associated with any facets of teacher-rated EF. This suggests that 1) children beginning with higher teacher-rated IC and WM were more likely to develop higher teacher-rated empathy and responsibility; and 2) teacher-rated initial social-emotional skills made no difference in later teacher-rated EF.

***Research question** 7: What are the associations between teacher-child/parent-child relationship quality and school readiness skills over time?*

RQ7 examined the directionality between parent-child/teacher-child relationship quality and school readiness skills including EF, social-emotional skills, and pre-academic competence. As for the parent-child/teacher-child relationship quality and direct measures of EF, no statistically significant associations were found. As for the relationship quality and indirect measures of EF, the parent-child relationship quality was not significantly associated with change in parent-rated EF, whereas initial parent-rated EF, particularly IC and CF, was significantly negatively associated with change in relational conflict. This suggests that 1) the initial parent-child relationship quality made no difference in later parent-rated EF; and 2) children with lower initial parent-rated IC and CF were more likely to have higher levels of conflict with their parents. Similarly, the initial teacher-child relationship quality was not significantly associated with change in teacher-rated EF, whereas all facets of initial teacher-rated EF were significantly negatively associated with change in relational conflict. This suggests that 1) the initial teacher-child relationship quality made no difference in later teacher-rated EF; and 2) children with lower initial teacher-rated EF were more likely to have higher levels of conflict with their teachers.

As for the relationship quality and social-emotional skills, initial parent-child closeness was significantly associated with change in parent-rated social competence and responsibility, whereas parent-rated initial social-emotional skills were not associated with later parent-child closeness. This suggests that 1) children beginning with higher levels of parent-child closeness were more likely to develop more social competence and responsibility; and 2) children's initial social-emotional skills made no difference in later parent-child closeness. Initial parent-child conflict was significantly negatively associated with change in parent-rated empathy and responsibility, whereas parent-rated initial empathy was significantly negatively associated with change in parent-child conflict. This suggests that 1) children beginning with higher levels of parent-child conflict were more likely to develop less empathy and responsibility; and 2) children with lower initial parent-rated empathy and social competence were more likely to develop higher levels of relational conflict with their parents.

Initial teacher-child closeness was significantly associated with change in teacher-rated social competence, whereas teacher-rated initial social-emotional skills were not associated with later teacher-child closeness. This suggests that 1) children beginning with higher levels of teacher-child closeness were more likely to develop higher social competence; and 2) children's initial social-emotional skills made no difference in later teacher-child closeness. Initial teacher-child conflict was significantly negatively associated with change in teacher-rated empathy, whereas teacher-rated initial responsibility was significantly negatively associated with change in conflict. This suggests that 1) children beginning with higher levels of teacher-child conflict were more likely to decrease in social competence; and 2) children with lower initial teacher-rated responsibility were more likely to develop higher levels of conflict with their teachers.

As for the relationship quality and pre-academic competence, the initial parent-child relationship quality was not significantly associated with change in pre-academic competence, whereas initial numeracy skills were significantly associated with change in parent-child closeness. This suggests that 1) the parent-child relationship quality made no difference in later pre-academic competence; and 2) children beginning with higher numeracy skills were more likely to develop closer relationships with their parents. Initial teacher-child relationship conflict was significantly associated with change in vocabulary, whereas initial pre-academic competence was not significantly associated with change in relationship quality. This suggests that 1) children beginning with higher levels of teacher-child conflict were more likely to develop more vocabulary; and 2) initial pre-academic competence made no difference in later teacher-child relationship quality.

Chapter 6: Discussion

6.1 Classroom process quality in three different programme types

RQ1 examined classroom process quality, focusing on child-teacher interactions using the CLASS observation measure in the three different programme types. Both Montessori and Reggio Emilia schools provided higher levels of emotional and organisation support compared to BCELF schools, although there was a general trend across the three programme types with moderate to high levels of Emotional Support and Classroom Organisation provision and low levels of Instructional Support provision. This pattern is consistent with other studies in which most observations score in the moderate to high range for Emotional Support and Classroom Organisation and the low range for Instructional Support (e.g., Hamre, Hatfield, Pianta, & Jamil, 2014; Hamre et al., 2013; La Paro, Pianta, Stuhlman, 2004; Rimm-Kaufman, Curby, Grimm, Nathanson, & Brock, 2009).

There were significant differences in four dimensions amongst the programme types: overall Montessori and Reggio Emilia schools exhibited significantly higher scores on Regard for Student Perspectives, Teacher Sensitivity, Instructional Learning Formats, and Concept Development than BCELF schools. In particular, Montessori schools exhibited the most effective interactions in two dimensions compared to Reggio Emilia and BCELF schools: Regard for Student Perspectives and Instructional Learning Formats. Regard for Student Perspectives measures how teachers promote students' autonomy and place importance on students' interests, motivation, and points of view. Supporting children's autonomy with a strong emphasis on self-directed actions is core to the Montessori approach (Koh & Frick, 2010; Lillard, 2005). Following this principle, Montessori teachers consistently showed flexibility in their educational planning by incorporating individual children's ideas and specific interests. As a result, children were given plentiful opportunities for exercising freedom of choice while held accountable for their own actions. Hamre (2009) reported similar findings in which Montessori classrooms (N = 17) showed a significantly higher degree of Regard for Student Perspectives (M = 6.12, SD = 0.64) than other types of preschool classrooms (t = 2.35, p < .05). Within Montessori pedagogy, education is not a passive experience of just receiving information but is rather an active participatory experience for children by making choices and setting their own goals (Duffy & Duffy, 2012). Instructional Learning Formats measures how teachers provide engaging and interesting materials/activities so that learning opportunities for, and active participation of, students are maximised. Montessori teachers also consistently provided a range of stimulating and interesting materials that facilitated auditory, visual, and movement opportunities for children. Montessori classrooms are equipped with specially designed materials with which children have in-depth hands-on experiences. Montessori teachers are trained to observe individual students so that they can provide a specific material/activity that is developmentally appropriate and responds to students' unique interests. For these reasons, it is not surprising that Montessori schools steadily received high scores in these two dimensions.

Significantly higher levels of Teacher Sensitivity were observed in Montessori and Reggio Emilia classrooms compared to BCELF classrooms. Teacher Sensitivity measures the teacher's level of awareness and responsiveness to children's cognitive and emotional needs. Montessori and Reggio Emilia teachers were often attuned to children's emotional functioning and were effective at addressing children's problems and concerns. Montessori education and the Reggio Emilia approach conceptualise the role of teachers similarly: teachers are the learning facilitators whose primary role is to respond to children's different needs and support their learning (Rinaldi, 1998). Both approaches also employ progressive teaching practices that focus on children initiating and teachers responding by providing appropriate autonomy and structural support. In fact, although Montessori schools were rated as most effective, Reggio Emilia schools also offered higher levels of Regard for Student Perspectives than play-based schools. Thus, the effective provision of Teacher Sensitivity and Regard for Student Perspectives highlights that the central tenet of the progressive practices are manifested in teacher behaviour in Montessori and Reggio Emilia classrooms.

Montessori and Reggio Emilia classrooms also provided higher levels of Concept Development compared to BCELF classrooms; however, each dimension of Instructional Support including Quality Feedback, Concept Development, and Language Modeling scored in the low range across the three programme types. The findings are consistent with other studies in which the average rating for the Instructional Support dimensions tends to be consistently low (e.g., La Paro et al., 2004; Hamre et al., 2014). One study that examined classroom process quality in 671 pre-K classrooms using the CLASS showed that only less than 1% of the classrooms achieved an average score of 5 or above and 87% of the classrooms achieved an average score between 1-3.24 in the Concept Development and Quality Feedback ratings (Burchinal et al., 2010). These collective results indicate that preschool teachers, regardless of their pedagogical approaches, rarely provide scaffolding or process feedback, use extended discussions to facilitate critical thinking skills, and engage in open-ended questions or use advanced language to expand children's language. One explanation is that there is a reported discrepancy between teachers' knowledge and practices; teachers' beliefs and knowledge might not be always reflected in their teaching behaviour (e.g., Charlesworth et al., 1991; Stipek & Byler, 1997; Wen et al., 2011). Hence, even if teachers possess adequate knowledge about effective teacher-child interactions, they might not be able to transfer that specific knowledge into changes and execute in their practice. An alternative explanation is that teachers might lack explicit knowledge about the link between teacher behaviour and child development, and professional development might be necessary to improve the quality of teachers' interactions with children. For example, training studies found that a face-to-face professional development course on specific knowledge about the role of effective teacher-child interactions in child learning and skill acquisition significantly increased teachers' intentional teaching beliefs and skills in detecting effective interactions (e.g., Early, Maxwell, Ponder, & Pan, 2017; Hamre et al., 2012). In addition, those teachers who participated in the training significantly improved their classroom's behaviour in providing effective emotional and instructional interactions. Taken together, compared to Emotional Support and Classroom Organisation, it might be more challenging for teachers to provide high levels of Instructional Support without explicit training that focuses on the intellectual and behavioural transformation.

6.2 The contribution of curriculum types

RQ2 examined the impact of different programme types on the development of school readiness skills including executive function (EF), social-emotional skills, and pre-academic competence across time. As for academic skills, enrolment in Montessori schools was the strongest predictor for positive gains in numeracy skills, while change in vocabulary showed no significant statistical differences across the three programme types. Higher achievement in numeracy skills amongst Montessori children may be attributed to mathematic materials and the effective use of these materials in Montessori education (Laski et al., 2015). Montessori manipulative materials are physical representations of numbers and mathematical concepts, and these materials do not have irrelevant features so as to avoid confusion. Children use these manipulative materials repetitively over a long period of time and progress from concrete to more abstract representations with the help of teachers' explicit instructions to establish the relation between the manipulative and the mathematical concepts (Laski et al., 2015). The early exposure to these didactic mathematic materials may also have a long-term benefit for later mathematical achievement. Dohrmann, Nishida, Gartner, Lipsky, and Grimm (2007) compared two groups of high school graduates who had attended either state Montessori programmes from preschool through fifth grade or traditional primary schools. As in the current study, randomised assignment was not feasible. Thus, statistical control was employed to establish a modified comparison group using the criteria of gender, ethnicity, and socioeconomic status. The results from the structural equation model (SEM) analysis showed that former Montessori students outperformed students who had attended regular primary schools on the mathematics/science factor ($\beta = .30$, $p < .05$), indicating a long-lasting effect of receiving Montessori education during the primary years on enhanced mathematical achievement.

On the contrary, there was no statistically significant difference in the development of vocabulary across the three programme types, although BCELF and Montessori children performed slightly better than Reggio Emilia children. The finding was consistent with a Montessori evaluation study by Lillard and Else-Quest (2006) in which Montessori and non-Montessori kindergarten children performed similarly in vocabulary, although Montessori children performed significantly better in other language areas such as phonological decoding ability and letter-word identification than non-Montessori children. The lack of statistical difference in the development of vocabulary might reflect a number of possible reasons. Firstly, it may be that all three programmes are equally placing importance on the development of oral language, which is often associated with vocabulary (NICHD Early Child Care Research Network, 2005), thus effectively improving children's vocabulary. One study supports this theory by showing that differences in programme contents did not produce significantly different results (van Druten-Frietman, Denessen, Gijsel, & Verhoeven, 2015). In their study, both teacher-directed and child-directed preschool curricula were beneficial to preschool vocabulary development ($\beta = .55$, $p < .05$, $\beta = .45$, $p < .05$, respectively). More unstructured nature of preschools compared to formal schooling regardless of curriculum types may offer more opportunities for children to have multi-turn conversations with their teachers and peers, leading to greater vocabulary development

(Cabell, Justice, McGinty, & DeCoster, 2015). Secondly, research points out that children from low socioeconomic status families tend to develop a more limited vocabulary due to a lack of parental knowledge and provision of a language-enriching environment, whereas children from middle to high socioeconomic status families such as those included in the current study are more likely to improve and expand vocabulary (e.g., Hoff, 2003; Pungello, Iruka, Dotterer, Mills-Koonce, & Reznick, 2009; van Druten-Frietman et al., 2015). Oral language might be also more easily enhanced at home through daily conversations and books (Warren & Young, 2002), whereas specific subject areas such as mathematics may require more knowledge and materials to facilitate its effective learning at home. Other research has also shown that parents tend to spend small amounts of time supporting children's numeracy development compared to literacy (Tudge & Doucet, 2004) because of their own negative views on mathematics and lower confidence in their subject knowledge (LeFevre, Polyzoi, Skwarchuk, Fast, & Sowinski, 2010).

As for performance-based EF, although Montessori children performed better than Reggio Emilia and BCELF children, there were no statistically significant differences in change across the three programme types. The lack of statistical difference in change in any facet of EF might reflect the nature of EF development. The growth spurt of EF occurs throughout childhood, although different constructs of EF appear to show varying developmental trajectories (Anderson, 2002; Best et al., 2009). It may be that EF develops rapidly during preschool years irrespective of curriculum content, especially when adequate support from adults and responsive learning environments is provided. For example, studies evaluating the effectiveness of a curriculum that specifically targets the development of EF for preschool and kindergarten children (Tools of the Mind; Bodrova & Leong, 1996) show inconclusive results suggesting that having the Tools of the Mind programme does not necessarily produce more positive effects on the development of EF compared to their counterparts (e.g., Barron et al., 2017; Farran & Wilson, 2014). It is reasonable to think that curricula that embrace conversational opportunities, promote joy and self-confidence, foster social interactions, and provide materials that allow children to engage in their learning and explore should be effective regardless of varying educational values (Diamond & Lee, 2011; Weisberg, Hirsh-Pasek, & Golinkoff, 2013). Although the three preschool programmes included in the current study propose their own unique educational philosophies, it is possible that there is overlap in their teaching and meeting the aforementioned criteria to be equally effective in facilitating the development of EF.

As for indirect measures of EF (BRIEF-P), no aspect of parent-rated EF showed a significant group difference in change across the three school types. It is possible that parents in all school types may view child behaviour at home similarly, as reflected in the lack of group difference in parental expectations for executive functioning related behaviour. On the contrary, teachers in Montessori and Reggio Emilia schools rated their students as making significantly fewer improvements in cognitive flexibility (CF) than did teachers in BCELF schools. CF in BRIEF-P predominately focuses on a behavioural aspect of adaptability (e.g., ‘Has trouble adjusting to new people’; ‘Has trouble changing activities’). The different perceptions amongst teachers may reflect a number of factors. One perspective is that Montessori and Reggio Emilia schools may offer more a flexible schedule by which students are more actively involved in their educational planning at their own pace. Consequently, these students may be less exposed to a situation where they are externally required to switch activities, and thus show less flexibility in their behaviours. The differences in teacher-rated CF can also be attributed to potential rater bias. As discussed in the previous chapter, teachers’ behavioural expectations and perceptions have a significant influence on their responses. For example, studies that examined kindergarten teachers’ views on school readiness (e.g., Lin, Lawrence, & Gorrell, 2003; Rimm-Kaufman et al., 2000) highlighted teachers’ high expectations for children exhibiting executive functioning aspect of behaviour such as following directions, paying attention, problem solving, and finishing tasks in relation to a successful school transition. Many teachers who participated in the current study also regarded these types of behaviour as very important or essential (e.g., *paying attention*, 61%; *problem-solving*, 85%; and *following direction*, 78%); Montessori and Reggio Emilia teachers in particular showed higher expectations that children should develop these skills compared to play-based teachers. Whether teachers actually categorise these behaviours as the CF aspect of EF or not, individual differences in preference and perceived acceptability for certain behaviours might have shaped how differently Montessori and Reggio Emilia teachers saw their students compared to BCELF teachers and, thus, rated children in their classrooms lower on measures of CF.

As for indirect measures of social-emotional skills (SEARS), although parents in all school types rated that their children improved to some degree, parents in both Montessori and Reggio Emilia schools described their children as showing significantly fewer improvements in social competence than did parents in BCELF schools. Parents in Montessori schools also described their children as showing significantly fewer improvements in empathy than did parents in BCELF schools. The pattern of significant group differences may reflect varying parental expectations. As reflected in the demographic questionnaire, Montessori parents in the current study indeed showed the highest expectations for social skills. Consequently, parental preference and acceptability for certain behaviours might have influenced responses, particularly for the Montessori parents. The significant group difference can also be attributed to a true variation of children's behaviour at home and school (Kerr et al., 2007). In fact, problematic behaviours such as aggression or rule-breaking are more likely to be identified by parents than teachers (Rettew et al., 2011). The current study also found low concurrent correlations between teachers and parents on a total score of social-emotional skills (r = -.04, r = .10 for T1 and T2 respectively) (Appendix J). Therefore, the significant group differences in parent-rated social-emotional skills might not be a reflection of a programme effect but rather a varying parental view for desired social-emotional behaviours.

On the contrary, although teachers in all school types rated that their children improved to some degree, no aspects of teacher-rated social-emotional skills showed any group difference in change despite teachers in the three programme types expressing significantly different expectations for children's social skills. One explanation is that children in all the programme types were already rated as showing higher levels of social-emotional skills to begin with such that the margin of improvement that teachers perceived might have been limited. An alternative explanation is that none of the programme types may be notably more beneficial to greater development of social-emotional skills. Although this possibility cannot be systematically tested further because only internal ratings were employed in the current study, existing research (e.g., Preschool Curriculum Evaluation Research Consortium, 2008; Sammons et al., 2008; Weiland & Yoshikawa, 2013) has also shown mixed results for the effectiveness of early childhood education programmes in promoting children's social-emotional skills.

6.3 The contribution of classroom process quality

Findings showed that children in classrooms with higher levels of Classroom Organisation where teachers enforced behavioural expectations consistently and clearly, managed instructional time and routines effectively, and provided more stimulating materials were more likely to make significantly greater gains in numeracy skills. This is consistent with the findings of a study by Downer et al. (2012), which demonstrated that higher levels of Classroom Organisation predicated gains in mathematics amongst pre-K children. As classroom activities require children to be engaged in order for learning to occur, effective classroom management is crucial to provide children with opportunities to be involved in these activities with focused attention and also to prevent disruptive behaviour that can interfere with learning (Emmer & Stough, 2001). In particular, the use of manipulative materials has been shown to be effective in mathematical learning for young children (Saracho & Spodek, 2009). As such, it is plausible to think that children in classrooms where teachers prepare a variety of materials and activities to effectively maximise children's engagement and learning are more likely to develop numeracy skills.

Surprisingly, children who experienced higher levels of all three CLASS domains were rated by teachers as exhibiting lower CF. As classrooms often experience an unexpected event or problem, the ability to respond to a new situation flexibly and adapt one's behaviour to changes is essential for a smoother classroom operation and learning (Huizinga, Smidts, & Ridderinkhof, 2014; Vitiello, Greenfield, Munis, & George, 2011). As a result, it is possible that teachers who offer more emotional, organisational, and instructional support hold higher expectations for cognitive and behavioural flexibility of their children in classrooms and, thus, regard children as lower on CF measures.

Emotional Support was not associated with most of the outcome measures. That is, children in classrooms where teachers had positive emotional connections with their children, provided support to emotional and cognitive needs of children, and emphasised children's interests and motivation were not more likely to develop school readiness skills than children who experienced less Emotional Support from their teachers. This is inconsistent with other studies, which demonstrated that higher quality Emotional Support predicted gains in academic competence (Burchinal et al., 2010) and social skills (Burchinal et al., 2010; Mashburn et al., 2008). It may be that the lack of associations between Emotional Support and outcome measures is the result of relatively little variation in this domain across different classrooms. The average score for the Emotional Support domain was 5.89 with a small standard deviation of .54. Other studies (e.g., Burchinal et al., 2010; Mashburn et al., 2008; LoCassale-Crouch et al., 2007) also point out that although there are individual differences amongst different programmes most early childhood education settings generally offer overall high levels of Emotional Support that reduces variability in programme quality, thereby attenuating prediction of this domain to children's development.

Similar to the lack of predictive power of Emotional Support reported in the current study, Instructional Support was not associated with most of the outcome gains either. This is inconsistent with other studies that demonstrated the role of Instructional Support in facilitating school readiness skills, particularly academic achievement including vocabulary and mathematics (e.g., Downer et al., 2012; Mashburn et al., 2008). The lack of associations between Instructional Support and outcome measures might be due to limited provision of this domain across participating schools. Research that has systematically tested for threshold effects of the CLASS scores (e.g., Burchinal et al., 2010; Curby et al., 2009) indicates that minimum levels of quality interactions are required in order for children to experience sufficient learning gains. For example, it is suggested that a minimum score of 5 (Burchinal et al., 2010), which is at the high end of the mid-range, is the quality cut-off for both Emotional Support and Classroom Organisation to promote children's development, whereas a cut-off quality score of 3 (Curby et al., 2009) or 3.25 (Burchinal et al., 2010), which is at the high end of the low range, is the minimal standard for Instructional Support to produce more academic gains. Although all the participating schools met the minimal standards for Emotional Support and Classroom Organisation, the average score for Instructional Support did not reach a threshold of 3, thus making little contribution to the development of children's school readiness skills.

6.4 EF and pre-academic competence

Direct measures of EF and pre-academic competence. All three aspects of performance-based EF predicted significant gains in numeracy skills. This finding is consistent with prior work involving first grade children in which core constructs of EF were significantly associated with mathematical ability (e.g., Bull et al., 2008). While much research asserts that inhibitory control (IC) and/or working memory (WM) are stronger predictors of academic ability than CF (e.g., Blair & Razza, 2007; Espy et al., 2004; Monette et al., 2011), evidence for the relation of CF to mathematical achievement is still inconclusive (e.g., Clements, Sarama, & Germeroth, 2015). The finding reported here that all three aspects of EF similarly accounted for change in numeracy scores provides further indication of the salience of CF for the development of emergent numeracy skills. From the standpoint of what is required for solving mathematics problems, the role of EF is apparent in a way that enables children to maintain information, to consciously inhibit certain procedures or irrelevant information, and to shift attention appropriately to the most relevant aspect of a given problem (Blair & Razza, 2007; Bull & Scerif, 2001). Bidirectional associations were also found between initial numeracy skills and EF, particularly WM and CF, but not IC. The general trend for reciprocal associations reported here is consistent with other studies (e.g., Fuhs et al., 2014; Welsh et al., 2010) in which early numeracy skills in pre-K predicted later EF, as well as the reverse. Given growing evidence of a close association between EF and the development of mathematics ability (Bull & Scerif, 2001; Friso-van den Bos, van der Ven, Kroesbergen, van Luit, 2013), it is possible that the growth of these skills might be an interactive process. Numeracy activities or related activities taking place in classrooms may require WM and CF, such as the ability to hold relevant information while shifting attention effectively between given tasks (Blair, Gamson, Thorne, & Baker, 2005), potentially contributing to children internalising these executive functioning skills. There was a unidirectional association between IC and numeracy skills in which IC predicted later numeracy skills, but the reverse path was not significant. This result might be explained by the small sample size in the current study given that the standardised coefficient for the inverse path (early numeracy skills predicting later IC) was .19, which was similar to the significant coefficients of .20 for the same inverse path in the findings of Welsh et al. (2010). However, the study by Welsh et al. utilised the unitary view of EF as opposed to the componential view such that a domain-specific association warrants further research.

No aspects of directly assessed EF accounted for unique variance in vocabulary development. The results in the current study failed to support the role of EF for greater vocabulary gains despite considerable evidence to suggest that EF skills underpin the development of language skills (e.g., Hongwanishkul, Happaney, Lee, & Zelazo, 2005; Rojas-Barahona, Förster, Moreno-Ríos, & McClelland, 2015; White, Alexander, & Greenfield, 2017). Similar to mathematics performance, it is clear that EF skills such as information processing, attention control, and working memory would be important for understanding and acquiring new words (Marchman & Fernald, 2008; White et al., 2017) as evidenced by the significant concurrent and longitudinal correlations between all three aspects of EF and vocabulary performance in the current study. The result that EF did not account for unique variance of vocabulary could be due to the fact that oral language is extensively emphasised in all three preschool types in the current study such that vocabulary may become more automatised and may not require high degrees of executive functioning skills. While no aspects of EF predicted later pre-academic competence, vocabulary made a unique, unidirectional contribution to the growth of WM. Fuhs and Day (2011) also found a significant contribution of verbal ability (both expressive and receptive vocabulary) to longitudinal EF change during preschool, but the inverse path between EF and verbal ability was not significant. It is possible that advanced vocabulary helps children form mental representations of goals and process information more effectively such that these children are more readily engaging in regulating their cognitive functioning (Slot & von Suchodoletz, 2018; Zakin, 2007).

Indirect measures of EF and pre-academic competence. Findings showed unidirectional relations between EF ratings and pre-academic competence, but in the opposite direction depending on the respondents. While no aspects of initial parent-rated EF predicated gains in pre-academic competence, numeracy skills predicted gains in parent-rated IC and WM, and initial vocabulary also marginally predicated gains in parent-rated IC. This unidirectional association between parent-rated EF and pre-academic competence is consistent with a study by Petersen et al. (2013) in which language ability predicted gains in mother-report of EF-related behaviour such as inattention and impulsivity more strongly than mother report of EF-related behaviour predicted gains in language ability. It is possible that children with higher numeracy skills might exhibit more advanced problem solving skills and flexibility in behaviour (Schoenfeld, 2009), thus being perceived as more self-regulated. Similarly, children with better vocabulary may be more effective at internalising regulatory mechanisms by using private speech, which can then elicit more positive responses from parents (Petersen et al., 2013). On the other hand, the opposite directionality was found between teacher-rated EF and pre-academic competence. All three aspects of teacher-rated EF predicted gains in vocabulary, but no initial pre-academic competence predicted gains in teacher-rated EF. Advanced EF has been shown to be critical for promoting literacy skills (e.g., Bull et al., 2008; Monette et al., 2011). Stipek, Newton, and Chudgar (2010) also found that teacher-rated self-regulatory behaviour of primary school children predicted gains in reading skills more strongly than reading skills predicted gains in teacher-rated self-regulatory behaviour. As everyday classroom learning activities require high cognitive and behavioural control, it is plausible to think that children who can control impulses and retain relevant information and who are flexible in thinking might be more likely to engage in effective learning.

Performance-based EF and rating measures of EF, especially parent ratings, in the current study showed a different directionality of associations; both teacher-rated and performance-based EF predicted later academic achievement, but parent-rated EF was not associated with later academic achievement. This is consistent with a meta-analysis of 13 studies by Toplak et al. (2013) that compared parent-ratings of the BRIEF-P and performance-based tasks and found that only 19% of the reported correlations were statistically significant. This indicates that performance-based and rating measures of EF, especially parent ratings, assess different underlying constructs. That is, ratings appear to measure the behavioural component of EF, while the performance-based tasks might assess the cognitive processes (Ten Eycke & Dewey 2016; Toplak et al., 2013). This may also explain why performance-based measures and ratings of EF showed a domain-specific association with academic achievement. For example, performance-based EF was associated with numeracy skills and teacher-rated EF was associated with vocabulary. It is possible that vocabulary is more observable than numeracy skills in classroom behaviour thus is more strongly associated with rating measures of EF that target a pattern of behaviour in real life settings. In contrast, mathematical proficiency requires cognitive domain skills such as the ability to represent or process information (Blair & Razza, 2007). Therefore, it is likely that performance-based EF that taps into the cognitive processes is more strongly associated with mathematics achievement.

6.5 Social-emotional skills and pre-academic competence

Children with higher initial levels of both parent and teacher ratings of empathy showed greater improvements in numeracy skills. This is consistent with other studies (e.g., Caprara et al., 2000; Malecki & Elliott, 2002; Warden & Mackinnon, 2003) in which children's prosocial behaviour, as reflected in empathetic understanding and cooperation, was significantly associated with academic learning. Since early mathematics learning involves processing auditory and visual cues (Aunola, Leskinen, Lerkkanen, & Nurmi, 2004), it is possible that the prosocial children are more likely to effectively interact with their parents and teachers to gain information necessary for learning and seek help to complete a task. Although numeracy skills did not reciprocally influence gains in parent-rated empathy, a bidirectional relation was found between numeracy skills and teacher-rated empathy, indicating that these two domains might be contributing to development of one another. The finding is consistent with the ecological model that views skill development as an interactive and co-active process (Bronfenbrenner & Morris, 2006). It is possible that highly empathetic children with the advanced ability to infer mental states can access relevant information and knowledge more effectively, which in turn helps them reason mathematically, leading to the development of numeracy skills (Cavadel & Frye, 2017; Freeman, Antonucci, & Lewis, 2000). Likewise, children with higher mathematical ability might have advanced mental state understanding, which in turn allows them to engage in perspective-taking and associated empathetic behaviour (Freeman et al., 2000).

Surprisingly, higher initial levels of teacher-rated responsibility predicted a significant decrease in vocabulary. This stands in contrast to other studies (e.g., Wentzel, 1991b, 1993) in which children who were more socially responsible demonstrated better academic ability. One possible explanation is that teachers may alter their interactional styles depending on children's behavioural displays. For example, existing research (e.g., Dobbs, Arnold, & Doctoroff, 2004) indicates that teachers tend to pay more negative attention to misbehaving children and that these children are more likely to receive more commands from teachers even when they are not acting up. As such, it is plausible to think that the teachers in the current study may have paid more attention to children who were perceived to be less responsible, affecting the amount of possible verbal interactions for vocabulary development. In contrast, vocabulary made a positive contribution to gains in teacher-rated responsibility. Previous studies (e.g., St Clair et al., 2011; Yew & O'Kearney, 2013) also demonstrated a link between language difficulty and later behaviour problems, indicating that children's levels of language ability influence behavioural development. One explanation is that vocabulary skills may be important for understanding social cues (Keenan & Shaw, 1997) and effective communications (Petersen et al., 2013). It is possible that more advanced vocabulary allows children to build positive relationships, which in turn further encourage them to engage in socially responsible behaviour (McCabe & Meller, 2004). In addition to vocabulary, numeracy skills also made a positive unidirectional contribution to gains in teacher-rated responsibility, indicating that higher mathematical understanding may elicit responsible behaviour. Higher mathematical ability appears to be closely linked to mental representation (Freeman et al., 2000) such that children with advanced mathematical skills might understand social information and rules more effectively and thus act responsibly.

No associations were found between both parent and teacher ratings of the social competence subset (e.g., agreeableness) and any aspects of pre-academic competence. The lack of reciprocal associations between these two domains stands in contrast to a study by Welsh et al. (2001) in which social and academic skills were reciprocally related to each other throughout early primary school years, although academic competence was a more consistent predictor over social competence. A meta-analysis study by Poropat (2014) also suggested that more agreeable children ages 5-11 tended to show better teacher-rated academic performance. It is intuitive to think that socially desirable characteristics such as agreeableness are linked to academic performance because more agreeable children may get more positive attention from teachers (Poropat, 2009); however, the Poropat study only included teacher-ratings of academic performance such that the association between children's agreeableness and performance-based academic achievement was unknown. In addition, Major, Turner, and Fletcher (2006) examined the relationship between agreeableness and learning motivation and found them to be uncorrelated. It is possible that displaying socially desirable behaviour such as agreeableness does not necessarily guarantee increased learning motivation and associated academic outcomes.

6.6 Parent and teacher agreement

Differences in predictive power of parents and teacher ratings on pre-academic competence were evident in which teacher ratings, especially EF, were more consistent and stronger predictors than parent-ratings of the same child. Other studies also reported discrepancies between parent and teacher ratings in which teacher ratings made a stronger contribution to the prediction of learning outcomes than parent ratings. For example, Blair and Razza (2007) found that preschool teacher-rated IC was moderately associated with letter knowledge and mathematics ability in kindergarten, but parent-rated IC was not associated with later academic achievement. In a similar vein, Dekker, Ziermans, Spruijt, and Swaab (2017) examined the unique influence of parent and teacher ratings of EF (BRIEF-P) on school achievement in first and second graders and found a similar pattern of associations. Their results showed that teacher-rated WM and CF explained unique variance in spelling achievement, whereas none of the parent ratings accounted for unique variance in academic achievement.

The discordance between parent and teacher ratings might be due to several reasons. Firstly, parents and teachers might have different views on children's behaviour. For example, parents in the current study reported that their children showed overall improvement in EF behaviour over time, whereas teachers reported that children decreased in EF behaviour. The correlations between parent and teacher ratings of EF and social-emotional skills were also generally low and non-significant (r from .06 to .28 for BRIEF-P; r from .04 to .21 for SEARS) (Appendix J). It is possible that parent and teacher ratings are predicated on their varying expectations and previous experiences. (De Los Reyes & Kazdin, 2005). The current study indeed demonstrated that teachers and parents held different expectations for children's academic and social functioning (Table B-3). Secondly, it may be that teachers view children's behaviour differently than parents because teachers not only have more reference points in their classrooms (Zeiner, 1997) but they might also be more aware of developmental changes and age-appropriate behaviour of children due to continuous educational training (Dinnebeil et al., 2013; de Nijs et al., 2004). It is not surprising that the teacher ratings were stronger predictors of children's pre-academic competence given that teachers play a major role in providing children with learning-related and observe children's behaviour more closely in the contexts of learning. Finally, a discrepancy between parent and teacher ratings might reflect true variations of child behaviour and social manifestations between home and school as differences in situational demands, environmental structure, and relational capacity across settings may have elicit different behaviour in one setting or another (Rettew et al., 2011).

6.7 EF and social-emotional skills

Support for a unidirectional relation emerged between both direct and indirect measures of EF and social-emotional skills in which levels of EF predicated gains in social-emotional skills, but the opposite directionality between social-emotional skills and EF was not significant except for the path between parent-rated responsibility and a direct measure of CF. Examining the individual components of EF and social-emotional skills separately, more domain-specific unidirectional associations were identified. For the associations between direct measures of EF and teacher-rated social-emotional skills, all three aspects of EF predicted larger gains in teacher-rated responsibility. Both WM and CF also predicted greater gains in teacher-rated empathy. Other studies further examined the role of core components of EF in supporting social performance. For example, it has been shown that children with better IC are more likely to be socially competent and display more prosocial behaviour (Hughes et al., 2000; Rhoades et al., 2009). Likewise, deficits in IC have also been linked to non-cooperative behaviour and aggression (Ciairano, Visu-Petra, & Settanni, 2007; Olson, Schilling, & Bates, 1999). As inhibition is the ability to control dominant responses and coordinate thoughts and actions towards goals, it is more likely that children with advanced IC are better able to control impulses in social situations thus select a more productive and responsible solution that allows them to attain their social goals (Rhoades et al., 2009; St Clair-Thompson & Gathercole, 2006). Similarly, research supports the role of WM in multiple aspects of social functioning including social acceptance and conduct (Kofler et al., 2011; McQuade, Murray-Close, Shoulberg, & Hoza, 2013). WM is the ability to manage goal-oriented representations actively in mind, access to goal-related information especially when there is interference, and choose an appropriate behavioural expression accordingly (Barrett, Tugade, & Engle, 2004). It is possible that children with higher WM are able to continuously keep social goals in mind, pay attention to collective social information, and generate more appropriate behavioural responses in order to navigate social situations more effectively (McQuade et al., 2013). In addition, children with higher CF have been found to engage in more cooperative behaviour during peer interaction (Ciairano, Bonino & Micheli, 2006). CF is the ability to shift attention and switch between mental sets (Garon et al., 2008; Miyake et al., 2000) such that children with higher CF might be able to modify behaviour and adapt to changing social circumstances more effectively (Eslinger & Grattan, 1993).

There was a unidirectional association between parent-rated responsibility and directly assessed CF, indicating that children who were perceived to be more responsible by parents made larger gains in CF. It may be that children who are perceived to be dependable tend to pay more attention and think before they act, thus performing better at the CF tasks. However, no other associations were detected between direct measures of EF and parent ratings of social-emotional skills, and teacher-rated responsibility did not show the same pattern of association. As such, the unidirectional association between parent-rated responsibility and directly measured CF reported here might be limited to the parents in the current sample.

For the rating measures, the associations between teacher-rated EF and social-emotional skills showed a similar directionality: both teacher-rated early IC and WM predicted gains in teacher-rated empathy and responsibility. In other words, teachers perceived children who could control impulses and were more focused at the beginning of the school year as making more progress in empathy and responsible behaviour. This is similar to a study by Araujo Jiménez, Jané-Ballabriga, Bonillo Martin, and Capdevilla i Brophy (2014) in which lower teacher-rated WM of BRIEF-P was associated with inattention and lower IC was associated with both oppositional defiant disorder (ODD) and conduct disorder (CD). CD is characterised by aggressive and disruptive behaviour, and ODD is characterised by disobedience (Rowe, Costello, Angold, Copeland, & Maughan, 2011). As a result, it makes sense that deficits in IC, which signify a lack of self-control or awareness, predicted perceived problem behaviour. Given an established link between behavioural regulation and social dysfunction, it is possible that children who are perceived to be having trouble concentrating on activities and more disruptive in classrooms may experience more negative interactions with their teachers and peers, which in turn interferes the development of empathetic and responsible behaviour.

For parent ratings of EF, initial levels of IC and CF predicted gains in parent-rated responsibility and social competence; parents perceived children who could control impulses and transition flexibly at the beginning of the school year as making more progress in social competence and responsible behaviour. Araujo Jiménez et al. (2014) also found that higher parent-rated IC was associated with lower CD and that higher CF was associated with lower ODD. As conduct problems are linked to parenting difficulty (Johnson & Jassy, 2007), it is possible that parents may give more coercive responses to children who they perceive as lacking self-control and behavioural flexibility. This, in turn, not only diminishes the opportunity to develop socially appropriate behaviour, but also increases children's frustration and negative behaviour.

Overall, a unidirectional association was found between EF and social-emotional skills. In other words, children with higher initial EF skills made larger gains in perceived social-emotional skills during the preschool year. On the contrary, children with higher initial social-emotional skills did not tend to make larger gains in EF skills over the same time period. This is consistent with other studies in which preschool children with higher EF skills were more likely to exhibit less concurrent and long-term negative social behaviour (Hughes, Cutting, & Dunn, 2001; Hughes et al., 2000), lending support to the position that views EF as a precursor to social-emotional development. As Russell (1996) proposed, it is possible that the ability to consider mental states of others and act upon them socially may rely on EF skills. Higher EF skills may allow children to process their thoughts and emotions more effectively, which in turn helps generate affective responses to social situations and encourages more socially appropriate conduct (Jacobson, Williford, & Pianta, 2011).

6.8 The contribution of relationship quality

Relationship quality and direct measures of EF. No significant associations were found between both teacher-child/parent-child relationship quality and directly measured EF in either direction. In other words, initial relationship quality made no difference in later EF. Likewise, children's initial levels of EF made no difference in later relationship quality. This is inconsistent with a study by Berry (2012), which found bidirectional associations between directly measured IC and teacher-rated relationship quality. That is, lower levels of IC of kindergarten children were associated with higher subsequent levels of teacher-child conflict, and higher levels of teacher-child conflict in kindergarten were reciprocally associated with lower subsequent levels of IC. The lack of significant associations reported in the current study could be due to the small sample size. For example, the standardised coefficient between IC and teacher-child conflict was .12 in the current study, which was larger than the significant coefficients in the Berry's study (.07), suggesting that the small sample size may have contributed to the non-significant effects.

Relationship quality and indirect measure of EF. A unidirectional association was found between indirect measures of EF and relationship quality, particularly conflict. That is, lower levels of both parent-and teacher-rated EF predicted significant gains in conflict, but relational conflict did not predict change in EF ratings. Specifically, children with lower parent-rated IC and CF significantly increased conflict with their parents. Similarly, children with lower teacher-rated IC, WM, and CF significantly increased conflict with their teachers. The effect was particularly large for children who were perceived to have lower teacher-rated WM. Put differently, both parents and teachers tended to develop more negative relationships with their children who were viewed as more impulsive (IC) and less adaptable (CF). Teachers were particularly more likely to increase negative interactions with their children who were perceived to have difficulty staying on and completing tasks (WM). Other studies also found that children who exhibited higher levels of inattention and impulsivity experienced increased conflict with their parents and teachers (e.g., Johnson & Jassy, 2007;

Portilla, Ballard, Adler, Boyce, & Obradović, 2014). Given substantive evidence that shows a powerful link between EF and behavioural and attentional problems (e.g., Riggs et al., 2006; Shoemaker et al., 2013; Willcutt et al., 2005), it is possible that children who are perceived to have lower levels of EF are more likely to engage in disruptive behaviours and require more attention and reminders. This may subsequently increase negative interactions and lead to more conflictual relationships with parents and teachers (Myers & Pianta, 2008; Rudasill & Rimm-Kaufman, 2009).

While children's perceived EF was a clear predictor of more conflictual exchanges, the relationship quality reported by both teachers and parents did not contribute to significant changes in EF, suggesting a stronger influence of child behaviour on relationship quality than vice versa. This is inconsistent with previous studies (e.g., Pianta & Stuhlman, 2004; Merz, Landry, Montroy, & Williams, 2017), which demonstrated the role of relationship quality in subsequent EF-related behaviour. One possible explanation is that relationship quality was reported during the preschool year when children were still quite young. Children exhibit rapid growth in behavioural regulation during the preschool years (Kochanska, Coy, & Murray, 2001). It may be that the nature of relationship quality changes as children get older and mature more behaviourally, and perceived relationship quality with slightly older children might be able to better predict behavioural outcomes. As an example, Pianta and Stuhlman (2004) reported that both teacher-reported conflict and closeness in preschool did not predict later self-regulatory behaviour problems, but teacher-reported conflict in kindergarten predicted self-regulatory behaviour problems in first grade. In addition, reciprocal associations might emerge later on. For example, Doumen et al. (2008) demonstrated reciprocal influences between teacher-child conflict and child behavioural problems over time; child aggressive behaviour in kindergarten led to increases in teacher-child conflict, which in turn led to exacerbated behaviour problems by the end of the year. Therefore, it is possible that how teachers and parents perceive child behaviour initially might be a strong determinant of the ways they interact with their children, especially when they are young, but child-adult relationships might change and have a more substantial impact as children get older.

Relationship quality and social-emotional skills. For parent ratings, there were unidirectional associations in which higher initial levels of parent-child closeness predicted significant gains in parent-rated social competence and responsibility, but parent-rated initial social-emotional skills did not predict later relational closeness. This strong influence of positive parent-child relationships is consistent with other studies (e.g., Connell & Prinz, 2002; Parker et al., 1999), which demonstrated that responsive parent-child interactions were positively associated with the development of social skills. As a positive parent-child relationship is characterised by high levels of parental support and sensitivity, it may be that children who experience closeness with their parents value positive interactions with others, thereby engaging in more prosocial behaviour that allows them to build trusting relationships (Bowlby, 1982).

Parent-child conflict and social-emotional skills showed more domain-specific, unidirectional associations. For example, higher levels of parent-child conflict predicted a significant decrease in parent-rated responsibility, but parent-rated responsibility did not predict later relational conflict. As relational conflict tends to increase children's physiological stress (Lisbonee, Mize, Payne, & Granger, 2008), it is possible that emotionally negative exchanges with their parents might increase children's stress levels and interfere with the development of socially responsible behaviour. The lack of associations between parent-rated responsibility and parent-child conflict might be explained by parental views or expectations on certain behaviour. As demonstrated earlier, parent-rated responsibility was not associated with any aspects of parent-rated EF, indicating that parents did not view children with lower levels of responsibility as exhibiting EF-related behaviour problems. Therefore, it may be that parental perceptions on whether children can be trusted or not might not be important to relational quality. In contrast, lower levels of parent-rated social competence predicted a significant increase in parent-child conflict while the inverse path was not significant. One possible explanation is that the social competence subset of the SEARS taps into shyness (e.g., 'My child is comfortable talking to many different people.'). As research demonstrates a link between child shyness and less positive parenting (e.g., Dumas, LaFreniere, & Serketich, 1995; Rubin, Nelson, Hastings, & Asendorpf, 1999), it is possible that a perceived lack of social competence may trigger parents to exert more insensitive responses (Putnam, Sanson, & Rothbart, 2002), which can lead to more negative parent-child interactions.

There was a bidirectional association between parent-child conflict and parent-rated empathy. In other words, children beginning with higher levels of parent-child conflict tended to undergo a significant decrease in empathy and children who were perceived to be less empathetic tended to experience more conflict with their parents. It could be that children who experience more conflictual interactions with their parents generate an expectation of negative affectivity in relationships and are less likely to develop prosocial behaviour (Clark & Ladd, 2000). It has also been shown that a lack of empathy is linked to parent-rated problem behaviour including aggression (e.g., Eisenberg et al., 1996; Murphy, Shepard, Eisenberg, Fabes, & Guthrie, 1999). Therefore, it is possible that children with lower levels of empathy might exhibit more aggressive behaviour, which then leads to more negative interactions with their parents.

Similar to parent ratings, there was a unidirectional association between teacher-child closeness and social competence in which higher levels of teacher-child closeness predicted significant gains in teacher-rated social competence. Birch and Ladd (1997) also found that kindergarten teachers' perceptions of relationship closeness with students were significant predictors of gains in prosocial behaviour in first grade. It could be that children who experience warm interactions with their teachers develop an expectation of positivity in relationships, which in turn helps them to be more receptive to socialisation with others (Clark & Ladd, 2000).

Support for a unidirectional relation also emerged between relational conflict and teacher-rated empathy in which higher levels of teacher-child conflict predicted a significant decrease in empathy, but teacher-rated empathy did not predict later relational conflict. Pianta and Stuhlman (2004) also found that teacher-child conflict in kindergarten predicted a significant decrease in teacher-rated social skills including empathy in first grade. Similar to the parent-child relationship, conflictual exchanges with teachers may also increase stress levels of children (Berry, 2012), which may diminish the development of empathetic understanding and associated prosocial behaviour.

While teachers' perceptions of children's empathy did not affect relational conflict later, their initial views on children's dependability appeared to predict later relational conflict. In other words, children who were perceived to be less responsible tended to experience more conflictual relationships with their teachers. As children are required to follow social rules and expectations in order to participate in various classroom activities (Wentzel, 1991b), it is plausible to think that teachers have high expectations for children to behave responsibly. In addition, teachers tend to regard children who have difficulties adhering to classroom norms (e.g., obedience) or expectations (e.g., paying attention) as irresponsible (Sun & Shek, 2011) and more stressful to teach (Greene, Beszterczey, Katzenstein, Park, & Goring, 2002). Therefore, teachers may pay more negative attention to children who are perceived to be less dependable, which in turn can generate more negative interactions between them.

Relationship quality and pre-academic competence. For parent ratings, support for a unidirectional association emerged in which lower levels of numeracy skills predicated a significant increase in parent-child closeness. This is inconsistent with other studies (e.g., Pianta et al., 1997; Morrison, Rimm-Kauffman, & Pianta, 2003), which demonstrated that the quality of early mother-child relationships had significance for predicting children's later academic outcomes including language and mathematics. Given a strong link between mathematics ability and positive behavioural display, the negative association between numeracy skills and parent-child closeness reported here is surprising. It may be that parents might lend more support to children with lower numeracy skills than children with advanced numeracy skills, which in turn provides more opportunities to build a close parent-child relationship. For teacher ratings, the opposite directionality was found between relationship quality and academic skills in which higher levels of conflict predicted a significant increase in vocabulary. This is counter-intuitive and stands in contrast with other studies (e.g., Birch & Ladd, 1997; Hamre & Pianta, 2001) in which relational negativity characterised by discord and frustration was linked to lower academic achievement. As conflictual exchanges between teachers and children have been also shown to be associated with children's poor self-direction and lack of liking for school (Birch & Ladd, 1997), it is possible that teachers might interact with these children who are perceived to be challenging more frequently, naturally increasing opportunities for more verbal interactions.

6.9 Theoretical implications

The current study employed both Bronfenbrenner's bioecological theory and the Contextual Systems Model (CSM) which emphasise the interactive nature of child development within multiple nested systems including child, family, and school. The CSM, in particular, provides a schooling framework that focuses on not only relations within the child, family, classroom and school, but also centralises the impact of relational quality within and between each system for optimal development of children. Informed by the bioecological-contextual framework, the current study included four major components of the PPCT model (Process-Person-Context-Time). For example, in order to understand a complex developmental process of school readiness skills, child characteristics such as age, fluid intelligence, and school readiness skills (Person) and relationship quality in both home and school environments (Context) were measured, and how a set of these contextual factors within school and family systems were associated to one another (Process) across two time points (Time) were also examined.

The findings in the current study support a central tenet of the bioecological-contextual framework in the sense that there was a trend for bidirectional associations between school readiness skills and contextual factors over time: 1) both school-entry EF and social-emotional skills predicted changes in pre-academic competence while school-entry pre-academic competence reciprocally predicted changes in both EF and social-emotional skills; and 2) relationship quality in both home and school environments predicted changes in social-emotional skills and pre-academic competence while school-entry EF, social-emotional skills, and pre-academic competence also predicated changes in teacher-child/parent-child relationship quality. These findings highlight that skill development is gradual and a by-product of on-going interactions between a child and a number of factors within nested systems, thus emphasising the importance of interconnectedness across elements in various systems. Consequently, school readiness skills are unlikely to be promoted when focusing narrowly on a function of one organism in isolation (Pianta & Welsh, 1996). Educational implications of these findings are discussed further in the subsequent section.

6.10 Educational implications

The results of this study have several educational implications in relation to contextual factors: curriculum, classroom quality, school readiness skills, and relational quality.
1) *Curriculum.* Montessori education appears to elevate children's numeracy skills. Although it is unclear what specific aspects of the Montessori curriculum promotes the development of numeracy skills, it is plausible to think that the extensive and repetitive use of manipulative mathematic materials with explicit instructions in Montessori classrooms helps children learn mathematical concepts more effectively. Since school-entry mathematical skills have been shown to predict later achievement more strongly than language, attention, and social skills (Duncan et al., 2007), other early childhood education

programmes can potentially incorporate purposeful manipulative materials into their learning activities so that they can facilitate children's numeracy skills.

2) *Classroom quality*. Findings demonstrated the role of high levels of Classroom Organisation in uniquely predicting numeracy skills. Put differently, when teachers are efficient in organising classroom activity and time while also managing children's attention and behaviour, classrooms run more smoothly with fewer disruptions, and it is likely that children are readier to engage in learning tasks. While early childhood teachers generally appear to be effective in providing emotional warmth and support (Burchinal et al., 2010; LoCasale-Crouch et al., 2007), better classroom management skills might depend on teachers' experience levels and training (Ritter & Hancock, 2007). As such, it will be useful to provide teachers, especially preservice or newly trained individuals, with professional development or training that targets effective classroom management strategies including implementing routines and establishing clearly defined parameters of acceptable behaviour in classrooms so that they can prepare a better platform for children to learn.

Although all three programme types consistently provided high-quality emotional and organisational support, a lack of quality instruction was evident across all classrooms. Research demonstrates that children benefit cognitively from being in classrooms where teachers encourage them to think about the how and why of learning (e.g., Zohar & Dori, 2003); provide scaffolding and informative feedback in a way that helps children expand their understanding and behaviour (e.g., Hatti & Timperley, 2007); and stimulate active conversations and the use of advanced language (e.g., Wasik, Bond, & Hindman, 2006). As evidenced by the significant contribution of Classroom Organisation in promoting numeracy skills, the exclusive focus on academic instruction might be unnecessary and does not adequately reflect other contributions that teachers make to support children's learning (Hamre et al., 2014). However, given that early academic competence underpins later school achievement, it is critical that teachers are made aware of the importance of providing at least the minimum level of instructional quality and that there will be support for teachers so that they can continue to improve the quality of their interactions.

3) *School readiness skills.* Findings underscored the importance of school readiness skills and their dynamic associations. Overall, school-entry EF and social-emotional skills predicted the academic gains, and school-entry pre-academic competence reciprocally

predicted the development of EF and social-emotional skills, suggesting that there may be overlapping developmental processes. These bidirectional findings concur with the bioecological-contextual model that emphasises the interactive nature of skill development. Therefore, it is important that school systems and teachers not only understand the significance of school readiness skills but also provide appropriate support with the intention of jointly enhancing these distinct yet inter-related skills to ensure a smooth transition and later school success.

4) *Relationship quality*. Overall, findings suggest that relationship quality is a strong predictor of the development of social-emotional skills, while EF ratings are strong predictors of relationship quality. Thus to strengthen children's school readiness, especially social-emotional skills, it is evident that both teachers and parents can work to maintain and improve the quality of adult-child relationships while also being mindful of the ramifications of having conflictual exchanges with children. Conversely, while performance-based EF did not influence relational quality, adults' perceptions on child's behavioural manifestations of EF in daily life appear to have a significant impact on the way teachers and parents interact with their children. Therefore, it might be necessary that adults' perceptions are challenged and self-reflected so that their subjective judgment does not form certain adult behaviour toward children. In a school context in particular, research posits that teachers' deficit views on children's behaviour and ability directly lead to instructional styles and treatment of children (Cooper, 2003; Oakes & Lipton, 1999) and that the perceived relationships tend to persist (Howes, Phillipsen, & Peinsner-Feinberg, 2000). Teacher training or professional development could be offered to raise more awareness of the impact of teachers' judgment and resultant behaviour on children's school experiences and encourage teachers to engage in reflective practices so that they can be self-aware and sensitive to the needs of individual children with varying characteristics.

6.11 Strengths of the study

The current study has three major strengths: a comprehensive evaluation of curriculum effectiveness, richness of data, and the use of advanced statistical methods. Firstly, to the best of the researcher's knowledge this is the first quantitative study that evaluated and compared Montessori, Reggio Emilia, and traditional play-based programmes in relation to the development of school readiness skills over time. The current study extended prior work (e.g., Lillard, 2012; Lillard et al., 2017) by examining the quality of teacher-child interactions as well as the relationship quality in both home and school environments in addition to the development of children's school readiness skills.

Secondly, the current study collected a rich set of data that included the various factors within both family and school systems in the bioecological-contextual model. In other words, each concept of the Process-Person-Context-Time (PPCT) model was incorporated in the study: teacher-child relationships (Process), demand and resource characteristics of individual children (Person), classroom process quality (Context), and the longitudinal development of school readiness skills (Time). The inclusion of multiple covariates such as teacher and parental education, their academic and social expectations, and children's fluid intelligence beyond basic demographic features also contributed to reducing selection bias.

Finally, the current study utilised advanced statistical methods including CFA, testing for longitudinal measurement invariance, and SEM with latent variables. CFA allowed an objective test of the theoretical models and factorial validity for EF, social-emotional skills, and relationship quality. Testing for longitudinal measurement invariance further ensured that the underlying factors reflected the same construct and each measurement operated in the same manner over time. The greatest advantage of using the SEM with latent variables was the ability to examine relationships between contextual factors and the development of school readiness free of measurement error.

These more sophisticated statistical methods along with the rich set of data effectively helped reduce bias and allowed a valid comparison amongst the three school types when conducting a randomised control study was not feasible due to ethical and practical reasons.

6.12 Limitations and future research directions

Several limitations should be acknowledged: sampling, implementation fidelity, curriculum evaluations, length of the study, measurement, and statistical analyses.

1) *Sampling.* One of the key limitations of this study lies in sampling. The study had a small sample size in all three groups, with 48 Montessori, 42 Reggio Emilia, and 29 BCEFL children, potentially increasing a Type II error. In addition, all the families were middle-income and mostly Caucasian such that the outcome differences might be relevant only to this demographic group. Consequently, although there is a general challenge in recruiting families and schools into research, future studies should aim to include a larger number of participants to increase statistical power and representativeness. Another weakness is the lack of randomisation. Several analyses were conducted to mitigate this issue: the majority of non-Montessori parents favoured Montessori schools as their alternative choice; analyses showed no differences in parental income, education, or expectations across programme types; and pretest scores showed no differences except on fluid intelligence, and this was subsequently used as a covariate. Despite these efforts, the findings might be attributed to differences in school quality, teacher and parent characteristics, or other unobserved factors.

2) *Implementation fidelity.* Although all the Montessori schools in the current study met the criteria for an authentic implementation of Montessori education, the Reggio Emilia and BCEFL programmes were selected based on their self-nomination as well as the researcher's judgments on the physical and educational traits of respective classrooms. Therefore, curriculum fidelity was unknown. It is possible that potential variation in the levels of implementation may have contributed to the outcomes, although teachers in the Reggio Emilia schools repeatedly completed professional development on the Reggio Emilia's pedagogical approach and teachers in BCELF schools were trained to deliver a play-based programme. Developing and utilising precise measures of fidelity that highlight key elements of each curriculum is warranted to better understand levels of implementation and thus give more credibility to the outcomes of interest.

3) *Curriculum evaluations*. The current study measured children's outcomes with a specific focus on school readiness skills and evaluated the curriculum effectiveness on a comparative basis; however, research focusing on instantaneous child outcomes might not be intrinsic to early childhood educators, especially those who are working in the alternative school systems such as Montessori and Reggio Emilia (Edwards, 2002). The central focus of both approaches is not about children's school readiness; instead, it is about building a community where children develop into active, responsible citizens while keeping the development of the whole child in mind. At the same time, educational goals of these programmes essentially

differ at the micro level; Montessori education emphasises the importance of functional independence and self-directed actions, while the Reggio Emilia approach values shared learning and expressive autonomy. Therefore, the assessed skill sets may only cover a limited range of curriculum goals of each programme, and differences in educational expectations and values also pose a challenge to make a fair comparison across different programmes. In addition to school readiness skills, future studies can potentially assess more specific skills (e.g., independence, peer engagement, creativity) that reflect the educational goals of the respective programme.

4) *Length of the study*. All the data were collected at the beginning and end of one preschool year at approximately seven month intervals. Primarily, it was encouraging that all children made significant improvements in areas of directly assessed EF and academic competence during one preschool year regardless of curriculum. However, seven month intervals might not be sufficient for a real curriculum effect to emerge. For example, authentic Montessori education is normally a three-year programme that promotes cross-age tutoring and cumulative learning (Lillard, 2005). In a recent three-year longitudinal study, Lillard et al. (2017) found that by the end of the third year in preschools the Montessori children who were admitted through a randomised lottery system performed significantly better at academic achievement (e.g., a combined score of both literacy and numeracy skills), social understanding, and mastery orientation compared to non-Montessori children. The study by Biroli et al. (2017) on the long-term effectiveness of the Reggio Emilia approach also suggested that individuals who had attended Reggio Emilia schools were more likely to show a higher level of civic engagement including voting and volunteer participation when they became adults compared to non-Reggio individuals. Therefore, a longitudinal study is warranted in order to determine whether any observed improvements are due to the curriculum effect or maturation.

5) *Measurement*. Classroom process quality was measured using the Classroom Assessment Scoring System (CLASS). Although the CLASS is useful to measure many elements of teacher-child interactions, it cannot capture all aspects of interactions in classrooms (Hamre et al., 2013). For example, the CLASS predominately focuses on teachers' behaviour and does not measure peer interactions or interactions with materials. In classrooms where the guiding principle is one of child-centred learning such as Montessori, many learning activities occur through didactic materials without directly involving teachers; however,

within the CLASS framework, lack of teacher involvement is considered as low levels of interaction quality (Shimamura, 2014). As a result, the suitability of the CLASS measure in assessing the aspect of classroom interactions, especially instructional support in child-centred approaches can be questionable. Future studies can extend to develop supplementary scales that can assess more individualised interactions with learning materials and peers so that child behaviour is also included in the observation procedure.

Another measurement limitation is potential rater bias. The assessments of children's classroom-related EF behaviour and social-emotional skills in the current study relied on parent and teacher ratings. Although teachers and parents are valuable informants as they interact with children on a daily basis, ratings can be influenced by raters' characteristics, previous experiences, and expectations (Abikoff et al., 1993; Campbell et al., 2016). Consequently, associations between certain variables (e.g., teacher-rated EF and teacher-rated social-emotional skills) might be subjected to rater bias. In addition, all the ratings only provide a top-down picture in which the child's perspective is not included. It is possible that children's perceptions on certain variables such as relational and instructional quality might provide a different picture of their overall school experience.

6) Statistical analyses. Given a small cluster size and reasonably low ICC, the study did not employ multiple-level modelling. Multiple analyses were also run to investigate the sheer number of variables. For example, the CLASS is organised into three domains of classroom process quality within which there are 10 separate dimensions. Children were tested twice a year such that there were two sets of scores for each component of school readiness skills. As a result, the Type I error might have been elevated, leading to spurious statistically significant results (Hox, 2010). Although this remains a concern for credibility of the findings as one cannot know whether any significant outcomes are simply the results of random chance, it is important to note that the study found only limited significant effects, especially in relation to the curriculum and classroom quality effectiveness. If the Type I error was a serious issue, then the results would have found more significant effects, which was not the case in the current study.

6.13 Conclusion

Early childhood is a critical window of opportunity when children's potential can be maximised or diminished: maxmised by a supportive learning environment to discover and nurture their own strengths or diminished to a dependence on external contingencies. As a crucial period for forming a foundation, how to best prepare young children during preschool years has become an important issue in order to meet the academic and behavioural demands of formal schooling. There is strong evidence that children's success and failure, both within the classroom and beyond, may underlie an acquisition of school readiness skills. School readiness skills describe a set of competencies including EF, social-emotional skills, and pre-academic competence that allow children to control, plan, direct actions, empathise, and communicate in both academic and social contexts. Hence, children who enter formal schooling without these skills are at a significantly greater risk of developing academic and behavioural difficulties throughout school years. The seeming rise in the number of children arriving at school without school readiness skills suggests the important role that early childhood programmes can play in providing children with positive experiences, thus facilitating the development of these essential skills and consequently increasing opportunities for lifelong learning.

With the growing interest in early childhood education, progressive programmes such as Montessori education and the Reggio Emilia approach provide a strong alternative to a traditional play-based programme and offer a widely popular curricula choice for parents and many school systems. While high-quality early childhood curricula have potential for wide-ranging effects on healthy child development, research comparing the effectiveness of these programmes is rare, especially in the Canadian context. Substantial individual differences in school readiness skills also emerge amongst children due to various sources of influences embedded in the child, family, and classrooms. For example, the bioecological-contextual model suggests that relationship quality is central for children's social-emotional, behavioural, and cognitive development and that multiple factors including relational capacity and individual characteristics within multi-layered systems jointly affect this developmental process (Bronfenbrenner & Morris, 1998; Pianta & Walsh, 1996).
Hence, the purpose of the current study was to 1) determine the effectiveness of these preschool curricula (Montessori, Reggio Emilia, and BCELF programme) in Western Canada on the development of children's school readiness including EF, social-emotional skills, and

pre-academic competence; and 2) examine other sources of influences in the child, family and school in relation to the development of these school readiness skills. Firstly, the findings highlighted that although Montessori education appeared to be the most effective in facilitating numeracy skills, no curriculum stood out as notably more effective than any of the others at improving other areas of school readiness skills. In fact, all children made significant advances in school readiness skills, especially performance-based EF and pre-academic competence, irrespective of programme types. Secondly, well-run classrooms where teachers were effective in time, behavioural, and attention management were most effective in promoting children's numeracy skills. Thirdly, as the bioecological-contextual framework suggested, school readiness skills (e.g., EF, social-emotional skills, and pre-academic competence) exhibited an overlapping developmental process over time. Fourthly, perceived relational quality in both home and school environments significantly affected the development of school readiness skills, especially social-emotional skills. Finally, adults' perceptions of children's behaviour had a significant consequence for how teachers and parents formed their relationships with their children.

Taken together, curriculum types may not be the primary determining factors for producing different results; rather, what is important is that children's experiences are of high-quality through teacher effectiveness in terms of classroom management and delivery of instructions, adults' healthy perceptions of child behaviour, and positive relational quality in both home and school environments. As an increasing number of children transition from preschool to kindergarten every year, issues related to school readiness are concerns for many parents and teachers. Despite the growing interest in early childhood education, most programmes are still privately operated such that research on the effectiveness of these programmes might not be generalisable to the general population. Continued research should include a larger and more representative sample and focus on curriculum effectiveness in relation to school readiness for children with disadvantaged backgrounds. If programmes are shown to be effective in enhancing school readiness for less privileged children, they have a potential for providing a protective factor for children at risk of school problems and consequently increasing the chances of school success for all children.

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Questionnaires to parents

Child: ____________________ Your relationship to the child: □ mother □ father

What is your highest level of education (e.g., 2-year-college, University degree, Master's degree, PhD, Professional degree): ______________

If your child's current school was not available, what types of school would you choose for your child?
□ Montessori □ Waldorf □ Reggio Emilia □ Other types of schools

What is your household income? (Check on box)
□ < $44,000 □ $44,000 - $89,000 □ >$89,000

Please read each statement and circle the number that best describes the child during the last 3-6 months. Please consider each statement based on the child's development, rather than comparing the child to older peers.

	Never 1	Sometimes 2	Often 3	Always 4
1. Is comfortable talking to many different people	1	2	3	4
2. Makes friends easily	1	2	3	4
3. Tries to understand how other students feel when they are not doing well	1	2	3	4
4. People think she/he is fun to be with	1	2	3	4
5. Understands how other people feel	1	2	3	4
6. Cares what happens to other people	1	2	3	4
7. Is dependable, someone you can rely on	1	2	3	4
8. Thinks of her/his problems in ways that help	1	2	3	4
9. Accepts responsibility when she/he needs to	1	2	3	4
10. Knows how to identify and change negative thoughts	1	2	3	4
11. I trust her/him	1	2	3	4
12. Can identify errors in the way she/he thinks about things	1	2	3	4

Please reflect on the degree to which each of the following statements currently applies to your relationship with this child. Using the scale below, circle the appropriate number for each item.

Definitely does not apply 1	Not really 2	Neutral, not sure 3	Applies somewhat 4	Definitely applies 5

1.	I share an affectionate, warm relationship with my child.	1	2	3	4	5
2.	My child and I always seem to be struggling with each other.	1	2	3	4	5
3.	If upset, my child will seek comfort from me.	1	2	3	4	5
4.	My child is uncomfortable with physical affection or touch from me.	1	2	3	4	5
5.	My child values his/her relationship with me.	1	2	3	4	5

6.	When I praise my child, he/she beams with pride.	1	2	3	4	5
7.	This child spontaneously shares information about himself/herself.	1	2	3	4	5
8.	My child easily becomes angry with me.	1	2	3	4	5
9.	It is easy to be in tune with what my child is feeling.	1	2	3	4	5
10.	My child remains angry or is resistant after being disciplined.	1	2	3	4	5
11.	Dealing with my child drains my energy	1	2	3	4	5
12.	When my child is in a bad mood, I know we're in for a long and difficult day.	1	2	3	4	5
13.	My child's feelings toward me can be unpredictable or can change suddenly.	1	2	3	4	5
14.	My child is sneaky or manipulative with me.	1	2	3	4	5
15.	My child openly shares his/her feelings and experiences with me.	1	2	3	4	5

Here is a list of statements that describe young children. We would like to know if the child had problems with these behaviours during the past 6 months. Please answer all the items the best that you can and circle the appropriate letter for each item.

	Never	**Some-times**	**Often**
1. When given two things to do, remembers only the first or last	N	S	O
2. Is unaware of how his/her behaviour affects or bothers others	N	S	O
3. Becomes upset with new situations	N	S	O
4. Has trouble carrying out the actions needed to complete tasks	N	S	O
5. Does not stop laughing at funny things or events when others stop	N	S	O
6. Has trouble adjusting to new people (such as babysitter, teacher, friend, or day are worker)	N	S	O
7. Has trouble concentrating on activities	N	S	O
8. Has to be more closely supervised than similar playmates	N	S	O
9. Is upset by a change in plans or routine (for example, order of daily activities, adding just last minute errands to schedule, change in driving route to store)	N	S	O
10. Repeats the same mistakes over and over ever after help is given	N	S	O
11. Acts wilder or sillier than others in groups (such as birthday parties, play group)	N	S	O
12. Takes a long time to feel comfortable in new places or situations (such as visiting distant relatives or new friends)	N	S	O
13. Makes silly mistakes on things he/she can do	N	S	O
14. Is fidgety, restless, or squirmy	N	S	O
15. Is bothered by loud noises, bright lights, or certain smells	N	S	O
16. Has trouble with activities or tasks that have more than one step	N	S	O
17. Is impulsive	N	S	O
18. Is disturbed by changes in the environment (such as new furniture, things in room moved around, or new clothes)	N	S	O
19. Needs help from adult to stay on task	N	S	O

20. Does not notice when his/her behaviour causes negative reactions	N	S	O
21. Has trouble changing activities	N	S	O
22. Forgets what he/she is doing in the middle of an activity	N	S	O
23. Does not recognize the certain actions bother others	N	S	O
24. Has trouble “joining in” at unfamiliar social events (such as birthday parties, picnics, holiday gatherings)	N	S	O
25. Has trouble finishing tasks (such as games, puzzles, pretend play activities)	N	S	O
26. Gets out of control more than playmates	N	S	O
27. Resists change of routine, foods, places, etc.	N	S	O
28. Cannot stay on the same topic when talking	N	S	O
29. Talks or plays too loudly	N	S	O
30. Acts overwhelmed or overstimulated in crowded, busy situations (such as lots of noise, activity, or people)	N	S	O
31. Has trouble getting started on activities or tasks even after instructed	N	S	O
32. Acts too wild or out of control	N	S	O
33. Does not try as hard as his/her ability on activities	N	S	O
34. Has trouble putting the brakes on his/her action even after being asked	N	S	O
35. Unable to finish describing an event, person, or story	N	S	O
36. Completes tasks or activities too quickly	N	S	O
37. Is unaware when he/she does well and not well	N	S	O
38. Gets easily sidetracked during activities	N	S	O
39. Has trouble remembering something, even after a brief period of time	N	S	O
40. Becomes too silly	N	S	O
41. Has short attention span	N	S	O
42. Plays carelessly or recklessly in situations where he/she could be hurt (such as playground, swimming pool)	N	S	O
43. Is unaware when he/she performs a task right or wrong	N	S	O

How important do you think these qualities are for your child to acquire/achieve by attending preschool? Please read each statement and circle the number that best matches your answer.

	Not at all 1	**Not very 2**	**Somewhat 3**	**Very 4**	**Essential 5**
1. Has plenty of time for free (unstructured) play	1	2	3	4	5
2. Finishes tasks	1	2	3	4	5
3. Can count to 20 or more	1	2	3	4	5
4. Takes turns and shares	1	2	3	4	5
5. Has good problem solving skills	1	2	3	4	5
6. Is enthusiastic and curious in approaching new activities	1	2	3	4	5
7. Is able to use pencils	1	2	3	4	5
8. Is not disruptive of the class	1	2	3	4	5
9. Develops the skills for an independent and autonomous action (e.g., dressing, tying shoelaces,	1	2	3	4	5

choosing his/her own activity)					
10. Is sensitive to other children's feelings	1	2	3	4	5
11. Can sit still and pay attention	1	2	3	4	5
12. Knows letters of the alphabet	1	2	3	4	5
13. Can follow directions	1	2	3	4	5
14. Communicate needs, wants, and thoughts verbally in the child's primary language	1	2	3	4	5
15. Knows the English language	1	2	3	4	5
16. Can understand and regulate his/her emotions	1	2	3	4	5
17. Develops a love of learning	1	2	3	4	5

Questionnaires to teachers

Child name: ______________________________ Child's gender □Male □Female

What is your highest level of education (e.g., 2-year-college, University degree, Master's degree, PhD, Professional degree): ____________________

Please read each statement and circle the number that best describes the child during the last 3-6 months. Please consider each statement based on the child's development, rather than comparing the child to older peers. Thank you!

	Never 1	**Sometimes 2**	**Often 3**	**Always 4**
1. Is comfortable talking to many different people	1	2	3	4
2. Makes friends easily	1	2	3	4
3. Tries to understand how other students feel when they are not doing well	1	2	3	4
4. People think she/he is fun to be with	1	2	3	4
5. Understands how other people feel	1	2	3	4
6. Cares what happens to other people	1	2	3	4
7. Is dependable, someone you can rely on	1	2	3	4
8. Thinks of her/his problems in ways that help	1	2	3	4
9. Accepts responsibility when she/he needs to	1	2	3	4
10. Knows how to identify and change negative thoughts	1	2	3	4
11. I trust her/him	1	2	3	4
12. Can identify errors in the way she/he thinks about things	1	2	3	4

Please reflect on the degree to which each of the following statements currently applies to your relationship with this child. Using the scale below, circle the appropriate number for each item.

Definitely does not apply 1	Not really 2	Neutral, not sure 3	Applies somewhat 4	Definitely applies 5

1.	I share an affectionate, warm relationship with this child.	1	2	3	4	5
2.	This child and I always seem to be struggling with each other.	1	2	3	4	5
3.	If upset, this child will seek comfort from me.	1	2	3	4	5
4.	This child is uncomfortable with physical affection or touch from me.	1	2	3	4	5
5.	This child values his/her relationship with me.	1	2	3	4	5
6.	When I praise this child, he/she beams with pride.	1	2	3	4	5
7.	This child spontaneously shares information about himself/herself.	1	2	3	4	5
8.	This child easily becomes angry with me.	1	2	3	4	5
9.	It is easy to be in tune with what this child is feeling.	1	2	3	4	5
10.	This child remains angry or is resistant after being disciplined.	1	2	3	4	5

11.	Dealing with this child drains my energy	1	2	3	4	5
12.	When this child is in a bad mood, I know we're in for a long and difficult day.	1	2	3	4	5
13.	This child's feelings toward me can be unpredictable or can change suddenly.	1	2	3	4	5
14.	This child is sneaky or manipulative with me.	1	2	3	4	5
15.	This child openly shares his/her feelings and experiences with me.	1	2	3	4	5

Here is a list of statements that describe young children. We would like to know if the child had problems with these behaviours during the past 6 months. Please answer all the items the best that you can and circle the appropriate letter for each item.

	Never	Some-times	Often
1. When given two things to do, remembers only the first or last	N	S	O
2. Is unaware of how his/her behaviour affects or bothers others	N	S	O
3. Becomes upset with new situations	N	S	O
4. Has trouble carrying out the actions needed to complete tasks	N	S	O
5. Does not stop laughing at funny things or events when others stop	N	S	O
6. Has trouble adjusting to new people (such as babysitter, teacher, friend, or day are worker)	N	S	O
7. Has trouble concentrating on activities	N	S	O
8. Has to be more closely supervised than similar playmates	N	S	O
9. Is upset by a change in plans or routine (for example, order of daily activities, adding just last minute errands to schedule, change in driving route to store)	N	S	O
10. Repeats the same mistakes over and over ever after help is given	N	S	O
11. Acts wilder or sillier than others in groups (such as birthday parties, play group)	N	S	O
12. Takes a long time to feel comfortable in new places or situations (such as visiting distant relatives or new friends)	N	S	O
13. Makes silly mistakes on things he/she can do	N	S	O
14. Is fidgety, restless, or squirmy	N	S	O
15. Is bothered by loud noises, bright lights, or certain smells	N	S	O
16. Has trouble with activities or tasks that have more than one step	N	S	O
17. Is impulsive	N	S	O
18. Is disturbed by changes in the environment (such as new furniture, things in room moved around, or new clothes)	N	S	O
19. Needs help from adult to stay on task	N	S	O
20. Does not notice when his/her behaviour causes negative reactions	N	S	O
21. Has trouble changing activities	N	S	O
22. Forgets what he/she is doing in the middle of an activity	N	S	O
23. Does not recognize the certain actions bother others	N	S	O
24. Has trouble "joining in" at unfamiliar social events (such as birthday parties, picnics, holiday gatherings)	N	S	O
25. Has trouble finishing tasks (such as games, puzzles, pretend play activities)	N	S	O

26. Gets out of control more than playmates	N	S	O
27. Resists change of routine, foods, places, etc.	N	S	O
28. Cannot stay on the same topic when talking	N	S	O
29. Talks or plays too loudly	N	S	O
30. Acts overwhelmed or overstimulated in crowded, busy situations (such as lots of noise, activity, or people)	N	S	O
31. Has trouble getting started on activities or tasks even after instructed	N	S	O
32. Acts too wild or out of control	N	S	O
33. Does not try as hard as his/her ability on activities	N	S	O
34. Has trouble putting the brakes on his/her action even after being asked	N	S	O
35. Unable to finish describing an event, person, or story	N	S	O
36. Completes tasks or activities too quickly	N	S	O
37. Is unaware when he/she does well and not well	N	S	O
38. Gets easily sidetracked during activities	N	S	O
39. Has trouble remembering something, even after a brief period of time	N	S	O
40. Becomes too silly	N	S	O
41. Has short attention span	N	S	O
42. Plays carelessly or recklessly in situations where he/she could be hurt (such as playground, swimming pool)	N	S	O
43. Is unaware when he/she performs a task right or wrong	N	S	O

How important do you think these qualities are for your child to acquire/achieve by attending preschool? Please read each statement and circle the number that best matches your answer.

	Not at all 1	**Not very 2**	**Somewhat 3**	**Very 4**	**Essential 5**
1. Has plenty of time for free (unstructured) play	1	2	3	4	5
2. Finishes tasks	1	2	3	4	5
3. Can count to 20 or more	1	2	3	4	5
4. Takes turns and shares	1	2	3	4	5
5. Has good problem solving skills	1	2	3	4	5
6. Is enthusiastic and curious in approaching new activities	1	2	3	4	5
7. Is able to use pencils	1	2	3	4	5
8. Is not disruptive of the class	1	2	3	4	5
9. Develops the skills for an independent and autonomous action (e.g., dressing, tying shoelaces, choosing his/her own activity)	1	2	3	4	5
10. Is sensitive to other children's feelings	1	2	3	4	5
11. Can sit still and pay attention	1	2	3	4	5
12. Knows letters of the alphabet	1	2	3	4	5
13. Can follow directions	1	2	3	4	5
14. Communicate needs, wants, and thoughts verbally in the child's primary language	1	2	3	4	5
15. Knows the English language	1	2	3	4	5

16. Can understand and regulate his/her emotions	1	2	3	4	5
17. Develops a love of learning	1	2	3	4	5

Appendix B: Parent and teacher expectations for social and academic related skills

As part of the demographic questionnaire, parents and teachers in the current study were asked concerning their expectations for their children's social and academic related skills in relation to school readiness. The questionnaire was adapted from the National Household Education Survey (NHES) by the US Department of Education. The questionnaire consisted of 16 questions concerning parental and teacher expectations for social skills (e.g., "Can take turns and share", "Is sensitive to other children's feelings"), learning attitude (e.g., "Is enthusiastic and curious in approaching new activities", "Develops a love of learning"), and academic skills (e.g., "Can count to 20 or more", "Knows letters of the alphabet"). Each item was rated on a 5-point Likert-type scale ranging from 1 (Not at all) to 5 (Essential). For the descriptive analysis, ratings within each scale were summed; the range of possible total score was 8-40 for social skills, 4-20 for learning attitude, and 4-20 for academic skills. For the parent sample (N = 80), the alpha coefficients were .81 for social skills, .51 for learning attitude, and .84 for academic skills. For the teacher sample (N = 25), the alpha coefficients were .83 for social skills, .84 for learning attitude, and .89 for academic skills.

Table B-1 and B-2 show the means, standard deviations, and range for each parent and teacher rated scale. Table also includes the results of the Levene's test and one-way ANOVA including the F-ratio and the degrees of freedom across the three school types. Table B-3 shows correlations between parent and teacher ratings.

Scale		Programme type			Levene's test	One-way ANOVA	
		Montessori	Reggio Emilia	BCELF		*F (df)*	Sig.
Social skills	*M*	36.2	34.0	34.5	0.07	2.59	.08
	SD	2.99	3.93	3.93			
	Range	28−40	21−40	21−40			
Learning attitude	*M*	17.74	17.0	16.72	2.42	2.43	.09
	SD	1.85	1.47	1.93			
	Range	14−20	14−19	14−20			
Academic	*M*	16.26	14.86	14.56	2.41	2.51	.09
	SD	2.92	3.06	3.24			
	Range	9−20	8−20	10−20			

Table B-1. Descriptive statistics of parental expectations

Scale		Programme type			Levene's test	One-way ANOVA	
		Montessori	Reggio Emilia	BCELF		*F (df)*	Sig.
Social skills	*M*	34.8	33.7	32.6			
	SD	2.38	4.38	4.31	2.52	3.365*	.04
	Range	32−38	24−40	28−39			
Learning attitude	*M*	18.25	15.6	14.41			
	SD	1.00	2.26	2.93	20.71**	35.44***	.001
	Range	15−20	11−19	11−20			
Academic	*M*	15.94	12.21	14.0			
	SD	2.61	2.33	3.07	7.18**	22.36***	.001
	Range	10−20	7−15	11−20			

Table B-2. Descriptive statistics of teacher expectations
Note. *p = < .05. ***p = < .001.

The Levene's test for the parent sample showed that the assumption of the homogeneity of variance was not violated while it was not the case for the teacher sample. Therefore, an alternative Games-Howell test for post-hoc comparisons was referred for the teacher sample. For the parent sample, although Montessori parents showed the highest expectations for all three scales, there was no statistically significant group difference. For the teacher sample, a one-way ANOVA revealed that there was a statistically significant difference in all three scales across programme types. For social skills, post-hoc comparison using the Games-Howell test indicated that Montessori teachers showed significantly higher expectations than BCELF teachers (p = .04). Montessori teachers and Reggio Emilia teachers or Reggio Emilia and BCELF teachers did not differ significantly from each other. For learning attitude, Montessori teachers showed significantly higher expectations than both Reggio Emilia (p = .001) and BCELF teachers (p = .001). Reggio Emilia and BCELF teachers did not differ significantly from each other. For academic skills, Montessori teachers showed significantly higher expectations than both Reggio Emilia (p = .001) and BCELF teachers (p = .02). BCELF teachers also showed significantly higher expectations than Reggio Emilia teachers (p = .03).

Parent	Teacher *1*	*2*	*3*
1. Social skills	-.02		
2. Learning attitude	-.01	.02	
3. Academic	.20	.31**	.17

Table B-3. Correlations between parent-and teacher-rated expectations
Note. *p = < .05. **p = < .01.

Appendix C: Testing normal distribution of data for BRIEF-P

	Pre-test			Post-test		
Item	*M (SD)*	Skewness	Kurtosis	*M (SD)*	Skewness	Kurtosis
WM1	2.39 (.62)	-0.509	-0.612	2.41 (.61)	-0.487	-0.618
WM4	2.51 (.58)	-0.685	-0.494	2.52 (.55)	-0.526	-0.855
WM7	2.59 (.54)	-0.790	-0.534	2.51 (.59)	-0.746	-0.393
WM10	2.75 (.44)	-1.157	-0.676	2.71 (.51)	-1.510	1.396
WM13	2.56 (.54)	-0.649	-0.760	2.64 (.51)	-0.871	-0.593
WM16	2.62 (.57)	-1.203	0.499	2.69 (.56)	-1.634	1.766
WM19	2.28 (.52)	0.251	-0.530	2.31 (.62)	-0.335	-0.629
WM22	2.79 (.41)	-1.443	-1.443	2.8 (.44)	-1.936	2.932
WM25	2.60 (.51)	-0.654	-1.029	2.64 (.55)	-1.236	0.591
WM28	2.62 (.55)	-1.088	0.198	2.69 (.52)	-1.354	0.886
WM31	2.58 (.54)	-0.742	-0.617	2.64 (.51)	-0.871	-0.593
WM33	2.43 (.60)	-0.503	-0.630	2.52 (.55)	-0.526	-0.855
WM35	2.80 (.43)	-1.933	2.857	2.75 (.44)	-1.157	-0.678
WM37	2.71 (.46)	-0.915	-1.188	2.72 (.48)	-1.356	0.677
WM39	2.61 (.51)	-0.703	-0.953	2.66 (.50)	-0.997	-0.319
WM41	2.53 (.54)	-0.514	-0.926	2.51 (.61)	-0.840	-0.262
WM43	2.66 (.48)	-0.702	-1.541	2.69 (.47)	-0.820	-1.361
IC2	2.07 (.51)	0.127	0.870	2.17 (.46)	0.586	0.791
IC5	2.63 (.55)	-1.142	0.331	2.59 (.56)	-0.994	0.009
IC8	2.82 (.46)	-2.637	6.479	2.82 (.47)	-2.680	6.645
IC11	2.59 (.57)	-1.048	0.134	2.55 (.65)	-1.167	0.229
IC14	2.42 (.65)	-0.669	-0.534	2.53 (.63)	-1.010	-0.017
IC17	2.45 (.52)	-0.037	-1.485	2.47 (.55)	-0.333	-1.008
IC20	2.44 (.52)	0.005	-1.485	2.47 (.57)	-0.486	-0.736
IC23	2.39 (.51)	0.216	-1.392	2.42 (.57)	-0.305	-0.828
IC26	2.76 (.46)	-1.565	1.341	2.70 (.51)	-1.430	1.128
IC29	2.32 (.67)	-0.474	-0.750	2.39 (.62)	-0.488	-0.614
IC32	2.60 (.57)	-1.099	0.246	2.60 (.56)	-1.051	0.135
IC34	2.27 (.52)	0.289	-0.458	2.31 (.58)	-0.172	-0.587
IC36	2.55 (.50)	-0.193	-2.005	2.51 (.50)	-0.025	-2.049
IC38	2.39 (.53)	0.004	-1.099	2.41 (.59)	-0.387	-0.699
IC40	2.41 (.61)	-0.510	-0.607	2.35 (.59)	-0.287	-0.643
IC42	2.66 (.48)	-0.702	-1.541	2.70 (.46)	-0.883	-1.252
CF3	2.32 (.55)	-0.001	-0.635	2.37 (.56)	-0.131	-0.818
CF6	2.39 (.66)	-0.614	-0.613	2.45 (.61)	-0.614	-0.531
CF9	2.56 (.60)	-0.997	0.019	2.53 (.61)	-0.937	-0.104
CF12	2.47 (.60)	-0.657	-0.499	2.42 (.59)	-0.430	-0.683
CF15	2.42 (.72)	-0.839	-0.615	2.41 (.72)	-0.796	-0.638
CF18	2.85 (.44)	-3.098	9.237	2.77 (.48)	-1.981	3.269
CF21	2.55 (.56)	-0.745	-0.476	2.51 (.53)	-0.281	-1.363
CF24	2.41 (.68)	-0.721	-0.576	2.41 (.65)	-0.633	-0.559
CF27	2.62 (.59)	-1.294	0.702	2.65 (.59)	-1.508	1.270
CF30	2.51 (.62)	-0.854	-0.250	2.51 (.67)	-1.022	-0.122

Table C-1. Descriptive of the parent-rated BRIEF-P for full sample
Note. Scale ranged from 1-3; WM = Working memory; IC = Inhibitory control; CF = Cognitive flexibility.

Item	Pre-test			Post-test		
	M (SD)	Skewness	Kurtosis	*M (SD)*	Skewness	Kurtosis
WM1	2.56 (.63)	-1.146	0.219	2.48 (.65)	-0.867	-0.313
WM4	2.64 (.64)	-1.583	1.273	2.55 (.59)	-0.925	-0.118
WM7	2.61 (.61)	-1.334	0.713	2.48 (.62)	-0.778	-0.373
WM10	2.68 (.54)	-1.427	1.130	2.63 (.61)	-1.432	-0.978
WM13	2.64 (.55)	-1.188	0.447	2.57 (.62)	-1.151	0.278
WM16	2.62 (.64)	-1.454	0.907	2.62 (.64)	-1.467	0.947
WM19	2.37 (.69)	-0.645	-0.704	2.34 (.69)	-0.560	-0.783
WM22	2.68 (.60)	-1.701	1.795	2.61 (.60)	-1.283	0.632
WM25	2.60 (.63)	-1.337	0.662	2.65 (.62)	-1.562	1.289
WM28	2.64 (.59)	-1.458	1.109	2.65 (.56)	-1.336	0.846
WM31	2.53 (.65)	-1.079	0.037	2.47 (.70)	-0.954	-0.362
WM33	2.53 (.61)	-0.906	-1.165	2.43 (.70)	-0.814	-0.546
WM35	2.73 (.58)	-2.037	3.014	2.71 (.54)	-1.752	2.206
WM37	2.58 (.58)	-1.026	0.078	2.55 (.65)	-1.126	0.134
WM39	2.71 (.60)	-1.954	2.594	2.61 (.65)	-1.456	0.852
WM41	2.51 (.73)	-1.125	-0.179	2.49 (.69)	-0.990	-0.259
WM43	2.63 (.55)	-1.143	0.335	2.55 (.64)	-1.123	0.174
IC2	2.42 (.70)	-0.775	-0.594	2.39 (.73)	-0.743	-0.749
IC5	2.67 (.59)	-1.601	1.547	2.58 (.63)	-1.233	0.414
IC8	2.67 (.60)	-1.650	1.631	2.66 (.62)	-1.608	1.427
IC11	2.54 (.66)	-1.147	0.120	2.60 (.60)	-1.214	0.464
IC14	2.50 (.71)	-1.079	-0.213	2.55 (.71)	-1.282	0.195
IC17	2.56 (.69)	-1.267	0.265	2.55 (.70)	-1.232	0.140
IC20	2.50 (.65)	-0.948	-0.195	2.44 (.68)	-0.817	-0.499
IC23	2.42 (.71)	-0.823	-0.585	2.43 (.71)	-0.836	-0.565
IC26	2.58 (.70)	-1.393	0.499	2.61 (.64)	-1.386	0.731
IC29	2.50 (.69)	-1.038	-0.185	2.45 (.70)	-0.897	-0.443
IC32	2.65 (.63)	-1.628	1.409	2.65 (.59)	-1.471	1.149
IC34	2.48 (.68)	-0.951	-0.278	2.48 (.70)	-0.983	-0.318
IC36	2.51 (.58)	-0.698	-0.481	2.37 (.65)	-0.541	-0.649
IC38	2.42 (.68)	-0.750	-0.576	2.40 (.69)	-0.735	-0.628
IC40	2.47 (.71)	-0.990	-0.360	2.45 (.59)	-0.563	-0.598
IC42	2.76 (.50)	-2.043	3.450	2.72 (.57)	-1.944	2.762
CF3	2.64 (.53)	-1.123	0.234	2.50 (.64)	-0.920	-0.197
CF6	2.52 (.61)	-0.872	-0.221	2.48 (.64)	-0.826	-0.336
CF9	2.73 (.48)	-1.496	1.251	2.67 (.58)	-1.614	1.593
CF12	2.53 (.60)	-0.842	-0.259	2.42 (.71)	-0.809	-0.595
CF15	2.73 (.52)	-1.768	2.318	2.66 (.59)	-1.565	1.436
CF18	2.72 (.49)	-1.437	1.051	2.71 (.51)	-1.542	1.495
CF21	2.63 (.58)	-1.307	0.736	2.64 (.63)	-1.583	1.273
CF24	2.56 (.63)	-1.146	0.219	2.50 (.69)	-1.051	-0.158
CF27	2.75 (.47)	-1.687	1.956	2.74 (.54)	-2.013	3.136
CF30	2.61 (.54)	-0.950	-0.167	2.57 (.62)	-1.151	0.278

Table C-2. Descriptive of the teacher-rated BRIEF-P for full sample
Note. Scale ranged from 1-3; WM = Working memory; IC = Inhibitory control; CF = Cognitive flexibility.

Appendix D: Testing normal distribution of data for CPRS and STRS

	Pre-test			Post-test		
Item	*M (SD)*	Skewness	Kurtosis	*M (SD)*	Skewness	Kurtosis
CL1	4.93 (.36)	-6.367	46.443	4.92 (.28)	4.416	7.463
CL3	4.79 (.54)	-3.351	13.339	4.81 (.45)	-2.350	5.066
CL5	4.94 (.29)	-4.958	26.497	4.87 (.44)	-3.427	11.256
CL6	4.81 (.47)	-2.507	5.769	4.78 (.59)	-3.294	11.866
CL7	4.44 (.73)	-1.418	2.250	4.46 (.69)	-1.121	0.966
CL9	4.29 (.79)	-1.357	2.704	4.47 (.70)	-1.608	3.369
CL15	4.41 (.79)	-1.273	1.056	4.53 (.65)	-1.068	0.030
CF2	2.19 (1.08)	0.848	-0.185	2.37 (1.21)	0.646	-0.727
CF4	1.39 (.98)	2.797	7.203	1.22 (.59)	3.294	11.866
CF8	2.60 (1.13)	0.217	-1.175	2.65 (1.13)	0.367	-1.089
CF10	2.46 (1.04)	0.419	-0.629	2.70 (1.15)	0.320	-1.050
CF11	2.54 (1.20)	0.363	-1.070	2.65 (1.13)	0.367	-0.896
CF12	2.26 (1.14)	0.780	-0.281	2.37 (1.24)	0.644	-0.757
CF13	1.78 (.97)	1.319	1.171	1.82 (.91)	1.455	2.591
CF14	1.88 (1.02)	1.159	0.799	1.72 (.88)	1.116	0.478

Table D-1. Descriptive statistics of CPRS
Note. Scale ranged from 1-5. CL = closeness; CF = conflict.

	Pre-test			Post-test		
Item	*M (SD)*	Skewness	Kurtosis	*M (SD)*	Skewness	Kurtosis
CL1	4.54 (.72)	-1.664	2.529	4.52 (.79)	-1.851	3.090
CL3	4.03 (1.03)	-0.903	0.079	4.13 (1.09)	-1.154	0.297
CL5	4.14 (.97)	-1.147	1.164	4.45 (.83)	-1.563	2.253
CL6	4.58 (.71)	-2.290	6.929	4.56 (.82)	-2.601	7.914
CL7	4.45 (.92)	-1.953	3.545	4.48 (.88)	-2.087	4.427
CL9	4.07 (.95)	-1.173	1.201	4.09 (1.01)	-1.348	1.632
CL15	4.24 (1.04)	1.041	1.879	4.34 (.99)	-1.803	3.108
CF2	1.51 (.79)	1.753	2.803	1.59 (1.00)	1.980	3.473
CF4	1.84 (1.17)	1.299	0.753	1.81 (1.28)	1.444	0.771
CF8	1.58 (.99)	1.992	3.649	1.58 (1.04)	1.798	2.136
CF10	2.09 (1.08)	0.894	0.184	2.08 (1.25)	0.918	-0.297
CF11	1.67 (1.04)	1.681	2.070	1.75 (1.17)	1.518	1.166
CF12	1.69 (1.03)	1.447	1.188	1.71 (1.16)	1.158	1.166
CF13	1.56 (.96)	1.883	2.969	1.55 (1.01)	1.855	2.483
CF14	1.61 (1.05)	1.661	1.664	1.71 (1.21)	1.624	1.326

Table D-2. Descriptive statistics of STRS
Note. Scale ranged from 1-5. CL = closeness; CF = conflict.

Appendix E: Testing normal distribution of data for SEARS

	Pre-test			Post-test		
Item	*M (SD)*	Skewness	Kurtosis	*M (SD)*	Skewness	Kurtosis
SC1	1.97 (.83)	-0.168	-1.017	1.90 (.75)	-0.201	-0.762
SC2	1.97 (.78)	-0.222	-0.640	2.09 (.72)	-0.131	-1.054
SC4	2.15 (.60)	-0.066	-0.288	2.20 (.58)	-0.023	-0.216
EMP3	1.74 (.70)	0.419	-0.897	1.73 (.75)	0.492	-1.079
EMP5	1.78 (.70)	0.150	-0.609	1.90 (.66)	0.105	-0.659
EMP6	2.09 (.62)	-0.062	-0.371	2.04 (.71)	-0.053	-0.981
RES7	1.80 (.69)	0.289	-0.886	1.90 (.66)	0.105	-0.659
RES8	1.61 (.69)	0.489	-0.520	1.62 (.62)	0.470	-0.621
RES9	1.77 (.69)	0.342	-0.868	1.62 (.62)	0.470	-0.621
RES10	1.41 (.77)	0.163	-0.259	1.51 (.69)	0.535	-0.205
RES11	2.27 (.63)	-0.541	0.752	2.28 (.67)	-0.399	-0.766
RES12	1.69 (.75)	0.091	-0.473	1.72 (.61)	-0.081	-0.085

Table E-1. Descriptive statistics of parent-rated SEARS for full sample
Note. Scale ranged from 1-4; SC = social competence; EMP = empathy; RES = responsibility.

	Pre-test			Post-test		
Item	*M (SD)*	Skewness	Kurtosis	*M (SD)*	Skewness	Kurtosis
SC1	2.01 (.84)	-0.278	-0.940	1.97 (.99)	-0.450	-1.021
SC2	1.94 (.89)	-0.179	-1.130	2.05 (.83)	-0.275	-1.060
SC4	2.06 (.75)	-0.220	-0.851	2.24 (.77)	-0.545	-0.721
EMP3	1.82 (.86)	0.111	-1.200	2.05 (.87)	-0.567	-0.463
EMP5	1.93 (.78)	-0.099	-0.846	2.11 (.81)	-0.591	-0.243
EMP6	1.98 (.82)	-0.256	-0.794	2.13 (.85)	-0.667	-0.288
RES7	1.98 (.88)	-0.276	-1.003	2.13 (.90)	-0.553	-0.904
RES8	1.66 (.82)	0.819	-0.605	1.87 (.89)	-0.314	-0.711
RES9	1.97 (.84)	-0.203	-0.954	2.07 (.82)	-0.407	-0.702
RES10	1.63 (.75)	0.238	-0.498	1.72 (.83)	-0.065	-0.637
RES11	2.24 (.80)	-0.458	-1.300	2.29 (.83)	-0.872	-0.189
RES12	1.75 (.83)	-0.252	-0.423	1.82 (.85)	-0.050	-0.899

Table E-2. Descriptive statistics of teacher-rated SEARS for full sample
Note. Scale ranged from 1-4; SC = social competence; EMP = empathy; RES = responsibility.

Appendix F: Factor loadings of items from BRIEF-P

	T1			T2		
	Factor loading					
Source of item and abbreviated item contents	*1*	*2*	*3*	*1*	*2*	*3*
Factor1: Working memory						
1:When given two things to do, remembers only…	.66			.70		
4: Has trouble carrying out the actions...	.70			.77		
7:Has trouble concentrating…	.81			.84		
10:Repeats the same mistakes…	.75			.76		
13:Makes silly mistakes…	.73			.70		
16:Has trouble with activities or tasks…	.83			.87		
19:Needs help from adult…	.73			.92		
22:Forgets what he/she is doing…	.75			.68		
25:Has trouble finishing tasks…	.81			.88		
28:Cannot stay on the same topic…	.84			.79		
31:Has trouble getting started on activities…	.80			.73		
33:Does not try as hard as…	.66			.75		
35:Unable to finish describing…	.72			.79		
37:Is unaware…	.82			.82		
39:Has trouble remembering…	.73			.81		
41:Has short attention span…	.82			.91		
43:Is unaware when he/she performs…	.86			.80		
Factor2: Inhibitory control						
2:Is unaware of how his/her behaviour affects...		.45			.52	
5:Does not stop laughing…		.64			.60	
8:Has to be more closely supervised…		.75			.67	
11:Acts wilder or sillier…		.70			.77	
14:Is fidgety…		.60			.82	
17:Is impulsive…		.50			.82	
20:Does not notice when his/her behaviour causes…		.63			.77	
23:Does not recognize the certain actions...		.75			.87	
26:Gets out of control…		.82			.92	
29:Talks or play too loudly…		.68			.73	
32:Acts too wild...		.80			.88	
34:Has trouble putting the brakes…		.64			.82	
36:Completes tasks or activities too quickly...		.45			.69	
38:Gets easily sidetracked…		.87			.88	
40:Becomes too silly…		.73			.91	
42:Plays carelessly or recklessly…		.68			.69	
Factor3: Cognitive flexibility						
3:Becomes upset with...			.69			.63
6:Has trouble adjusting...			.52			.66
9:Is upset by a change…			.68			.83
12:Takes a long time to feel comfortable...			.86			.87
15:Is bothered by loud noises...			.59			.53
18:Is disturbed by changes...			.77			.77
21:Has trouble changing...			.84			.62
24:Has trouble “joining in” at unfamiliar...			.59			.77
27:Resists change…			.80			.92
30:Acts overwhelmed...			.76			.97

Table F-1. Factor loading of items from the parent-rated BRIEF-P

	T1			T2		
	Factor loading					
Source of item and abbreviated item contents	*1*	*2*	*3*	*1*	*2*	*3*
Factor1: Working memory						
1:When given two things to do, remembers only…	.86			.89		
4: Has trouble carrying out the actions...	.93			.91		
7:Has trouble concentrating…	.88			.90		
10:Repeats the same mistakes…	.83			.95		
13:Makes silly mistakes…	.92			.91		
16:Has trouble with activities or tasks…	.89			.96		
19:Needs help from adult…	.92			.95		
22:Forgets what he/she is doing…	.91			.87		
25:Has trouble finishing tasks…	.94			.97		
28:Cannot stay on the same topic…	.85			.82		
31:Has trouble getting started on activities…	.90			.93		
33:Does not try as hard as…	.80			.83		
35:Unable to finish describing…	.88			.84		
37:Is unaware…	.82			.71		
39:Has trouble remembering…	.85			.93		
41:Has short attention span…	.96			.91		
43:Is unaware when he/she performs…	.82			.78		
Factor2: Inhibitory control						
2:Is unaware of how his/her behaviour affects...		.85			.87	
5:Does not stop laughing…		.86			.75	
8:Has to be more closely supervised…		.85			.89	
11:Acts wilder or sillier…		.92			.86	
14:Is fidgety…		.96			.87	
17:Is impulsive…		.95			.88	
20:Does not notice when his/her behaviour causes…		.93			.88	
23:Does not recognize the certain actions...		.88			.87	
26:Gets out of control…		.96			.93	
29:Talks or play too loudly…		.88			.83	
32:Acts too wild...		.93			.95	
34:Has trouble putting the brakes…		.91			.90	
36:Completes tasks or activities too quickly...		.74			.81	
38:Gets easily sidetracked…		.99			.90	
40:Becomes too silly…		.93			.89	
42:Plays carelessly or recklessly…		.93			.83	
Factor3: Cognitive flexibility						
3:Becomes upset with...			.72			.99
6:Has trouble adjusting...			.54			.73
9:Is upset by a change…			.79			.84
12:Takes a long time to feel comfortable...			.61			.80
15:Is bothered by loud noises...			.95			.74
18:Is disturbed by changes...			.96			.86
24:Has trouble “joining in” at unfamiliar...			.75			.87
27:Resists change…			.91			.88
30:Acts overwhelmed...			.94			.92

Table F-2. Factor loading of items from the teacher-rated BRIEF-P

Appendix G: Factor loadings of items from the CPRS and STRS

	T1		T2	
	Factor loading			
Source of item and abbreviated item contents	*1*	*2*	*1*	*2*
Factor1: Closeness				
1:I share an affectionate…	.81		.99	
3:If upset, my child will seek…	.45		.60	
5:My child values…	.99		.83	
7:This child spontaneously shares…	.45		.72	
9:It is easy to be in tune with…	.67		.64	
15:My child openly shares…	.48		.72	
Factor 2: Conflict				
2:My child and I always seem to be struggling…		.55		.74
4:My child is uncomfortable with physical…		.39		.77
8:My child easily becomes angry…		.67		.77
10:My child remains angry…		.84		.69
11:Dealing with my child drains…		.71		.67
12:When my child is in a bad mood…		.78		.69
13:My child's feelings toward me…		.84		.94
14:My child is sneaky…		.50		.66

Table G-1. Factor loading of items from the CPRS

	T1		T2	
	Factor loading			
Source of item and abbreviated item contents	*1*	*2*	*1*	*2*
Factor1: Closeness				
1:I share an affectionate…	.85		.85	
3:If upset, this child will seek…	.79		.81	
5:This child values…	.72		.84	
6:When I praise this child…	.70		.56	
7:This child spontaneously shares…	.86		.87	
9:It is easy to be in tune with…	.70		.85	
15:This child openly shares…	.81		.87	
Factor 2: Conflict				
2:This child and I always seem to be struggling…		.83		.79
4:This child is uncomfortable with physical…		.35		.54
8:This child easily becomes angry…		.86		.88
10:This child remains angry…		.76		.85
11:Dealing with this child drains…		.82		.93
12:When this child is in a bad mood…		.80		.89
13:This child's feelings toward me…		.92		.92
14:This child is sneaky…		.86		.83

Table G-2. Factor loading of items from the STRS

Appendix H: Factor loadings of items from SEARS

	T1			T2		
			Factor loading			
Source of item and abbreviated item contents	*1*	*2*	*3*	*1*	*2*	*3*
Factor1: Social competence						
1:Is comfortable talking to…	.73			.68		
2:Makes friends easily…	.73			.82		
4:People think she/he is fun…	.96			.91		
Factor2: Empathy						
3:Tries to understand how other students feel…		.78			.85	
5:Understands how other…		.79			.90	
6:Cares what happens…		.94			.87	
Factor3: Responsibility						
7:Is dependable…			.82			.83
8:Thinks of her/his problems…			.76			.84
9:Accepts responsibility…			.68			.74
10:Knows how to identify…			.76			.72
11:I trust…			.68			.79
12:Can identify errors…			.53			.78

Table H-1. Factor loading of items from the parent-rated SEARS

	T1			T2		
			Factor loading			
Source of item and abbreviated item contents	*1*	*2*	*3*	*1*	*2*	*3*
Factor1: Social competence						
1:Is comfortable talking to…	.80			.68		
2:Makes friends easily…	.96			.82		
4:People think she/he is fun…	.87			.91		
Factor2: Empathy						
3:Tries to understand how other students feel…		.91			.85	
5:Understands how other…		.89			.90	
6:Cares what happens…		.93			.87	
Factor3: Responsibility						
7:Is dependable…			.89			.83
8:Thinks of her/his problems…			.96			.84
9:Accepts responsibility…			.89			.74
10:Knows how to identify…			.85			.72
11:I trust…			.85			.79
12:Can identify errors…			.91			.78

Table H-2. Factor loading of items from the teacher-rated SEARS

Appendix I: Correlations for parent and teacher ratings

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*
1. Programme types	-																										
2. Parent education	-0.04																										
3. CPRS (Clo) T1	-0.18	**-0.21**																									
4. CPRS (Clo) T2	-0.02	0.04	**0.54**																								
5. CPRS (Conf) T1	0.05	-0.18	**-0.25**	**-0.38**																							
6. CPRS (Conf) T2	0.01	-0.18	**-0.51**	**-0.35**	0.72																						
7. Digit Span (bwd) T1	**-0.27**	-0.04	0.08	0.05	-0.12	-0.12																					
8. Digit Span (bwd) T2	**-0.22**	0.06	0.08	0.13	-0.08	-0.04	**0.35**																				
9. Peg Tapping T1	0.02	0.11	0.16	0.20	-0.10	**-0.25**	0.18	**0.36**																			
10. Peg Tapping T2	-0.01	-0.02	0.08	0.13	0.04	-0.03	0.10	**0.29**	**0.48**																		
11. DCCS T1	-0.06	0.14	0.12	-0.05	-0.04	-0.04	0.13	**0.27**	**0.42**	**0.39**																	
12. DCCS T2	0.14	0.18	0.05	0.03	-0.15	-0.17	0.17	**0.29**	**0.39**	**0.45**	**0.32**																
13. BRIEF-P WM T1	0.03	0.04	**0.35**	**0.37**	-0.17	-0.15	0.09	**0.25**	**0.38**	**0.30**	0.05	**0.29**															
14. BRIEF-P WM T2	-0.01	-0.01	**0.33**	**0.40**	-0.16	**-0.35**	0.07	0.15	**0.35**	**0.31**	0.01	0.22	**0.71**														
15. BRIEF-P IC T1	0.12	**0.32**	0.13	**0.32**	**-0.41**	**-0.49**	0.04	0.09	0.17	0.05	-0.08	0.16	**0.62**	**0.49**													
16. BRIEF-P IC T2	0.07	**0.28**	**0.27**	**0.24**	**-0.25**	**-0.46**	0.05	0.09	**0.34**	0.14	-0.06	0.13	**0.46**	**0.62**	**0.73**												
17. BRIEF-P CF T1	-0.07	0.02	0.12	**0.24**	**-0.30**	**-0.49**	0.17	-0.01	**0.24**	-0.03	-0.08	0.13	**0.31**	**0.24**	**0.33**	**0.30**											
18. BRIEF-P CF T2	0.06	-0.05	**0.38**	0.38	-0.23	**-0.47**	0.08	-0.01	**0.31**	0.07	0.01	0.10	**0.23**	**0.32**	**0.30**	**0.42**	**0.76**										
19. SEARS SC T1	-0.14	-0.11	**0.36**	**0.38**	**-0.22**	**-0.36**	0.12	0.01	0.19	0.09	0.04	0.05	**0.25**	0.09	0.07	0.05	**0.50**	**0.49**									
20. SEARS SC T2	0.07	0.05	**0.41**	0.34	-0.05	**-0.32**	0.03	-0.04	**0.23**	0.18	0.09	0.12	**0.24**	0.20	0.17	0.15	**0.53**	**0.57**	**0.62**								
21. SEARS Empathy T1	-0.01	0.05	**0.32**	0.42	-0.17	**-0.33**	0.04	0.04	0.19	0.04	-0.01	0.14	**0.24**	0.23	**0.24**	0.17	0.16	0.20	**0.27**	**0.29**							
22. SEARS Empathy T2	0.09	0.14	**0.41**	**0.43**	**-0.32**	**-0.41**	0.03	-0.07	**0.28**	0.09	-0.04	0.19	0.17	**0.27**	**0.31**	**0.29**	**0.25**	**0.28**	0.22	**0.44**	**0.71**						
23. SEARS Res T1	-0.16	0.12	**0.28**	0.22	**-0.24**	**-0.26**	0.11	0.08	**0.26**	0.08	-0.02	**0.29**	**0.38**	0.21	**0.25**	0.19	0.18	0.11	**0.42**	0.18	**0.53**	**0.39**					
24. SEARS Res T2	-0.07	0.20	**0.48**	**0.42**	**-0.34**	**-0.49**	0.05	0.08	**0.33**	0.09	0.02	0.20	**0.34**	**0.37**	**0.42**	**0.37**	**0.36**	**0.37**	**0.28**	**0.52**	**0.53**	**0.59**	**0.59**				
25. BAS Vocabulary T1	0.09	0.10	**0.22**	**0.23**	-0.04	-0.09	0.04	**0.24**	**0.26**	**0.20**	0.13	0.04	**0.25**	0.14	0.16	0.15	0.01	0.07	0.07	0.18	0.06	0.13	-0.09	0.06			
26. BAS Vocabulary T2	-0.01	**0.22**	0.12	0.08	0.11	0.05	-0.06	**0.22**	**0.22**	**0.36**	**0.21**	0.20	0.15	**0.22**	-0.01	0.09	-0.08	-0.02	0.01	0.07	0.05	0.07	-0.08	0.02	**0.57**		
27. BAS Early Number T1	-0.13	-0.03	0.17	-0.07	-0.05	-0.04	0.18	**0.34**	**0.55**	**0.43**	**0.33**	**0.30**	**0.24**	**0.32**	-0.01	0.11	0.04	0.02	0.05	0.08	0.01	0.02	0.09	0.07	**0.32**	**0.27**	
28. BAS Early Number T2	**-0.33**	-0.01	**0.22**	0.09	-0.04	-0.06	**0.29**	**0.31**	**0.43**	**0.54**	**0.32**	**0.43**	**0.31**	**0.29**	0.09	0.07	0.04	0.04	0.01	0.05	0.14	0.14	0.13	0.11	0.14	**0.24**	**0.50**

Table I-1. Pearson correlations (Parent ratings).

Note. Values in bold are statistically significant ($p<.05$).

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*22*	*22*	*23*	*24*	*25*	*26*	*27*	*28*
1. Programme types	-																											
2. Teacher education	**-0.43**																											
3. Years of teaching	**0.44**	**-0.26**																										
4. STRS (Clo) T1	**0.18**	0.03	0.14																									
5. STRS (Clo) T2	**0.27**	-0.02	**0.28**	**0.57**																								
6. STRS (Conf) T1	-0.06	0.16	**-0.19**	-0.15	-0.14																							
7. STRS (Conf) T2	-0.16	0.13	**-0.27**	-0.13	**-0.27**	**0.55**																						
8. Digit Span (bwd) T1	**-0.27**	**0.20**	-0.13	0.16	0.12	-0.04	0.02																					
9. Digit Span (bwd) T2	**-0.22**	**0.18**	-0.01	0.03	0.03	-0.18	-0.13	**0.35**																				
10. Peg Tapping T1	0.02	0.17	-0.08	0.12	0.16	-0.08	-0.12	0.18	**0.36**																			
11. Peg Tapping T2	-0.01	**0.19**	-0.07	0.16	0.13	-0.04	-0.02	0.10	**0.29**	**0.48**																		
12. DCCS T1	-0.06	**0.19**	-0.15	-0.04	0.05	-0.15	-0.08	0.13	**0.27**	**0.42**	**0.39**																	
13. DCCS T2	-0.14	**0.21**	-0.09	0.04	0.03	-0.04	-0.01	0.17	**0.29**	**0.39**	**0.45**	**0.32**																
14. BRIEF-P WM T1	0.16	0.04	0.15	0.09	0.09	**-0.50**	**-0.44**	0.01	0.17	0.12	0.07	0.09	0.05															
15. BRIEF-P WM T2	0.07	-0.04	**0.25**	0.09	**0.19**	**-0.40**	**-0.61**	-0.05	0.14	0.13	0.15	0.05	-0.06	**0.60**														
16. BRIEF-P IC T1	0.13	0.09	0.18	0.07	0.02	**-0.62**	**-0.48**	-0.01	0.15	0.13	0.02	0.17	0.05	**0.69**	**0.50**													
17. BRIEF-P IC T2	0.09	0.03	0.16	0.03	0.18	**-0.45**	**-0.70**	-0.03	0.17	0.13	0.11	0.13	-0.05	**0.52**	**0.76**	**0.68**												
18. BRIEF-P CF T1	-0.02	0.01	0.11	0.14	0.11	**-0.54**	**-0.45**	-0.02	0.03	0.06	0.01	0.04	-0.03	**0.46**	**0.41**	**0.37**	**0.29**											
19. BRIEF-P CF T2	0.01	-0.03	**0.24**	0.13	**0.35**	**-0.28**	**-0.49**	0.11	0.02	0.08	0.07	0.02	-0.06	**0.29**	**0.57**	0.17	**0.38**	**0.53**										
20. SEARS SC T1	-0.08	**0.25**	0.04	**0.36**	**0.34**	0.06	0.03	0.09	0.06	**0.24**	0.15	0.09	0.04	0.05	-0.01	-0.14	-0.12	**0.24**	**0.20**									
21. SEARS SC T2	0.06	0.05	**0.26**	**0.36**	**0.58**	0.14	**-0.20**	0.08	-0.01	0.16	**0.22**	-0.03	0.04	-0.04	**0.19**	**-0.23**	0.03	0.15	**0.53**	**0.55**								
22. SEARS Empathy T1	-0.02	**0.22**	0.04	**0.49**	**0.30**	**-0.20**	-0.12	**0.23**	**0.22**	**0.29**	**0.26**	**0.21**	0.17	**0.26**	0.09	**0.27**	**0.20**	0.01	0.03	**0.49**	**0.26**							
23. SEARS Empathy T2	-0.02	0.12	0.15	**0.31**	**0.45**	**-0.24**	**-0.57**	0.15	**0.21**	**0.21**	**0.24**	**0.18**	0.10	**0.24**	**0.38**	**0.30**	**0.49**	0.15	**0.33**	0.17	**0.51**	**0.39**						
24. SEARS Res T1	0.18	0.06	0.10	**0.41**	**0.33**	**-0.53**	**-0.46**	0.15	**0.24**	**0.38**	**0.23**	**0.25**	0.14	**0.55**	**0.38**	**0.54**	**0.44**	**0.33**	**0.21**	**0.31**	0.14	**0.67**	0.43					
25. SEARS Res T2	0.15	0.07	**0.25**	**0.28**	**0.48**	**-0.30**	**-0.69**	0.08	0.18	**0.33**	**0.27**	0.15	0.13	**0.40**	**0.55**	**0.43**	**0.61**	**0.30**	**0.45**	**0.18**	**0.49**	**0.33**	**0.82**	**0.54**				
26. BAS Vocabulary T1	0.09	0.11	0.01	0.10	0.08	-0.11	-0.01	0.04	**0.24**	**0.26**	**0.20**	0.13	0.04	0.17	0.18	0.12	0.15	0.09	-0.01	-0.04	-0.08	0.07	0.03	0.17	0.11			
27. BAS Vocabulary T2	-0.01	**0.27**	0.02	-0.05	-0.02	0.07	0.09	-0.06	**0.22**	**0.22**	**0.36**	**0.21**	**0.20**	-0.01	0.08	-0.10	-0.02	-0.08	0.01	-0.02	0.01	-0.04	0.07	-0.07	0.07	**0.57**		
28. BAS Early Number T1	-0.13	0.06	-0.13	-0.03	0.06	-0.11	-0.05	0.18	**0.34**	**0.55**	**0.43**	**0.33**	**0.30**	0.14	0.08	-0.03	0.02	0.01	0.11	0.09	0.12	0.12	0.08	**0.19**	0.11	**0.32**	**0.27**	
29. BAS Early Number T2	**-0.33**	**0.22**	**-0.25**	0.05	0.04	-0.01	-0.05	**0.29**	**0.31**	**0.42**	**0.54**	**0.32**	**0.43**	0.03	0.09	0.04	0.15	-0.12	0.04	0.13	0.17	**0.26**	**0.28**	**0.19**	**0.27**	0.14	**0.24**	**0.50**

Table I-2. Pearson correlations (Teacher ratings).

Note. Values in bold are statistically significant ($p<.05$).

Appendix J: Correlations between parent and teacher ratings of BRIEF-P and SEARS

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1. P-rated IC T1											
2. P-rated WM T1	.62**										
3. P-rated CF T1	.33**	.31**									
4. P-rated IC T2	.73**	.46**	.30*								
5. P-rated WM T2	.49**	.71**	.24*	.62**							
6. P-rated CF T2	.30*	.23	.76**	.42**	.32**						
7. T-rated IC T1	.28*	.09	-.16	.24*	.11	-.02					
8. T-rated WM T1	.12	.06	-.13	.19	.19	.11	.69**				
9. T-rated CF T1	-.07	-.12	.13	-.05	-.13	.24	.37**	.46**			
10. T-rated IC T2	.22*	.07	-.15	.17	.10	-.08	.68**	.52**	.29*		
11. T-rated WM T2	.05	.06	-.06	.07	.11	-.05	.50**	.60**	.41**	.76**	
12. T-rated CF T2	-.16	-.02	.22*	-.11	-.09	.22	.17	.29*	.53**	.38**	.57**

Table J-1. Correlations between parent-and teacher-rated BRIEF-P
Note. P-rated = parent rated; T-rated = teacher rated; IC = Inhibitory control; WM = Working memory; CF = Cognitive flexibility. *p = < .05. **p = < .01.

Variable	*1*	*2*	*3*
1. P-rated SEARS T1			
2. P-rated SEARS T2	.65**		
3. T-rated SEARS T1	-.04	.26*	
4. T-rated SEARS T2	.07	.10	.47**

Table J-2. Correlations between parent-and teacher-rated SEARS's total scores
*Note.**p = < .05. **p = < .01.

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1. P-rated SC T1											
2. P-rated Emp T1	.27*										
3. P-rated Res T1	.42**	.53**									
4. P-rated SC T2	.62**	.29*	.18								
5. P-rated Emp T2	.22	.71**	.39**	.44**							
6. P-rated Res T2	.28*	.54**	.59**	.52**	.59**						
7. T-rated SC T1	.21*	-.11	-.07	.26*	-.04	.05					
8. T-rated Emp T1	.06	.04	.06	.23*	.21	.30**	.49**				
9. T-rated Res T1	-.06	.04	-.07	.18	.15	.21	.31**	.67**			
10. T-rated SC T2	.30**	-.07	.07	.29	.03	-.03	.55**	.26*	.14		
11. T-rated Emp T2	.02	.13	.06	.05	.16	.06	.18	.39**	.43**	.51**	
12. T-rated Res T2	-.02	.08	-.01	.09	.08	.05	.18	.33**	.54**	.49**	.82**

Table J-3. Correlations between parent-and teacher-rated SEARS
Note. P-rated = parent-rated; T-rated = teacher-rated; SC = social competence; Emp = empathy; Res = responsibility. *p = < .05. **p = < .01.

Appendix K: Intra-class correlation value for each measure at school levels

Measure	Item	Time1	Time2
Direct measure of EF	Peg Tapping	.029	.019
	Digit Span backwards	.077	.135
	DCCS	.020	.028
Parent-rated EF	BRIEF-P (IC)	.077	.103
	BRIEF-P (WM)	.023	.034
	BRIEF-P (CF)	.061	.008
Teacher-rated EF	BRIEF-P (IC)	.087	.102
	BRIEF-P (WM)	.125	.114
	BRIEF-P (CF)	.006	.105
Parent-rated social-emotional skills	SEARS (Social competence)	.124	.013
	SEARS (Empathy)	.029	.025
	SEARS (Responsibility)	.163	.103
Teacher-rated social-emotional skills	SEARS (Social competence)	.137	.069
	SEARS (Empathy)	.130	.013
	SEARS (Responsibility)	.100	.167
Academic achievement	BAS3 (Vocabulary)	.056	.001
	BAS3 (Early Number Concepts)	.059	.298

Table K. Intra-class correlation value for each measure at school levels
Note. BRIEF-P = Behavioural Rating Inventory of Executive Function-Preschool Version; SEARS = Social-Emotional Assets and Resiliency Scale; BAS = British Ability Scale.

University of Oxford
CENTRAL UNIVERSITY RESEARCH ETHICS COMMITTEE (CUREC)
CUREC /1A CHECKLIST FOR THE SOCIAL SCIENCES AND HUMANITIES

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 on human subjects 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 the CUREC website to ensure that you have the correct checklist for your project.

ONLY TYPE-WRITTEN CHECKLISTS WILL BE ACCEPTED. PLEASE DO NOT SEND HANDWRITTEN CHECKLISTS.

ONLY EMAILED APPLICATIONS WILL BE ACCEPTED. PLEASE DO NOT SEND APPLICATIONS BY POST.

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, 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).

The use of an *asterisked word underlined* in this checklist indicates a phrase defined in CUREC's glossary. The glossary and further information on the University's research ethics procedures are available from the CUREC website: http://www.admin.ox.ac.uk/curec/

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 (eg 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.

Office use only: IDREC Ref. No. ___________________

Date of confirmation that checklist accepted on behalf of IDREC: // //

Please complete the sections that follow and follow prompts to stop completion and/or submit other documents.

Please indicate your answer to all the Yes / No questions with a type-written "X".

Example:	**YES**	**NO**

1) 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)?	*X*	

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.		
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 FAQ C12), prisoners or vulnerable adults) *Note: sometimes participants aged 16-17 are regarded as "competent youths" and may be able to consent for research themselves. Please consult the FAQ C12 on the CUREC website. However, if any of your participants are aged 16 or under, please answer 'yes' here and also answer question 4) 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
If you 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 4 below.		
4) Is your project covered by one of our approved research protocol(s)? (see CUREC website) If yes, please give protocol number(s): 25	**YES** X	**NO**
If you answered Yes to ANY of questions 1-3, and answered No to question 4, please STOP COMPLETING THIS CHECKLIST and do not submit it for ethical review. ***Instead, please complete the CUREC/2 application form, available to download from the CUREC website. Then submit the CUREC/2 for ethical review.*** ***If you answered Yes to ANY of questions 1-3, and answered yes to question 4, please go on to SECTION B.***		

SECTION B: contact details and project description (NB must be typed not handwritten).

Contact details	
1) *Principal researcher* / supervisor (if student research):	Hanako Shimamura Supervisors: Dr. Maria Evangelou and Dr. Lars-Erik Malmberg
2) Name of student (if student research):	Hanako Shimamura
3) Degree programme, eg DPhil, BA, MPhil, BSc, MSc (if student research):	DPhil in Education
4) Department or institute name:	Department of Education at the University of Oxford
5) Address for correspondence (if different from 4):	

6) University email address and phone contact:	hanako.shimamura@education.ox.ac.uk Phone: 07500665525
7) Name and status of others taking part in the project. Eg 3rd year undergraduate; post-doctoral research assistant:	First year DPhil

Project description	
8) Title of research project:	Schooling effects on children's self-regulation and cognitive and social-emotional development
9) List of locations(s) where project will be conducted:	Canada
10) If your research involves overseas travel or fieldwork, by the time the research starts, will you have completed and returned a travel risk assessment form? (This may be necessary to ensure that the activity is covered by the University's travel insurance – see http://www.admin.ox.ac.uk/finance/insurance/travel/)	N/A
11) Anticipated duration of project:	16 months
12) Anticipated start date:	15 / 04 /2015
13) Anticipated end date:	30/ 09 /2017

14) Title and brief lay description of *research* (about 150 words), plus description (about 200 words) of the nature of participants.

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.

When describing participants, please include criteria for inclusion/exclusion, method of recruitment, and processes (as appropriate) for consent to participate. To support your description please attach documentation such as:

- recruitment and advertisement material eg a poster or invitation letter
- information for participants to read before they agree to take part eg participant information sheet(s)
- a document to record informed consent eg written consent form(s) or oral consent script in case of an oral consent process
- a guide to interview questions (this may be a list of questions to be asked, or a preliminary scope of questions) or sample of other instruments such as a sample questionnaire
- debriefing document after participants have taken part (if relevant)

Detailed guidance is found on the CUREC website

Title and brief lay description of research (150 words)

Title: Schooling effects on children's self-regulation and cognitive and social-emotional development

Aim: 1) To determine whether some forms of preschool programmes are more effective than others in promoting children's self-regulation and cognitive and social-emotional development, and 2) to examine how the classroom quality reflected in the quality of student-teacher relationships is related to the development of children's self-regulation and cognitive and social-emotional competences.

Research Questions: 1) Is attendance at three different preschool settings (Montessori, MindUP, and regular school) more effective than others in facilitating children's self-regulation, academic achievement, and social-emotional development? 2) Does classroom quality (e.g., emotional support, classroom organization, and instructional support) contribute to children's task engagement? 3) To what extent do different aspects of self-regulation predict different measures of cognitive and social-emotional development? 4) To what extent does the quality of student-teacher relationships predict different measures of cognitive and social-emotional outcomes?

Measurement/instruments:

Direct observation by the researcher

a) The classroom quality (direct observation)– 1) **The Classroom Assessing Scoring System** (CLASS; Pianta, La Paro, & Hamre, 2007). The CLASS (K-3) focuses on three dimensions of quality of student-teacher interaction: emotional support, classroom organization, and instructional support, 2) **Early Childhood Environment Rating Scale Revised** (ECERS-R; Harms, Clifford & Cryer, 1988). ECERS-R evaluates the quality of early childhood settings by measuring the physical environment, basic care of children, curriculum, interactions, schedule and programme structure.
b) Child's task engagement – **Individualized Classroom Assessing Scoring System** (inCLASS; Downer et al., 2010). This assesses child's task orientation including engagement within tasks and self-reliance.

Direct assessment by the researcher

c) Self-regulation skills – Self-regulation will be assessed by well-known tasks according to three core self-regulatory skills (inhibitory control, working memory, and attention) (Diamond et al, 2007): **peg tapping, head toes knees shoulders (HTKS), digit span and dimensional change card sorting (DCCS)**.
d) Cognitive ability – **British Ability Scale Third Edition** (BAS 3; Elliot & Smith, 2011)
e) Literacy attainment – **The York Assessment of Reading Comprehension** (YARC; Snowling et al., 2009).

Questionnaire completed by teachers

f) Student-teacher relationship – **Student Teacher Relationship Scale** (STRS; Pianta, 2001). The STRS measures student-teacher relationship quality in terms of conflict, closeness, and dependency.
g) **Behavioural assessment - Behavioural Rating Inventory of Executive Function (BRIEF-P).** BRIEF-P measures rating scale to capture problems related to everyday executive function behaviours of preschool children.
All completed questionnaires will be collected in sealed envelopes provided by the researcher to ensure a confidential way of delivering and receiving them. Then, names will be replaced with ID numbers, thus all participants remain anonymous.

All data will be stored on the researcher's encrypted and password protected computer / laptop. All names of participants (which are needed for linking data) will be stored separately in a locked filing cabinet in the second supervisor's office. Paper questionnaires and documents will be stored at least five years after any publication of results (in dissertation and articles), and thereafter discarded. Anonymised electronic data matrices will be stored indefinitely.

As participants are below the age of 18 all children require opt-in parental /guardian consent according to protocol 25.

<u>Description of participants and obtaining informed consent (200 words)</u> ***Participants.*** Overall, 120 four and five year-old children are expected to participate in this study. The participants will be made up of three groups of students living in Vancouver, Canada, who attend different forms of educational programmes (Montessori, MindUP and conventional preparatory school). ***Recruitment***: The researcher will send an invitation letter and consent to head teachers (APPENDIX D), and then information sheet (APPENDIX E) and consent form to lead teachers and parents for their participation as well as their children's (APPENDIX F). All children with informed opt-in consent by parents and teachers and parents with the opt-in consent will participate in the study.

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 wants 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 safety as a researcher, participant burdens/risks, and data protection/confidentiality. For more guidance on ethical issues, please see http://www.admin.ox.ac.uk/curec/resources/.*
Ethics: Only the data of those who have signed the consent form will be analysed and used in the study. No reference to individuals will be made within the final report, and thus anonymity will be upheld. There is no perceived harm, risk, or possible injury anticipated from this proposed study. ***Protocols:*** P. 25 (non-invasive methods with children) are applied since this study involves classroom observations as well as human participants under 18 whose ability to give free and informed consent is in question. Parents' consent form is provided to ensure their right for "opting-in" to the study.

16) Will you obtain informed consent according to CUREC guidelines and good practice in your discipline before participation?	**YES**	**NO**
	X	
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**	**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.		**X**

18) Will you ensure that *personal data* collected directly from participants or via a *third party* is held and processed in accordance with the provisions of the Data Protection Act?	**YES**	**NO**
	X	

19) How will you ensure that any personal or sensitive data are captured, transferred and stored securely? *In particular if data are to be captured electronically, please consult with your local IT department and, with respect to University IT security policies, please comment on how you will capture such data in the first instance, how you will transfer them over networks or via portable media and how and where data will be stored. For more information please see the University's web pages on research data management: http://researchdata.ox.ac.uk/university-of-oxford-policy-on-the-management-of-research-data-and-records/*
All consent forms and individual paper-records will be kept behind lock and bar. The Anonymised data in spss-format will be securely stored on the researcher's password protected and encrypted laptop. The supervisor will have a back-up copy on his office PC. Only the researcher and her supervisors will have the access to these data. Data electronic data will be stored indefinitely, while the paper records will be discarded 5 years after the project.

SECTION C: methods and procedures to be used.

In this section, please mark X against as many methods or procedures as apply to your research. (This section will help the committee understand the nature of your research and may be used for audit).

	Please mark "X"
1) Analysis of existing records	
2) Snowball sampling (recruiting through contacts of existing participants)	
3) Use of casual or local workers eg interpreters	
4) Participant observation	
5) Covert observation	
6) Observation of specific organisational practices	**X**
7) Participant completes questionnaire in hard copy	**X**
8) Participant completes online questionnaire or other online task	
9) Using social media	
10) Participant performs paper and pencil task	
11) Participant performs verbal or aural task (eg for linguistic study)	**X**
12) Focus group	
13) Interview	
14) Audio recording of participant	
15) Video recording of participant	
16) Photography of participant	
Others (please specify):	

SECTION D: professional guidelines and training.

In this section, please mark X against at least one of the following professional guidelines. 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 (active links below)**	**Please mark "X"**
Anthropology	Association of Social Anthropologists of the UK and Commonwealth	

Criminology	British Society of Criminology: Code of Ethics for Researchers in the Field of Criminology	
Education	British Educational Research Association Ethical Guidelines for Educational Research	**X**
Geography	Association of American Geographers Statement on Professional Ethics	
Geography	Royal Geographical Society: Research Ethics and Code of Practice	
History	Oral History Society of the UK Ethical Guidelines	
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 British Psychological Society: Conducting Research on the Internet: (Guidelines for internet-mediated research)	
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 ***Protocol 25***		

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://www.admin.ox.ac.uk/curec/training/)

If no formal training has been received, please indicate any discussions of research methodology between researchers and supervisors here.

- Online training for ethics (Research Integrity: social and behavioural sciences) – completed Apr 7, 2014.

SECTION E: Signatures.
Please ensure this checklist is signed by:

For staff research:	*For student research:*
1) *Principal researcher*	**1) *Principal researcher* (project supervisor)**
2) Head of Department (or nominee)	**2) Head of Department (or nominee)**
-	**3) Student researcher**

1) Principal researcher signature / supervisor signature (if student research)

I understand my responsibilities as *principal researcher* 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 researcher on this project and supply the name and contact details of my successor if appropriate.

Signed by principal researcher / supervisor: …   ……

Print name (block capitals) ……Lars-Erik Malmberg………Maria Evangelou ……………………………….

Date …9/3/2015……….

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 researcher 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 protocols, and that it is appropriate for the research to proceed (noting the principal researcher'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) consider that the principal researcher/supervisor/student researcher is aware of her/his ethical responsibilities in regard to this research. I 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)* 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 researcher properly authorised by the CUREC system.
Signed by student: ……Hanako Shimamura………………………….. Print name (block capitals) …Hanako Shimamura………….. Date: ……March 9, 2015……………………..

SECTION F: final check before submitting your application.

	Please mark "X"
Have you completed Sections A-E?	X
Have you included copies of any documentation produced with your application? ***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
Have you signed as principal researcher and gathered signatures of the student (for student research) and department nominees as appropriate?	X
Have you declared conflicts of interest (if any) in Section B question 14?	

Are all pages (including supporting document attachments) numbered?	X
Have you defined all technical terms and abbreviations used?	X

How to submit the completed checklist

- ***If your department has a Departmental Research Ethics Committee (DREC), submit this checklist and supporting information to the appropriate departmental officer. To see a list of DRECs, go to www.admin.ox.ac.uk/curec/about/sshidrec/drecs/***

- ***If your department does not have a DREC, submit the checklist and supporting information to the SSH IDREC (email ethics@socsci.ox.ac.uk). NB applications must be sent by email. Please do not send applications by post.***

Note on how to send signatures needed in Section E

- ***If you have obtained handwritten (wet-ink) signatures, please scan them plus the rest of the checklist pages to create a single PDF document and email through.***

- ***Alternatively, we accept "electronic signatures" sent as email confirmations from a University of Oxford email address. Separate emails should come from each of the relevant signatories as outlined in Section E, indicating acceptance of the relevant responsibilities.***

IDRECs and/or CUREC will review a sample of completed checklists and may ask for further details of any project.

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

15 Norham Gardens, Oxford OX2 6PY
Tel: + 44(0) 1865 274024

Schooling effects on promoting children's self-regulation and cognitive and social-emotional development

Dear Principal and Teachers,

My name is Hanako Shimamura, and I am a doctorate student at the Department of Education at the University of Oxford. I am also a trained early childhood educator/BC Independent teacher certificate holder and have worked in Vancouver, Canada in the past. As a doctorate project, I am hoping to conduct a survey and observation study at your school.

The aim of the research is to 1) determine the benefits of different early childhood education programs and 2) examine the role of the quality of teacher-child relationships, self-regulation, and social-emotional skills in promoting academic achievement and how these factors are affecting one another. I am writing to you today to kindly ask for your permission to carry out a study in your school. The results of the study will be reported in my dissertation paper.

The participants will be preschool-aged children and their teachers and parents, and the study will involve classroom observations once a year and questionnaires twice a year (fall and spring). The observation will be administered for 2 hours per classroom. Individual students are asked to complete tasks regarding their self-regulation skills, cognitive ability and early academic achievement. Parents are asked to fill in questionnaires regarding their relationships with their child and their perspectives of the child's general behaviours twice a year, which is estimated to take approximately 10 minutes. Each teacher is asked to fill in questionnaires about his/her relationships with each child and behavioural and social-emotional skills of individual children.

By participating in the study, your school will contribute to our research project aiming at deepening knowledge about the benefits and importance of early childhood education programs. Research findings can also shed light on an impact of child-teacher interactions upon different aspects of child development.

If your school agrees to participate I hope you will allow me to observe the classrooms and ask head teachers and parents to complete questionnaires. I would like to kindly request teachers' help in distributing and collecting consent forms.

Care will be taken to work out a schedule with teachers, so that there is minimal disruption to a smooth classroom operation. All measures will be considered to ensure that children are happy and comfortable.

All data collected as well as consent forms will be securely stored in a locked filing cabinet at the University of Oxford, and available only to my supervisors and myself. The study is not intended as a specific evaluation of a child. No reference to individuals will be made within the final report, and thus anonymity will be upheld. There is no perceived harm, risk, or possible injury anticipated from this proposed study. At the end of the study, I will send a brief summary of the findings to those who are interested. The study has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.

I hope you will be interested in participating in this research. If you have any questions or concerns at any time before, during or after the project, please feel free to contact me at hanako.shimamura@education.ox.ac.uk, or my supervisor Dr. Lars-Erik Malmberg at lars-erik.malmberg@education.ox.ac.uk or Dr. Maria Evangelou at maria.evangelou@education.ox.ac.uk.

I would be grateful if you could complete the pro-forma below and return it to me. I know that you are busy, so thank you very much for your time. I look forward to hearing from you.

Best wishes,

Hanako Shimamura

- I wish to participate in this study. **Yes/ No**

Please return this to the researcher.

Thank you very much for your help.

Hanako Shimamura
University of Oxford
hanako.shimamura@education.ox.ac.uk

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

15 Norham Gardens, Oxford OX2 6PY
Tel: + 44(0) 1865 274024

Dear Parents/Guardians,

In partnership with the University of Oxford, your child's school has kindly agreed to participate in a study for a doctorate research project; *Schooling effects on promoting children's self-regulation and cognitive and social-emotional development.* The expected commencing date is November 2015.

Who is carrying out the study?
My name is Hanako Shimamura, and I am currently a doctorate student at the Department of Education at the University of Oxford. I am also a trained early childhood educator who has worked in Canada for six years in the past.

What is the aim of this study?
The primary aim of the study is to 1) examine the benefits of different early childhood education programmes and 2) explore the relations among the quality of student-teacher interactive relationships, children's self-regulation, academic achievement, and social-emotional competences. I am especially interested in the impact of the student-teacher relationships on children's developmental trajectories.

Why is this study important?
The time that children spend in school is a critical window of opportunity during which their learning abilities can be maximized or limited. It is important to understand how/what types of classroom characteristics, especially student-teacher interactions, can help provide an effective and emotionally supportive learning environment for the healthy development of young children. I am hoping that the findings of this study will help promote the benefits and importance of quality early childhood education programmes.

What will involve?
I will visit your child's classroom twice a year (autumn and spring) to observe the teacher-child interactions that take place there. I will ask your child to complete various tasks/games to measure different developmental aspects. I will also like you to fill in a questionnaire regarding your child's general behaviours twice a year, which is estimated to take approximately 10 minutes each time. Each teacher will be asked to fill in brief questionnaires about his/her relationship with your child and general behaviours of your child at school.

Would my child and I need to participate in this study?

Participation in this study is completely voluntary. You and your child have the right to withdraw from the study at any stage by simply informing the researcher.

What are the benefits of my participation?

By participating in this study, you and your child will contribute to our research project aiming to determine the benefits of early learning centres and examine the contribution of quality student-teacher relationships. The implications of the research findings can shed important light on the importance of early childhood education. Your help will be tremendously appreciated!

What will happen to the data/findings of the study?

The study is not intended as a specific evaluation of the child. All data collected for this research will be securely stored in a locked filing cabinet, and will be only available to my supervisors and myself. No reference to individuals will be made within my dissertation, and thus anonymity will be upheld. There is no perceived harm, risk, or possible injury anticipated from this proposed study. At the end of the study, I will give your school a brief report of the findings and it will be available to interested families.

Ethics

The study has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.

Contact

If you have any questions or concerns at any time before, during or after the project, please feel free to contact me at hanako.shimamura@education.ox.ac.uk, my supervisor Dr. Lars-Erik Malmberg at lars-erik.malmberg@education.ox.ac.uk or Dr. Maria Evangelou at maria.evangelou@education.ox.ac.uk.

Please complete the following section and return to your child's teacher.

Thank you very much for your time.

Hanako Shimamura
PhD Candidate
Department of Education
University of Oxford

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

15 Norham Gardens, Oxford OX2 6PY
Tel: + 44(0) 1865 274024

Schooling effects on promoting children's self-regulation and cognitive and social-emotional development

Parent/guardian consent form

I hereby confirm that (please tick boxes)

☐ I have read and understood the details of the study.

☐ I have had the opportunity to ask questions and discuss the study with others.

☐ I understand that the participation is voluntary and that my child or I are free to withdraw from the study at any given time by simply advising the researcher, without giving further explanation.

☐ I understand that this project has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.

☐ I understand who will have access to the data collected, how the data will be stored, and what
will happen to the data at the end of the study.

☐ I give permission for my child and myself to take part in the study.

Child's Name (block capitals): ____

Parent/Guardian Name (block capitals):
____

Parent/Guardian Signature: ______________________ Data: __________

Researcher's Name:
____

Researcher's Signature: _________________________ Data: __________

UNIVERSITY OF OXFORD

DEPARTMENT OF EDUCATION

15 Norham Gardens, Oxford OX2 6PY
Tel: + 44(0) 1865 274024

Schooling effects on promoting children's self-regulation and cognitive and social-emotional development

Teachers consent form

I hereby confirm that (please tick boxes)

☐ I have read and understood the details of the study.

☐ I have had the opportunity to ask questions and discuss the study with others.

☐ I understand that the participation is voluntary and that my students or I are free to withdraw from the study at any given time by simply advising the researcher, without giving further explanation.

☐ I understand that this project has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.

☐ I understand who will have access to the data collected, how the data will be stored, and what will happen to the data at the end of the study.

☐ I agree to take part in the study.

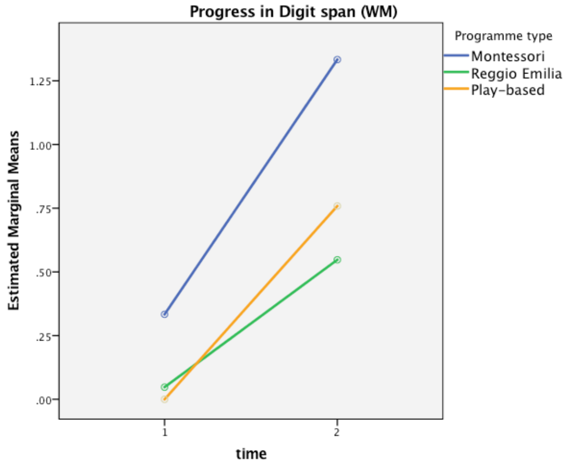
Your Name (block capitals): ____

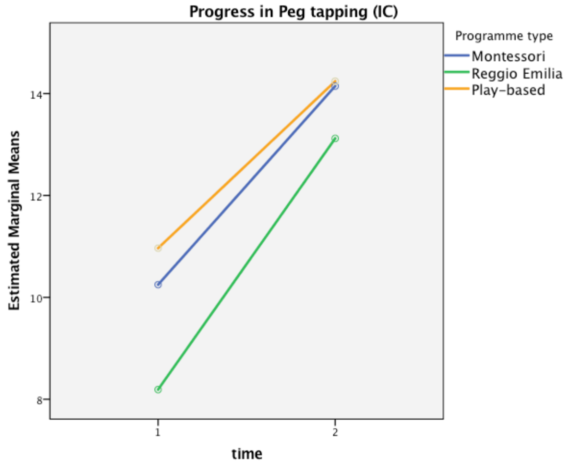
Your Signature: ________________________ Data: ___________

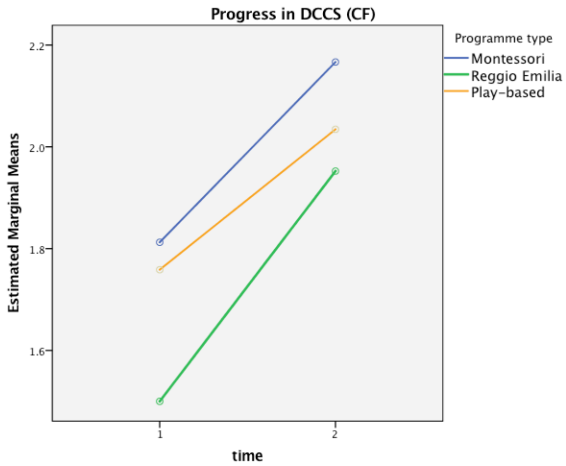
Researcher's Name: ____

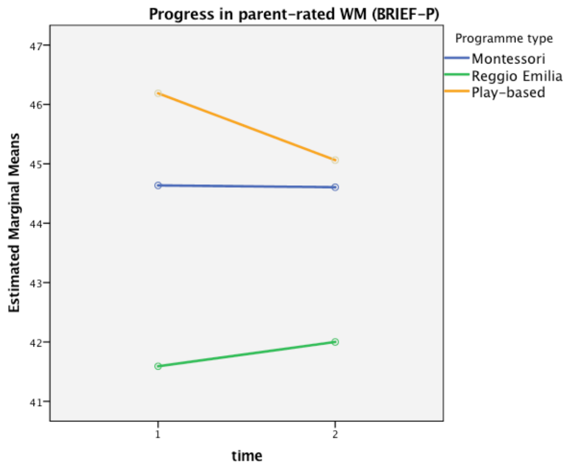
Researcher's Signature: ___________________________ Data: ___________

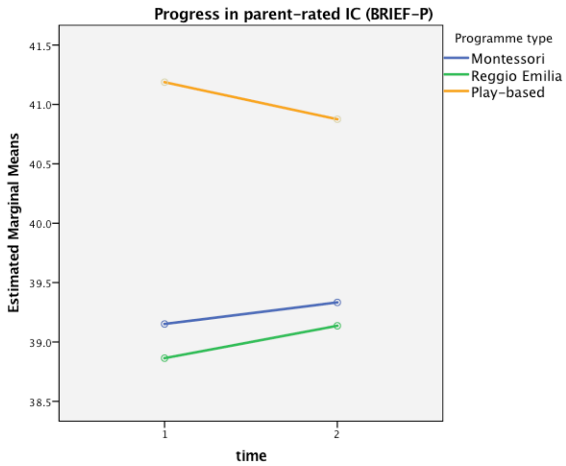
Appendix Q: Main effects for time in a mixed between-within subjects ANOVA

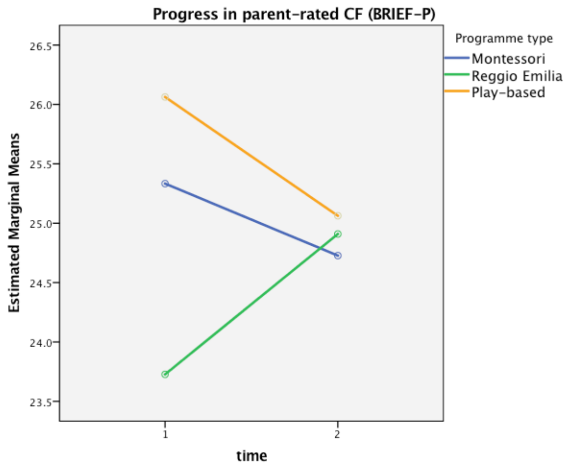


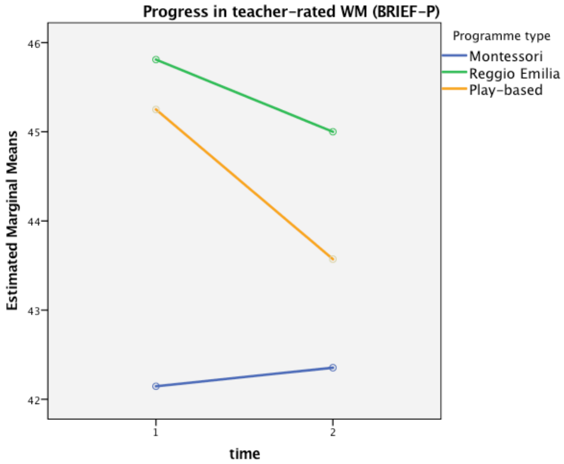


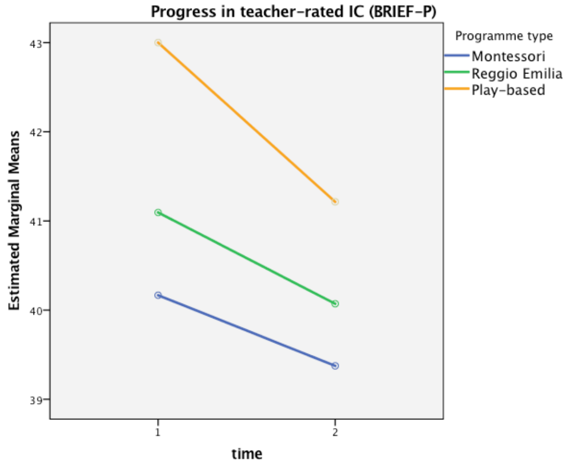


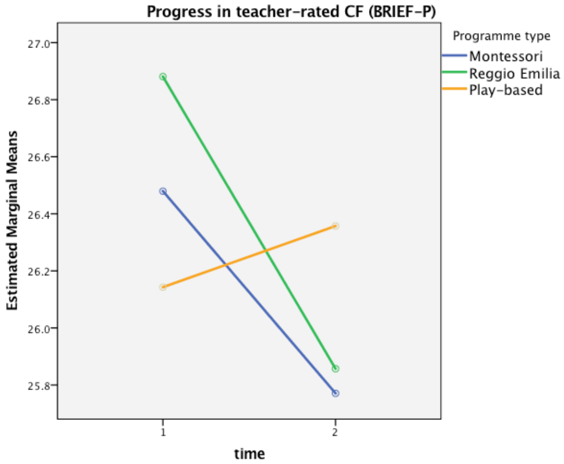


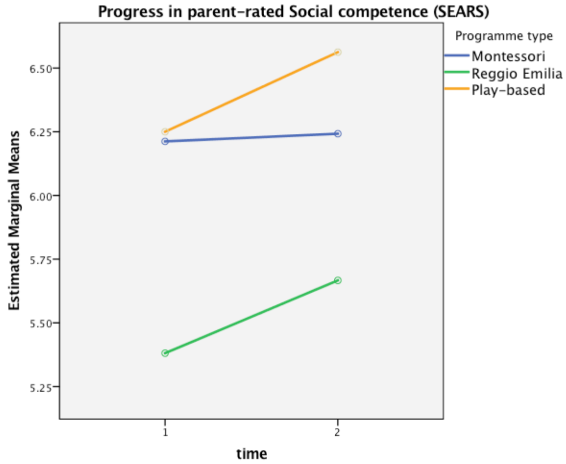


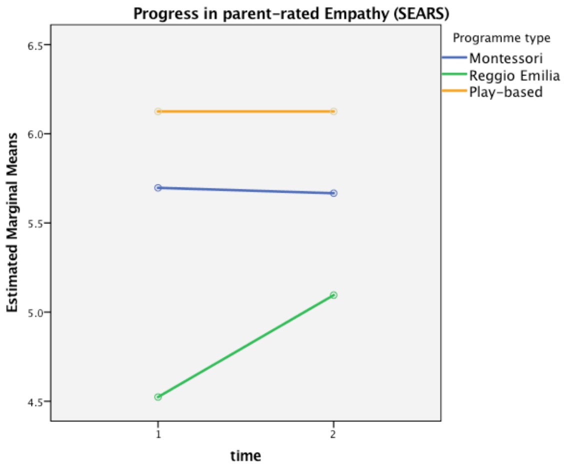


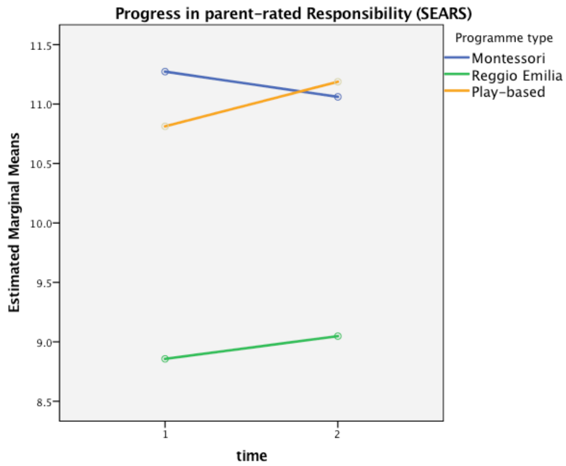

Progress in teacher-rated WM (BRIEF-P)
Programme type
Montessori
Reggio Emilia
Play-based
Estimated Marginal Means
42
43
44
45
46
1
2
time

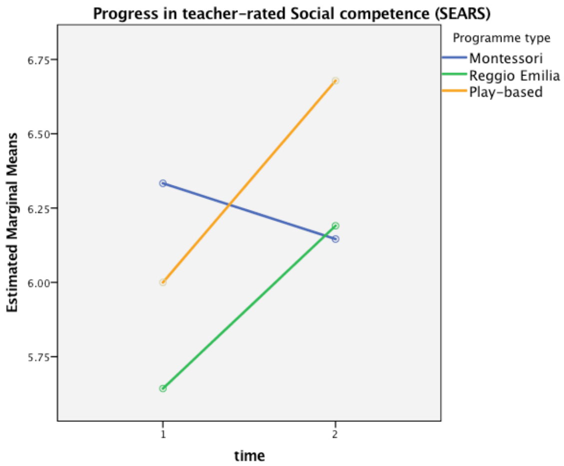

Progress in teacher-rated IC (BRIEF-P)
Programme type
Montessori
Reggio Emilia
Play-based
Estimated Marginal Means
39
40
41
42
43
1
2
time

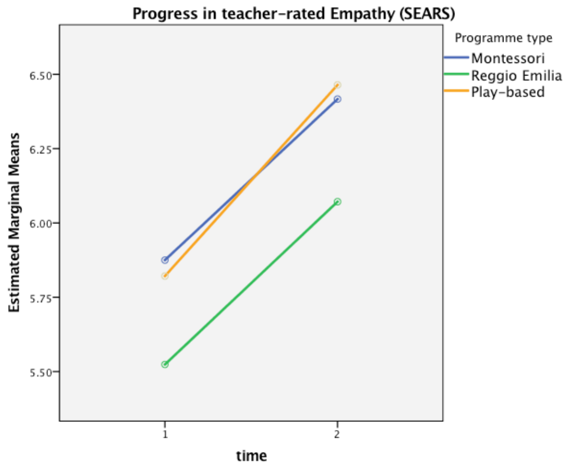

Progress in teacher-rated CF (BRIEF-P)
Programme type
Montessori
Reggio Emilia
Play-based
Estimated Marginal Means
25.8
26.0
26.2
26.4
26.6
26.8
27.0
1
2
time

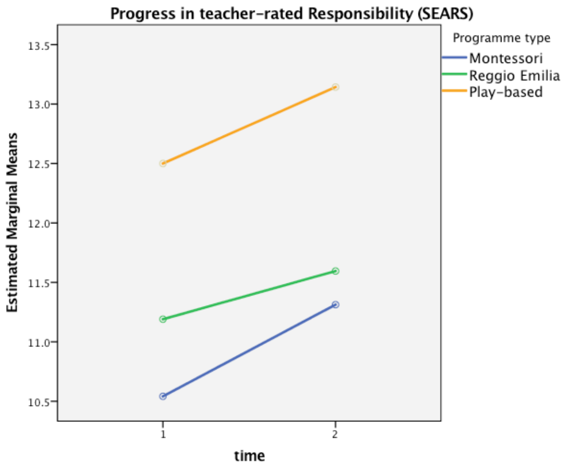

Progress in parent-rated Social competence (SEARS)
Programme type
Montessori
Reggio Emilia
Play-based
Estimated Marginal Means
5.25
5.50
5.75
6.00
6.25
6.50
1
2
time

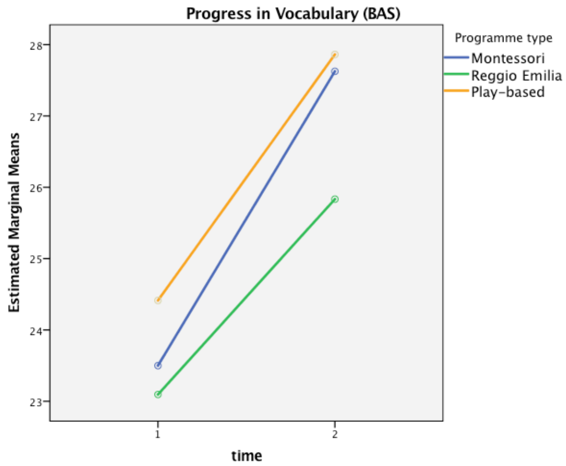

Progress in parent-rated Empathy (SEARS)
Programme type
Montessori
Reggio Emilia
Play-based
Estimated Marginal Means
4.5
5.0
5.5
6.0
6.5
1
2
time

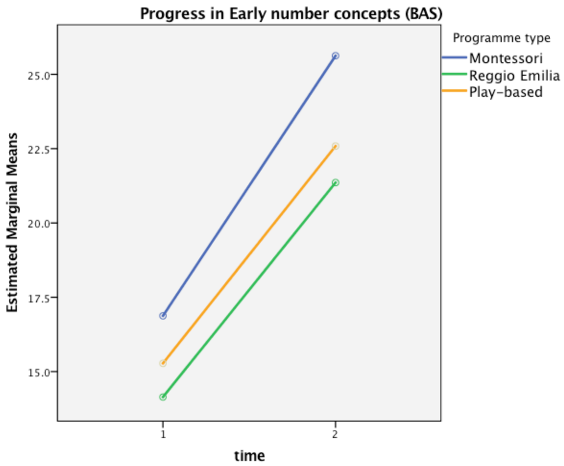

Progress in parent-rated Responsibility (SEARS)
Programme type
Montessori
Reggio Emilia
Play-based
Estimated Marginal Means
8.5
9.0
9.5
10.0
10.5
11.0
11.5
1
2
time


Progress in teacher-rated Social competence (SEARS)
Estimated Marginal Means
6.75
6.50
6.25
6.00
5.75
1
2
time
Programme type
Montessori
Reggio Emilia
Play-based


Progress in teacher-rated Empathy (SEARS)
Estimated Marginal Means
6.50
6.25
6.00
5.75
5.50
1
2
time
Programme type
Montessori
Reggio Emilia
Play-based


Progress in teacher-rated Responsibility (SEARS)
Estimated Marginal Means
13.5
13.0
12.5
12.0
11.5
11.0
10.5
1
2
time
Programme type
Montessori
Reggio Emilia
Play-based


Progress in Vocabulary (BAS)
Estimated Marginal Means
28
27
26
25
24
23
1
2
time
Programme type
Montessori
Reggio Emilia
Play-based


Progress in Early number concepts (BAS)
Estimated Marginal Means
25.0
22.5
20.0
17.5
15.0
1
2
time
Programme type
Montessori
Reggio Emilia
Play-based

Appendix R: Correlations between the CLASS domains and school readiness skills

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*
1. CLASS Emotional Support	-																								
2. CLASS Classroom Organisations	**0.85**																								
3. CLASS Instructional Support	0.57	**0.32**																							
4. Peg tapping T1	-0.07	0.01	**-0.29**																						
5. Peg tapping T2	-0.11	-0.03	**-0.20**	**0.48**																					
6. DSBWD T1	**0.22**	**0.27**	-0.05	0.18	0.10																				
7. DSBWD T2	0.13	**0.18**	-0.06	**0.36**	**0.29**	**0.35**																			
8. DCCS T1	0.01	0.06	-0.15	**0.42**	**0.39**	0.13	**0.27**																		
9. DCCS T2	0.03	0.15	**-0.21**	**0.39**	**0.45**	0.17	**0.29**	**0.32**																	
10. BRIEF-P Teacher-rated WM T1	0.08	-0.07	-0.07	0.12	0.07	0.01	0.17	0.10	0.05																
11. BRIEF-P Teacher-rated WM T2	0.11	-0.01	0.14	0.13	0.15	-0.05	0.14	0.05	-0.06	**0.60**															
12. BRIEF-P Teacher-rated IC T1	0.12	-0.02	0.01	0.13	0.02	-0.01	0.15	0.17	0.05	**0.69**	**0.50**														
13. BRIEF-P Teacher-rated IC T2	0.07	-0.01	0.06	0.13	0.11	-0.03	0.17	0.13	-0.05	**0.52**	**0.76**	**0.68**													
14. BRIEF-P Teacher-rated CF T1	0.13	0.01	**0.22**	0.06	0.01	-0.02	0.03	0.04	-0.03	**0.46**	**0.41**	**0.37**	**0.29**												
15. BRIEF-P Teacher-rated CF T2	0.09	0.05	**0.22**	0.08	0.07	0.11	0.02	0.02	-0.06	**0.29**	**0.57**	0.17	**0.38**	**0.53**											
16. SEARS Teacher-rated SC T1	0.01	0.05	0.03	**0.24**	0.15	0.09	0.06	0.09	0.04	0.05	-0.01	-0.14	-0.12	**0.24**	**0.20**										
17. SEARS Teacher-rated SC T2	-0.18	-0.01	0.05	0.16	**0.22**	0.08	-0.01	-0.03	0.04	-0.04	**0.20**	**-0.23**	0.03	0.15	**0.53**	**0.55**									
18. SEARS Teacher-rated Emp T1	-0.02	0.04	-0.15	**0.29**	**0.26**	**0.23**	**0.22**	**0.21**	0.17	**0.26**	0.01	**0.27**	**0.20**	0.01	0.03	**0.49**	**0.26**								
19. SEARS Teacher-rated Emp T2	-0.02	0.06	-0.05	**0.21**	**0.24**	0.15	**0.21**	**0.18**	0.10	**0.24**	**0.38**	**0.30**	**0.49**	0.15	**0.33**	0.17	**0.51**	**0.39**							
20. SEARS Teacher-rated Res T1	-0.03	-0.06	-0.11	**0.38**	**0.23**	0.15	**0.24**	**0.25**	0.14	**0.55**	**0.38**	**0.54**	**0.44**	**0.33**	**0.21**	**0.31**	0.14	**0.67**	**0.43**						
21. SEARS Teacher-rated Res T2	-0.15	-0.01	-0.12	**0.33**	**0.27**	0.15	0.18	0.15	0.13	**0.40**	**0.55**	**0.43**	**0.61**	**0.30**	**0.45**	**0.18**	**0.49**	**0.33**	**0.82**	**0.54**					
22. BAS Vocabulary T1	-0.09	-0.08	**-0.20**	**0.26**	**0.20**	0.04	**0.24**	0.13	0.04	0.17	0.18	0.12	0.15	0.10	-0.01	-0.04	-0.08	0.07	0.03	0.17	0.11				
23. BAS Vocabulary T2	-0.14	-0.07	**-0.27**	**0.22**	**0.36**	-0.06	**0.22**	**0.21**	**0.20**	-0.01	0.08	-0.10	-0.02	-0.08	0.01	-0.12	0.01	-0.04	0.07	-0.07	0.07	**0.57**			
24. BAS Early Number T1	0.09	**0.19**	-0.11	**0.55**	**0.43**	0.18	**0.34**	**0.33**	**0.30**	0.14	0.08	-0.03	0.02	0.01	0.11	0.09	0.12	0.12	0.08	**0.20**	0.11	**0.32**	**0.27**		
25. BAS Early Number T2	0.12	**0.36**	-0.13	**0.43**	**0.54**	**0.29**	**0.32**	**0.32**	**0.43**	0.03	0.10	0.04	0.14	-0.12	0.04	0.13	0.17	**0.26**	**0.28**	**0.19**	**0.27**	0.14	**0.24**	**0.50**	

Table R. The correlations between the CLASS domains and outcome variables.

Note. DSBWD=Digit span backwards; DCCS=Dimensional change card sorting; WM=Working memory; IC=Inhibitory control; CF=Cognitive flexibility; SC=Social competence; Emp=Empathy; Res=Responsibility.