Artificial Intelligence (AI): How can we use Artificial Intelligence in Secondary School Geography?

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MSc in Learning and Teaching, 2024

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To my parents—

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Abstract

This research and development project uncovers how artificial intelligence (AI) can be used by secondary school geography teachers. A critical review of the literature suggests a gap for empirical research on AI in the geography classroom. Whilst AI has much to offer geography teachers, there are important ethical dilemmas (Wilby and Esson, 2023). Contextualised in an institution with a whole-school focus on creativity, the literature on creativity is critically reviewed. This practitioner research employs a qualitative methodology. Interviews with geography teachers (*n=4*) are the main research instrument to uncover how (and why) teachers use AI, how AI enhances creativity and the barriers to usage before and after an intervention. The project is designed in collaboration with colleagues, with professional learning being central to the intervention which seeks to develop participants' use of AI. The findings firstly suggest that AI is used to varying degrees and for varying purposes, in general with a greater degree and variety of use following the intervention. Second, AI is positioned to assist, but not replace, students and teachers in their pursuit of creativity in geography education. Third, operational and broader, ideological barriers restrict teachers' AI usage. Before the intervention, these included a lack of training and concerns with reliance, with concerns over access, inaccurate information, misuse and student apprehension prevailing after the intervention. The project suggests that avenues for further research include cross-department or cross-institutional studies exploring creative teaching and learning with AI, together with investigations into the impact of AI use on teachers and students.

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1. Introduction

As a geography teacher at a progressive London school, technology use is highly encouraged under school policy. Despite this, and the increasing attention given to the impact of AI in education within policy documents (Felix and Webb, 2024; Department for Education (DfE), 2023a; 2023b; 2024), academia (Dignum, 2021; Karan and Angadi, 2023) and the media (see, for example, Jorgenson, 2024), some colleagues are uncertain over if, and when, they could use AI. As AI captivates 'significant attention across all areas of social life' (Eynon and Young, 2021, p.166), I use this research and development project to uncover how geography teachers in my school (School A) use AI, in pursuit of further developing professional practice. In this study, 'AI' refers to commercially available 'generative AI language models such as ChatGPT' (Chang and Kidman, 2023, p.88) and other models available to teachers at School A, including Google Gemini. This study builds on my Year 1 Assignment, which explores how teachers use technology within Year 12 geography, with both projects helping shape my own practice through my concurrent early career teacher (ECT) years and beyond. This project also aims to develop colleagues' professional practice by expanding their use of AI.

The calls for further research on AI in geography education literature form a second rationale. The theoretical perspectives suggest AI *may* be useful to geography teachers. For example, the editors of the journal *International Research in Geographical and Environmental Education (IRGEE)*, call for projects to explore 'the key issues and discover better ways to engage' technology such as AI (Chang and Kidman, 2023, p.87). The current study responds directly to this invitation by exploring how AI is used by geography teachers within School A. This aims to move forward conversations on 'the pedagogic potential of digital technologies to

support, inspire and empower students' learning' (Willis, 2023, p.110) by uncovering how newly-commercially available AI models fit into and develop professional practice. To do this, the study aims to answer three research questions (RQs):

1. How is AI used by geography teachers?
2. How can AI be used creatively by geography teachers?
3. What are the barriers to AI usage by geography teachers?

RQ1 explores to what extent, and for what purpose, AI is used by geography teachers at School A. Given a whole-school focus on creativity across the duration of the study, RQ2 explores how teacher AI usage can lead to or enhance creativity. RQ3 recognises, that despite huge opportunities, AI models are not a panacea for geography education (Wilby and Esson, 2023), uncovering the existing obstacles to using the technology. The literature review critically reviews how AI in education and creativity are conceptualised, together with an analysis of the ethical issues concerning AI in school. The study concludes that AI usage is highly variable, and whilst AI can help enhance creativity, there exist key operational and broader barriers to usage.

2. Critical Review of the Literature

This exploratory study aims to uncover how teachers of geography use AI. This critical review of the literature presents the context of the current study, by positioning this research as an empirical addition to the existing literature. As a means of reviewing the surrounding literature, ideas are explored under three main questions:

1. How is AI conceptualised in geography education?
2. How does has creativity been conceptualised?
3. What ethical issues arise with the use of AI in education?

These questions enable a critical review of evidence from a broad range of sources. To examine question 1, a range of academic, professional and policy literature is examined, which brings to light the views and practices of geography teachers. For the second question, academic literature is analysed in conjunction with policy and teacher views to uncover how creativity is understood. Finally, question 3 draws on a range of policy and academic sources to explore the issues raised by AI use in education, coupling these with the experience of teachers.

2.1 How is AI conceptualised in geography education?

Research on the 'digital' in the discipline of geography is not novel. The subject has been theorised as undergoing a 'digital turn', within which 'geographies produced *through*, produced *by* and *of* the digital' is a framework for exploring the implications of technology on the subject (Ash *et al.*, 2018, p.27). Indeed, geographical scholarship suggests that algorithms have a profound effect on prosaic activities (Dodge and Kitchin, 2005), including the 'reshaping [of] home life in different domestic space' (Dodge and Kitchin, 2009, p.1344). To exemplify this,

Dodge and Kitchin (2005, p.164) use three brief episodes to highlight how 'code mediates, augments, regulates, and facilities' the lives of individuals in London. Dodge and Kitchin's (2005; 2009) arguments appear to support the multifaceted impacts of technology that Ash *et al.* (2018) present. In effect, 'software... modulates how space comes into being through a process of transduction (the constant making anew of a domain in reiterative and transformative practices)', meaning that the geographical concept of space is directly influenced by technology (Kitchin and Dodge, 2011, p.16). The way geography education changes due to technological developments is becoming increasingly important in the literature (Walshe and Healy, 2021), and whilst Kitchin and Dodge's (2005) arguments are almost twenty years old, much of their original discussions remain relevant as debates have advanced. For example, conversations have developed towards how technology impacts knowledge (Puttick, 2021), the threat of inaccurate information (Roberts, 2021) and the relative merits of using specific technologies, such as virtual reality (Hagge, 2023) and video games (Hobbs *et al*., 2023) in the classroom. Therefore, geography has a role in exploring how technology reshapes existing practices.

The study of AI in geography, and geography education, is more novel. Willis (2023, p.110) signposts the dichotomy between groups who view AI as an 'existential threat for humanity' and those who suggest that AI has beneficial potential. When considering any technology, it is important to 'highlight the importance of context, acknowledging the physical and social environments and relations within which technology is adopted and used' (Willis, 2023, p.110), and AI is no different. In this vein, the use of AI in geography education is school and lesson-specific. This is a theme which has not been considered well in the literature. Equally, technologies such as AI are unlikely to solve educational problems, and may worsen

some (Willis, 2023). Willis' (2023) warning supports Selwyn's (2022, p.624) argument that using AI in education can further 'systematically disadvantage and oppress minoritised groups', but there is a need to evaluate and evidence these concerns. Whilst the potential issues of AI use are discussed in Section 2.3, there is some concern with the use of AI in geography.

AI is conceptualised as a technology that holds potential within geography education. In their review of popular generative AI model, ChatGPT, Wilby and Esson (2023, p.6) argue that the tool is 'the start of an AI revolution in learning and research', which has scope for developing geography education. 'High-level synthesis, editing, resource creation, [and] sequential information-gathering' are among the opportunities posed by ChatGPT (Wilby and Esson, 2023, p.6), and, whilst this may be the case, further research is needed to support these claims. Indeed, the ability of AI tools to quickly 'present a century's worth of' data is currently a key strength (Lee, 2023, p.1131), but one may question how this relates to the classroom. Nevertheless, AI tools hold much potential to sort and generate data (Lee, 2023; Wilby and Esson, 2023).

2.1.1 Benefits of AI

Pragmatic pedagogical benefits of using AI are beginning to feature within the literature. Writing in the professional journal *Teaching Geography*, Griffiths (2023a) explores the role of using AI to support a topic on climate change. Although there are some clear issues with using AI, for example being unable to correct mistakes in prompts, generative AI tools can 'reignite students' curiosity, reflect on geographical and ethical dimensions', and create a 'deep well of essay-style text to critique' (Griffiths, 2023a, p.71). Therefore, AI could be used to appraise an argument, in addition to providing different perspectives on a given 'moral, geographical issue',

even if the understanding is sometimes 'flawed' (Griffiths, 2023a, p.69). Griffiths (2023a) exhibits some potential benefits of AI, but the literature needs to explore these in greater depth to evaluate these claims. Indeed, generative AI tools could 'considerably decrease teachers' workload' and provide students a partner to 'debate' with to develop their argumentation (Farrokhnia *et al.*, 2023, p.6), but similar caution must be applied until this is proven. Therefore, there are some pedagogical opportunities to use AI.

AI could also be beneficial in providing evaluation of written work. Zhai (2022, p.9) suggests that AI could write a paper that was 'coherent, (partially) accurate, informative, and systematic'. This means that AI tools could help with the refinement of thoughts and the co-production of high-quality resources in school. Steiss *et al*. (2024) take this further, noting that whilst tools such as ChatGPT are not impeccable in critiquing work, it could be useful in providing constructive comments on initial ideas and writing. AI facilitates 'immediate feedback' on early versions of ideas and potentially signposts additional avenues of thought (Steiss, 2024, p.13). Importantly, however, AI does not replace the role of the teacher. Instead, ChatGPT provides 'feedback immediately and iteratively' in situations when teacher input may be unavailable, meaning that AI tools essentially enhance the learning process (Steiss *et al.,* 2024, p.2). Steiss *et al*.'s (2024) argument supports Farrokhnia *et al.*'s (2023) in that AI tools can relieve pressure on teachers by enabling more seamless comments on ideas. In this vein, AI can create written material (Zhai, 2022) and help develop ideas (Steiss, 2024).

Blog posts also share some AI best practices in geography education. Stockings (2023) argues that geography teachers must explore using AI to ensure their literacy with these tools, and this study moves the conversation towards the outcome of this. Such endeavours may

further enable the sharing of best practices, which will inform the future of AI usage in geography education (Stockings, 2023). With AI's ability to produce material at speed (Griffiths, 2023b), the benefits for teacher workload are well documented (Farrokhnia *et al.*, 2023; Monteith, 2023) and there seem to be many AI tools that may aid geography teachers (Ali, 2023). However, there is a dearth of evidence on empirical impact or usage of these. Indeed, some geography teachers are eager to see how AI will develop in teaching (Kerr, 2023), and whilst there is some guidance on how to use this technology in geography teaching (Geographical Association (GA), no date) this could change in the future. For instance, the use of 'flipped learning' whereby higher-order thinking is completed in class could be aided by AI and reduce the potential negative impact of inappropriate AI usage (Alcock, 2024, n.p.) and AI itself could support revision activities if used correctly (Logue, 2023). Although these examples signpost potential avenues for AI intervention, the context-specific nature of the technology means teachers will need to carefully consider how to implement AI in their classrooms. Despite this, blog posts enable the sharing of best practices.

In contrast, AI has been conceptualised as capable of revolutionising assessment. It has been argued that testing needs 'reimagining' following the increasing accessibility of AI (Lee and Syam, 2023, n.p.). In some settings, assessment has been thoughtfully reconsidered. At the University of Sydney, a '"two-lane" approach to assessment' is pioneered, whereby some assessments are taken in controlled conditions without AI access, and, in others, AI usage is encouraged (Lui and Bridgeman, 2023, n.p.). The approach described by Lui and Bridgeman (2023) is a sensible step and perhaps endorses Richardson's (2023) argument that AI can enhance assessment. Indeed, 'AI in language assessment has proved to be a game changer'

(Richardson and Clesham, 2021, p.10), and other subjects should aim to use AI in similar ways. Richardson and Clesham (2021) outline an intricate process of ensuring the AI model understands how to mark correctly, but high-stakes testing is used to exemplify their argument. As one of the authors declares employment at a global education assessment organisation, which publicly advocates the use of AI in assessment (see Pearson, 2023), assessment innovation appears more relevant on national to global scales than within individual schools. At the time of writing, there are no high-stakes applications of AI to mark students' geographical work, although some literature suggests that ChatGPT could accurately mark short-answer questions and arrive at the correct level for an A-Level essay question (Hickman and Ghosh, 2024). Whilst Hickman and Ghosh (2024) recognise the importance of teacher expertise, the analysis is based on only two example responses (with a handful of marking options), so further testing is needed to validate these claims. Whilst the ethical concerns of AI assessment are discussed in Section 2.3, educational assessment can be refined in the face of AI.

2.1.2 Concerns surrounding AI

There are some limitations to using AI in geography education. In this section, concerns about over-reliance, the role of the teacher, assessment and teacher concerns will be explored. First, Chang and Kidman (2023) highlight many questions that researchers in geography education should address and suggest that there are multiple reasons to avoid an over-reliance on AI, for example, due to the quality of information provided. Indeed, AI tools sometimes produce 'hallucinated text' which 'gives the impression of being fluent and natural despite being unfaithful and nonsensical' (Ji *et al*., 2022, p.4) and the ethical implications of this are interrogated in Section 2.3.3. Although computers acting in this way is not new (Baker and

Kanade, 2000), incorrect output is concerning across sectors, from medical research (Alkaissi and McFarlane, 2023) to education (Mollick and Mollick, 2023). For geography education, it would be concerning to take the information produced by an AI tool as accurate without first checking the validity of this (Mollick and Mollick, 2023). Therefore, over-reliance should be avoided due to the risks of incorrect information.

Second, there is a concern about the role of the teacher. Chang and Kidman (2023, p.87) raise concerns over the potential decrease in 'the amount and quality of human interaction in the classroom' due to AI. Edwards and Cheok (2018, p.345) appear to advocate for 'a future classroom with independent robot teachers', and whilst this was dismissed as conjecture, AI usage needs to be 'extensively scrutinised, challenged and questioned' by leaders and teachers (Selwyn, 2022, p.627). The teaching profession faces some headwinds (Maisuria *et al*., 2023), and Selwyn's (2022) advice is particularly valid in the face of these difficulties; the technology needs to be considered methodically. The implementation of AI can automate some tasks that teachers would normally carry out, but not adversely realise Chang and Kidman's (2023) concern. Although technology is not interchangeable with teachers, teachers need to navigate workplaces that are evermore mediated by AI (Selwyn, 2019). This project uncovers how this presents in School A.

The extent to which the role of the teacher will change is contested. Alam (2021, p.1) appears to take Selwyn's (2019) ideas further, suggesting that technology can 'perform instructional tasks autonomously or collaboratively with teachers'. Whilst the latter seems to corroborate Selwyn's (2019) views, critically, there remains a concern that teachers could be bypassed. Felix and Webb (2024, p.4) helpfully suggest that although the Government

have invested in educational AI software, available via Oak National Academy, all tools are in 'an early phase' and are unlikely to materially replace teachers. Alarmingly, Oak National Academy (2024) does not currently provide geography resources above Key Stage (KS) 2 level. Felix and Webb's (2024) ideas echo Haw's (2019) argument that humans possess skills that AI machines do not, and this finding is central to the reason why the extent of change is limited. Technology should be used to 'enhance learning' and 'as a tool to support, rather than replace, human teachers' (Chan and Tsi, 2023, p.15) and this is a judicious approach. Therefore, despite contention, the teacher is likely to remain integral to the learning process.

AI has been conceptualised as a concern for assessment. The use of AI must indeed be regulated, and students should ensure assignments submitted for public examination is sufficiently original (Joint Council for Qualifications (JCQ), 2024a). JCQ (2024a, p.4) suggests that work must result from 'independent work and independent thinking', with sections derived from AI being 'appropriately acknowledged'. In many ways, these JCQ (2024a) guidelines are similar to those that need to be applied to using traditional references. However, concerns have been raised over the detection of AI misuse. For instance, the '*same AI software'* can produce 'two *different* answers' to similar prompts, which is problematic for academic integrity screening (Woods, 2023, n.p., original emphasis). Indeed, popular plagiarism detection software company Turnitin (2023, p.2) encourages students to prepare to discuss their 'writing process' if accused of AI misuse, suggesting the ability to disprove an accusation of plagiarism. As JCQ (2024a) recommends such plagiarism software in determining AI usage, this is problematic and requires further investigation. Therefore, AI usage has been written about as a

potential concern for assessment and avenues for navigating this ethically are analysed in Section 2.3.1.

Given the difficulties described above, AI is likely to alter assessment. Anderson and Krathwohl's (2001, cited in Stutz *et al*., 2023) interpretation of Bloom's (1956) work to argue that AI usage in assessment needs further critical attention, whereby students need to acquire the skills to 'evaluate the plausibility and veracity of AI results' and tasks should assist with developing these skills (Stutz *et al.,* 2023, p.7). In this way, the purpose of education may move towards educating students on how to use AI productively, and assessments will need to move with this (Stutz *et al*., 2023). Lo (2023, p.410) takes Stutz *et* al.'s (2023) ideas further, arguing that 'immediate action should be taken to update the assessment methods and institutional policies in schools and universities'. This is certainly true, but how to do this remains challenging for schools. The need to reconsider how assessments are delivered is important now and in the future (Stutz *et al*., 2023; Lo, 2023).

Some geography teachers are also concerned about AI. Rakuasa (2023, p.78) argues that increasing use of AI in the discipline calls for 'deep technical and pedagogical understanding from teachers'. In this vein, for AI to be used effectively teachers need training. Unsurprisingly, trainee geography teachers suggest that digital tools should be used within teaching to advance student outcomes (Çifçi and Dikmenli, 2019), but training needs to be available to increase teacher confidence (Rakuasa, 2023). Whilst the intervention (see Chapter 3) aims to implement small-scale training within School A, teachers are concerned about ineffective guidance on these technologies (Rakuasa, 2023).

2.2 How has creativity been conceptualised?

Creativity can be explored via academic theory or empirical projects. The academic study of creativity has yielded a variety of results, whilst creativity is a notion that some schools, including School A, are aiming to promote. For example, this year the whole school focus within School A is to promote creativity, whilst senior leaders such as the Head of Research are considering what this looks like in practice. Indeed, 'critical thinking and creativity is becoming increasingly important in the labour market, and contribute to a better personal and civic life' (Vincent-Lancrin *et al.*, 2019, p.14) and is an 'essential 21st-century skill' (Kupers *et al*., 2019, p.93). In an older review of the literature, Mayer (1999, quoted in Kaufman and Baer, 2012, p.83) concluded that 'there appears to be a consensus that the two defining characteristics of creativity are originality and usefulness', but more recent literature has complicated this. To understand creativity, the following section explores how the concept has been written about in education, with the subsequent section investigating how teachers understand the skill.

2.2.1 How has creativity been conceptualised in education?

Creativity is a crucial skill which involves novel thought. Despite this, there is a lack of a homogeneous definition of creativity. Indeed, 'clear definitions of creativity are rarely consistent, if offered at all', with 'only 34 (38%)' of analysed articles providing 'an explicit definition of the term *creativity*' (Plucker *et al.,* 2004, p.88), suggesting that scholars sometimes avoid giving definitions of the concept and often descriptions are contradictory between authors. This sentiment is echoed in more recent literature, where following a systematic review, Mullet *et al.* (2016, p.10) argue that 'creativity is a complex construct and scholars have yet to achieve consensus on how to define creativity'.

Whilst there is no agreed definition of creativity, some academics use models to describe the facets of creativity. Lucas *et al*. (2013, p.16) argue that there are five key 'creative dispositions', that could be used as a framework to identify creativity. These traits include 'inquisitive', 'persistent', 'imaginative', 'collaborative' and 'disciplined', whereby a person could be ranked as 'awakening' to 'adept' in each of these categories (Lucas *et al.,* 2013, p.18). This is summarised in Figure 1 below. Lucas *et al*.'s (2013) model of creativity is useful because it theorises ways in which creativity can be measured, but it offers a wide and somewhat complicated interpretation of the skill. Nonetheless, models can help uncover the characteristics of creativity.

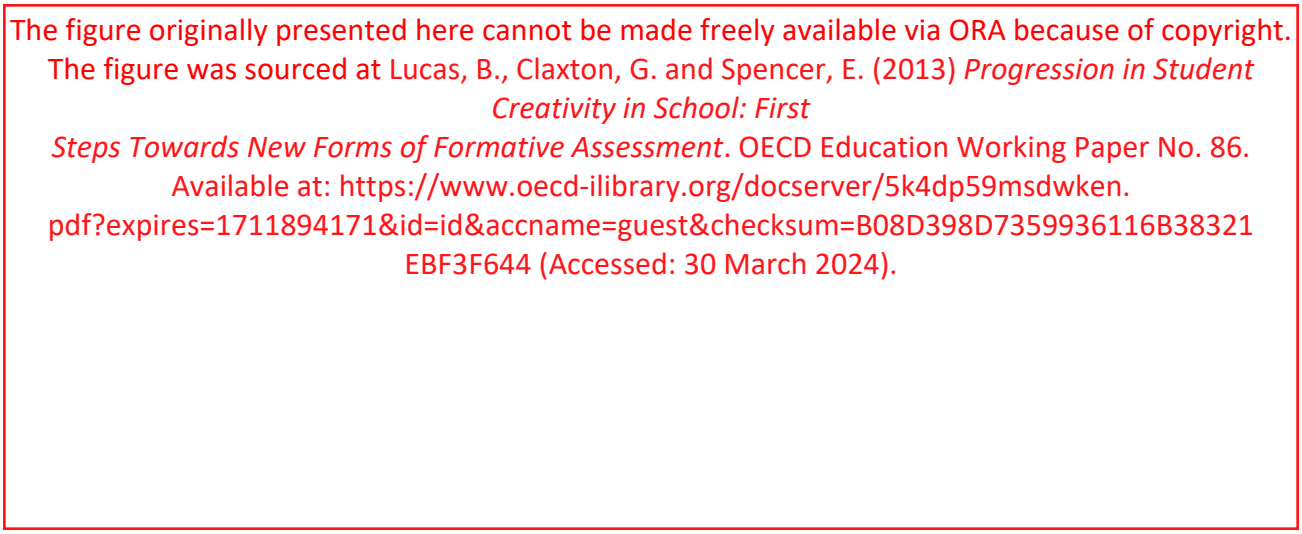

Figure 1: Model for creativity. Source: Lucas et al. (2013, p.18).

Lucas *et* al.'s (2013) model provides an overview of measuring creativity. These dimensions are too extensive for prosaic application by teachers, and Mayer's (1999, quoted in Kaufman and Baer, 2012, p.83) promotion of 'originality and usefulness' as the essence of creativity remains relevant. Indeed, to be 'imaginative' is to 'come up with imaginative solutions and possibilities' and to be 'disciplined' is to 'counterbalance... the 'dreamy'' by

ensuring that ideas are pragmatic (Lucas *et al*., 2023, p.17). These traits have been discussed more broadly in the literature. For example, Vincent-Lancrin *et al*. (2019, p.23) argue that 'creativity aims to create novel, appropriate ideas and products'. In this vein, to be creative is to generate thoughts and outcomes that have not surfaced before, but they must be regulated so they remain applicable. Creative thinking is original, but not inappropriate (Mayer, 1999, quoted in Kaufman and Baer, 2012, p.83; Lucas *et al*., 2013; Vincent-Lancrin *et al*., 2019): this is the definition of creativity that the current study will employ.

One may question what remaining applicable looks like in practice. The use of the terms 'disciplined' (Lucas *et* al., 2013, p.17) and 'appropriate' (Vincent-Lancrin *et al*., 2019, p.23) are notable as they appear to suggest that ideas must be measured in such a way that they are not irrelevant. It would be valid to question what type of thought fits into these criteria. Kaufman and Baer (2012, p.90) highlight that in areas where there are 'clear-cut experts, researchers should either describe their judges' expertise or, if novices or quasi-experts are being used, describe any existing evidence that such judges demonstrate validity in this domain'. This means that when assessing creativity, if there are available 'experts' this group should be used by researchers to evaluate creativity and their credentials highlighted in reports (Kaufman and Baer, 2012, p.90). In contrast, if specialists are not used, 'it is incumbent upon researchers to briefly discuss these issues' (Kaufman and Baer, 2012, p.90). In addition to fulfilling the other criteria above, Kaufman and Baer's (2012) argument suggest that thought may be creative if assessors deem the idea appropriately creative for the context. This study will use teachers as the specialists to assess creativity because these are the professionals who are available for this

study. Whilst teachers may take a more practical view of creativity, they are the professionals who assess creativity in School A.

Creativity can be seen in the ideas behind an outcome. The characteristics that Lucas *et al.* (2013) describe could be viewed as part of the creative process, or within the product. Indeed, this is not a new concept. For instance, creativity is described as a 'decision-making process' whereby sets of choices lead to the creation of a creative process (Sternberg, 2003, p.91). Taking this further, creativity is highlighted as a 'social process' within which 'languages, knowledge and actions that are socially constructed' are important (Elisondo, 2016, p.194). Furthermore, in presenting a framework to conceptualise creativity, Lubart (2017, p.294) contend that 'creating' and 'creations' are two different, yet constituent components of creativity. Creativity is more than simply the eventual result (Sternberg, 2003; Elisondo, 2016; Lubart, 2017), and this study will explore this in relation to AI.

There are different versions of creativity. For example, Creely *et al*. (2020, p.315) present creativity as 'visceral, ideational and observational', whereby creativity exists within and between these three zones. First, the 'visceral' concerns itself with how the body is 'an instrument for creative expression in space' and encounters 'complex interactions with the materiality of the world' (Creely *et al*., 2020, p.315). Second, the 'ideation mode' is where 'thought leads to embodied action and embodiments lead to thought', and third, the 'observational' concentrates on 'what lies beyond experience and individual creative output, to the social and institutional practices that moderate creativity' (Creely *et al*., 2020, p.315). Creely *et al*.'s (2020, p.313) are set in a music lesson, with much reference to 'preforming... visual or fine arts', but the notions can be related to other subjects. Indeed, the 'observational mode'

(Creely *et al.,* 2020, p.315) adds to the ideas of restraint (Kaufman and Baer, 2012; Lucas *et al*., 2013; Vincent-Lancrin *et al*., 2019) by suggesting that this aspect of creativity is socially constructed in view of 'potential risks' and the 'purposes of the creative product', supporting Elisondo's (2016) view of creativity. Although Creely *et al.'s* (2020) arguments are more theoretical, the authors contend that creativity is a complicated interplay of how bodies think new ideas, which may create new outcomes, but are regulated by actors around them. In this vein, creativity can be viewed as both a process of ideas and outcome (Creely *et al.,* 2020).

Divergent thinking has been studied in parallel with creativity. Ferrándiz *et al*. (2017, p.41) define divergent thinking as ideas which include 'fluency... flexibility... [and] originality'. Certainly, the concept is distinct from 'convergent thinking' which 'leads to conventional and "correct" ideas and solutions rather than original options' and is often connotated with creativity but they are not the same (Runco and Acar, 2012, p.66). Historically, this has been problematic as researchers sometimes used divergent thinking assessments to recognise creativity leading to issues with research conclusions (Mumford, 2003). In this vein, it is important to separate divergent thinking from creativity, even though they are closely related. Runco and Acar (2012, p.72) provide a reasonable resolution to this, suggesting that assessment for divergent thinking provides 'estimates of the potential for creative problem solving', but, critically, this is only an approximation and not a reliable endeavour. Divergent thinking may allow for creativity, but divergent thinking is not the same as being creative (Runco and Acar, 2012).

Technology interacts with creativity in numerous ways. Creely *et al*. (2020) quote Pea's (1987, p.91) broad definition of technology as 'any medium that helps transcend the limitations

of the mind... in thinking, learning, and problem-solving activities', which should now include AI. Whilst technology does not need to be present to enable creativity, 'technologies are ubiquitous in mediating creative experience and substantive creative production' (Creely *et al*., 2020, p.310) and the study of AI in this requires investigation. In this vein, technology is often present in the creative process. Indeed, some take this further, arguing that 'human content knowledge and technology can lead to deeper and more profound creative insights' (Mishra and Yadav, 2012, p.13). Whilst possible, it is important to consider the role of technology in the creative process. If technology acts as a facilitator for humans to create, such as the digital scenes Hall (2012) documents, then technology can enable or strengthen creativity. The notion of technology developing creativity is not new (Satell, 2014) and may continue to develop with the advent of new technologies. It should be noted that creativity is sometimes discussed by transnational corporations (Madrigal, 2012), but this review considers creativity in relation to the academic literature. Therefore, technology can facilitate (Mishra and Yadav, 2012; Hall, 2012; Creely *et al.*, 2020) or develop (Satell, 2014) creativity, but technology does not have to be present for creativity to occur (Creely, 2020).

Augmented reality (AR) can extend the scope of creativity. In art lessons, Bower *et al*. (2014, p.1) highlight that the use of AR led to 'high levels of independent thinking' and 'creativity' whereby the software permits student creativity. In this vein, technology has enabled students to be creative in a digital space that would not be possible without the technology (Bower *et al*., 2014). This is taken further by Roylance (2017, n.p.), who suggests that AR 'is the perfect holistic approach to creativity' because it can 'alter a user's environment in a nearly infinite number of ways', which creates further avenues for creativity. Despite these

possibilities, accessibility is not ubiquitous and so developments in this area are not equally received within schools. Nevertheless, AR can develop creativity (Bower *et al.*, 2014; Roylance, 2017).

Some scholars argue that AI is not connotated with creativity. Esling and Devis (2020, p.8) suggest that AI is moving towards a type of 'artificial creativity'. Central to Esling and Devis' (2020, p.10) argument is the notion that current AI technologies are not creative, but may become somewhat more useful, leading to novel relationships between people 'and machines through *co-creativity* approaches'. This suggests AI alone cannot produce creativity, but humans working with machines can. The contention that the technology 'can only produce artificial creativity' is taken further by Runco (2024, p.5), who also suggests that human thinking is better studied than AI's. The way AI achieves an output is not creative, so AI alone cannot produce creativity (Runco, 2024), but this neglects the role human interaction plays, as Esling and Davis (2020) recognise.

AI models can cause a user to think in a novel way, enabling creativity. For example, AI could create 'novel combinations of familiar ideas' and generate 'transformations that enable the generation of previously impossible ideas', (Boden, 1998, p.347), which could reflect creativity. Whilst Boden (1998) does not directly address the concerns around the creative process highlighted by Runco (2024), Boden (1998, p.354) suggests the possibility of AI use could lead to new thoughts that could be valuable, particularly if AI systems are afforded a method of 'evaluation' of outputs although how this could be achieved is unclear.

Instead, AI could be viewed as a different instrument. The technology is 'closer to a *medium'* than a 'tool' when used by humans, as AI can develop over time and therefore enable

human creativity (Mazzone and Elgammal, 2019, p.34, original emphasis). As a result, AI should be considered a 'creative partner' to humans, where 'both halves bring skill sets to the process of creation' (Mazzone and Elgammal 2019, p.34), and this would be a stronger representation of the technology. Cheng (2022, p.115) takes this further, arguing that 'AI art is artistically creative', which corroborates Boden's (1998) view of AI, but this is contested (see University of Plymouth, 2022). Whilst a full exploration of AI and art is outside the scope of this review, Cheng's (2022) contention indicates the possibility that AI could lead to creativity in a more explicit way than Mazzone and Elgammal (2019) suggest. There is recognition of the 'importance and the variety of patterns of collaboration between humans and AI', given ChatGPT can write 'collaborative' sections of academic papers (Vinchon *et al*., 2023, p.480), supporting the ideas presented by Mazzone and Elgammal (2019). In short, humans and AI can work together to produce (Mazzone and Elgammal 2019; Vinchon *et al*., 2023).

2.2.2 How do teachers understand creativity?

Teachers' perceptions of creativity are more practical. Indeed, teacher's views of creativity diverge from the literature (Mullet *et al.,* 2016). Government reports previously separated 'teaching creatively' from 'teaching *for* creativity' (National Advisory Committee on Creative and Cultural Education (NACCCE), 1999, p.90), although this distinction has been criticised for an inappropriate division (Jeffrey and Craft, 2004). A more useful delineation is to explore the 'relationship between the creative teaching of the teacher and the creative learning of the learner' (Jeffrey and Craft, 2004, p.86). Whilst 'teachers value creativity, their conceptions of creativity are uninformed by theory and research on creativity' (Mullet, 2016, p.9). The intervention used, among others, Lucas *et al*.'s (2013) model to highlight the facets of

creativity to participants as this was the model promoted by leaders at School A. Taking a more holistic view of creativity in schools in this way, as suggested by Jeffrey and Craft (2004), is useful. Indeed, evaluating creativity has long been an issue in education (Treffinger *et al*., 2022), as explored above. The fact that 'intelligence and creativity are similar cognitive strengths' (Silva, 2015, p.599), further complicates perceptions of the concept. Therefore, teachers often have understandings of creativity that diverge from the literature (Mullet *et al.,* 2016).

Despite these differences, creativity is important within education. This is true from Iceland (Jónsdóttir, 2017) to Australia (Gonski *et al*., 2018) and creativity is valuable in academic outcomes (Akpur, 2020). Although essential to the curriculum, encouraging creativity in school is 'a complex endeavour' for teachers (Jónsdóttir, 2017, p.127). This may be why creativity has declined in some settings (Kim, 2011) although assessing is subjective, as described above. Organisations which 'include teaching for creativity-specific trainings in teacher education programmes' may promote creativity (Katz-Buonincontro *et al*., 2020, p.11), and the intervention aimed to do this. Such programmes may reduce the misunderstandings identified by Mullet *et al*. (2016).

2.3 What ethical issues arise with the use of AI in education?

Ethical considerations are important throughout education. Whilst the ethical considerations of the study are discussed within Section 3.5, AI raises some ethical concerns across academic subjects and levels. The British Educational Research Association (BERA, 2018; 2024) advises on some essential aspects of educational research, including the mutual appreciation of all stakeholders.

However, the guidelines for AI research are not well-developed. BERA's (2024, p.12) recently updated guidelines now explicitly, and perhaps unsurprisingly, state that 'digital/online research, as well as the use of artificial intelligence, is a rapidly developing area, therefore conventions as to what constitutes good practice are not as well established as in most other areas of educational research'. This leads to thin protocols on the use of AI. Furthermore, BERA (2024) point to the Association of Internet Researchers (AoIR, 2019) guidance as a key resource for ensuring ethical considerations are appropriately addressed. There is a need for researchers to ensure that statutory data protection rules are adhered to and for participants to be kept safe online, with researchers ensuring that participants are aware of what the study entails (AoIR, 2019). Whilst these are important principles, these documents lack pragmatic advice for stakeholders on how to achieve safety. United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2022) provide more detailed instruction on the use of AI in particular, but the document is equally limited in its practical scope. Given the dynamic nature of this field, the ethical issues raised are likely to continue to evolve, but fundamental ethical ideals should be applied (AoIR, 2019; BERA, 2024).

There are emerging policy documents on the use of AI. For example, the Department for Education's (DfE, 2023a, p.35) investigation echoes BERA's (2024) assertion on the dynamic nature of this digital space, furthermore, suggesting that there is concern surrounding the risks of 'increased academic misconduct, pupil over-reliance on AI, and data security and privacy issues', but practical advice for schools remains similarly underdeveloped. In effect, the contention over academic discipline, dependency and data protection raised by DfE (2023a) are valid ethical considerations and are best addressed by examining the ethical principles that

allow for navigating these. The following sections critically review the literature on the issues of using AI in education, with particular focus on ethical principles, bias and misinformation.

2.3.1 Ethical principles

One ethical principle to consider is that of data protection. To remain policy compliant, schools should aim to follow existing legislation on ensuring stakeholder information is safe (DfE, 2023b) under the Data Protection Act (DPA) (2018). In practice, this means that Information Commissioner's Office (ICO, 2022) guidance should be used to ensure that data is treated in the correct way. In summary, schools may wish to consider 'prohibiting [the] inputting of personal data' into AI tools to ensure that data is protected appropriately (DfE, 2024, p.26). Whilst this suggestion seems logical, it raises issues and limits for the potential uses of AI. Indeed, some opportunities for AI use include 'marking' and 'report writing', leading to 'significant time savings' in a portion of instances (DfE, 2023a, p.15). The cases described by DfE (2023a) appear to contradict similar publications that 'pupils own the intellectual property (IP) to original content they create' and so work should not be shared with AI tools who may use it for training purposes, or personal data being shared to enable report writing if the data is then accessible by the company running the AI (DfE, 2023b, n.p.). This contradiction is problematic for teachers and schools. Given the seemingly conflicting advice, formal guidance on personal data (DPA, 2018; ICO, 2022) should be followed and personal data should not be shared with AI until further guidelines are published. Equally, student assignments should not be 'used to train generative AI models unless they have appropriate consent or exemption to copyright' (DfE, 2023b, n.p.). In this vein, data needs appropriate protections to ensure ethical AI use.

Second, upholding academic discipline is an important ethical principle. As discussed in Section 2.1.2, the extent to which AI use is acceptable is sometimes unclear (Woods, 2023). For the secondary school, this means that deciphering a principle on how AI should be used is difficult. JCQ (2024b, p.39) outlines the parameters for malpractice in public assessments, including the definition of 'plagiarism' as the 'unacknowledged copying from, or reproduction of, third party sources or incomplete referencing (including the internet and artificial intelligence (AI) tools)'. Whilst this definition highlights that failing to recognise AI use in assignments is unacceptable, it does not answer Woods' (2023) question surrounding the volume of AI-produced material needed within one assignment to alter the authorship and detection remains problematic, as discussed above. Although Leo (2023) suggests that universities should encourage assessments where this type of plagiarism can be limited, the current high-stakes assessment model for secondary schools—and, in particular, qualifications with coursework—remains exposed to this ethical concern. The guidance from JCQ (2024b) maintains the academic principles that work should be original or properly cited, and whilst there remains some ambiguity with this, these fundamentals remain critical. Therefore, to uphold academic discipline, students and teachers should strive to ensure work is produced originally or cited correctly (JCQ, 2024b).

Preventing dependence on AI is a similarly key ethical principle. Marzuki *et al*. (2023, p.5) suggest that AI models 'may inadvertently promote over-reliance among students', for example, if the model is used for 'correction without thoroughly understanding their mistakes'. This is plausible, but perhaps critically important for students with lower motivation to correct their errors. In this vein, Marzuki *et al*. (2023) highlight that using AI to replace thinking means

that students may subsequently struggle when AI use is not possible. Johinke *et al*. (2023) expand on this, raising more alarming concerns about the implications AI may have on student thoughts and misconduct. Indeed, Rudolph *et al.* (2023, p.349) argue that 'AI is less competent with content that requires higher-order thinking (critical, analytical thinking)', meaning that if students depend on AI as Marzuki *et al*. (2023) suggest, these skills may be underdeveloped or lost. For instance, 'over-dependence on ChatGPT' may reduce 'higher-order cognitive skills' (Farrokhnia *et al*., 2023, p.9) and AI could encourage 'laziness' or inhibit students' desire to 'conduct their own investigations and come to their own conclusions and solutions' (Kasneci *et al*., 2023, p.5). For teachers, this 'can reduce the quality of their interactions with students and exacerbate existing inequalities' (Farrokhnia *et al*., 2023, p.9), which is an equally concerning prospect. Although this is perhaps a sensationalist concern, as AI cannot help with every task, inappropriate reliance is emerging in the literature. Therefore, dependence on AI needs to be approached carefully.

AI should instead work productively with humans. For instance, AI should not be an alternative to humans: it should be 'used as an asset to assist human' activities (Pavlik, 2023, p.92) and this notion should be adopted as a key principle. Kasneci *et al.* (2023) appear to corroborate Pavlik's (2023) argument, emphasising some important elements of a strategy to avoid dependency on AI, including using traditional resources to validate AI material and using AI to highlight alternative outlooks, to aid thinking. Universities are beginning to assist students in using AI in acceptable and non-dependant ways (see Russell Group, 2023; University College London (UCL), 2023), but the success of implementation—and creation of similar initiatives in

schools—remains in progress. Therefore, secondary schools must avoid human dependency on AI.

2.3.2 Algorithmic bias

Algorithmic bias an ethical issue arising from AI use. In addition to the general concerns addressed in Section 2.1.3 above, unbalanced opinion is an important ethical problem. Although there are many definitions of algorithmic bias, the current study will follow Fazelpour and Danks' (2020, p.2) suggested 'neutral' definition of the concept, whereby algorithmic bias is when an output is unduly unbalanced in any dimension within the setting it is used. Whilst government briefing papers attempt to keep policymakers informed on technology in education (Tobin, 2023; Felix and Webb, 2024), independent experts are that it is clear that 'AI is moving far too quickly for government or parliament alone to provide the real time advice that school need' (AI in Education, no date, n.p.). Critically, this means that government advice to schools and teachers is not always up to date. Therefore, avoiding algorithmic bias in education needs further critical attention.

Many instances reveal the consequences of algorithmic bias (see Bhatnagar and Gajjar, 2024). For example, this concept has been shown in the advertising of work opportunities whereby 'female' users received a lower frequency of advertisements 'related to high-paying jobs than setting it to male' (Datta *et al.*, 2015, p.92) and identified that code used in health care 'exhibits a significant racial bias' whereby care for white patients is prioritised over more unwell black patients (Obermeyer *et al*., 2019, p.447). Datta *et al*.'s (2015) and Obermeyer *et al*.'s (2019) findings together exemplify only two instances of how algorithmic bias can negatively affect certain groups, but more attention needs to be paid to how similar code can

impact schools. If this type of bias becomes apparent in AI systems, it raises important questions about how personal characteristics can impact the output of an AI model in educational settings. Moving the conversation forward, AI systems need to be understood for the impact they may have on populations if they contain these biases.

Algorithmic bias can be introduced in many ways. For example, how designers make decisions when creating AI models can create such problems (Christie, 2020). In this vein, algorithmic bias can be embedded within the system by the information that is given to it and this would be outside the control of schools and teachers. Similarly, Hao (2019) argues that one cause of algorithmic bias in AI systems is that the information given to an AI in the designing phase may not represent the truth, or it may echo real injustices. This issue would also be difficult for teachers to detect and mitigate. Danks and London (2017) helpfully outline how algorithmic bias of AI is technically introduced, but the usefulness of this for teachers is limited. Instead, the conversation must shift towards how teachers, schools and policymakers can combat algorithmic bias. Certainly, there is a 'need for an improvement in critical AI literacy', but Ferrer *et al.* (2021, p.78) offer no pragmatic way of achieving this. Instead, they posit that AI being 'made *aware'* of and subsequently limiting bias is a sensible solution (Ferrer *et al*., 2021, p.79, original emphasis), which could be effective in the mid- to long-term, but not an appropriate panacea in the short-term. Ferrer *et* al.'s (2021) proposal relies on wider action, whereas a more immediate remedy may be education on identification and mitigation of unbalanced information. In either case, algorithmic bias can be introduced in many ways.

2.3.3 Misinformation

One final ethical issue is that of misinformation. This refers to information that appears correct, but is then proven untrue (Lewandowsky *et al*., 2012). Indeed, Cook *et al.* (2015) take this further, highlighting that misinformation creates an inaccurate image of reality. Whilst these definitions are useful for characterising the concept, they are too broad, and the current study will apply a more focussed definition. Building on Lewandowsky *et al*.'s (2012) and Cook *et al*.'s (2015) work, the definition adopted here is material that is untrue in the context of learning or teaching. Whilst the causes of AI-generated misinformation are similar to the causes of algorithmic bias outlined in the section above, and a full investigation into this is outside the scope of this review, misinformation is a specific ethical problem. Although bias and misinformation are similar, bias presents an imbalance (Fazelpour and Danks, 2020), whilst misinformation generation can present outputs that are untrue (Lewandowsky *et al*., 2012; Cook *et al*., 2015). Misinformation is problematic as it can enable students or teachers to understand the world in incorrect ways.

AI models can be sources of misinformation. For instance, the system may suffer a 'hallucination' whereby the output is 'a convincing but completely made-up answer' (Athaluri *et al*., 2023, p.1). This has far-reaching implications for education, if AI is used by teachers and students. Indeed, Sison *et al.* (2023, p.15) label ChatGPT as 'a "weapon of mass deception"' in education due to the threat of AI-generated misinformation and urge users 'to verify or fact-check ChatGPT outputs'. Whilst Sison *et al*. (2023, p.15) reiterate the need to 'verify or fact-check' the products of AI models, this is a significant barrier within the secondary school context. Although Sison *et al*.'s (2023) suggestion is sensible, it reduces efficiency and may not

be practical for teachers such as those in School A who are short of time. Consequently, misinformation is an important ethical issue.

3. Methodology

Within this chapter, the design of this practitioner research project is explained. The intervention takes the form of a department meeting I ran, with teacher interviews occurring before and after the intervention creating three main phases of research. The participants are geography teachers at School A, with collaboration being key across the project from planning to dissemination. The fundamental ethical concerns centre around the investigation, with the main research instrument being the interview, whilst thematic analysis, following Braun and Clarke (2006), was employed to analyse the data methodically.

3.1 Phases of research

The research took place in three main stages (see Figure 2). At Stage 1, I invited eligible teachers (as defined within Section 3.2) to an interview with me about how they currently use AI. At Stage 2, I ran a department meeting that formed the intervention. Stage 2 allowed me to coach participants in AI 'best practices' in geography, and created a group discussion forum for participants to share their ideas about AI usage (see Section 3.4). Finally, at Stage 3, I invited participants to a second interview about how their AI use had changed, reflecting on successes, failures and further thoughts.

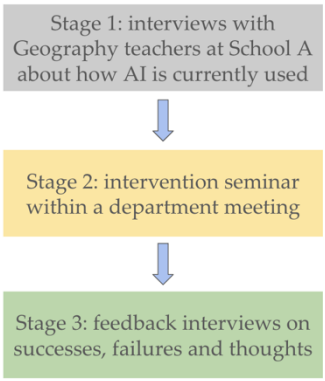

Figure 2: Summary of main phases of research. Source: Author.

Prior to the project commencing, School A and colleagues were informed of the research. Initially, relevant managers were consulted, such as the day-to-day headteacher (Vice Master) who was briefed on the project's scope and provided with the Letter to the Headteacher (Appendix A). After approval was given, eligible participants were then approached in person, introduced to the study and offered a Participant Information Sheet (Appendix B) with a Consent Form (Appendix C). I also collaborated with the Head of Department to form a plan for the study.

The project ran across the Spring and Summer terms of the 2023/24 academic year. More specifically, the project was advertised prior to and during January 2024. Stage 1 began in early February 2024 and Stage 3 concluded in June 2024, with Stage 3 taking place in March 2024. Whilst ethical issues are discussed in full within Section 3.5, this timescale allowed for potential participants to consider their involvement without time pressure and for convenient organisation of all research activities with participants.

Initially, Stages 1 and 3 were planned to include the option of digital questionnaires instead of interviews. The main reason for this was to provide participants with greater

flexibility and to limit the time burden. However, all participants indicated that they would prefer to take part via interview, rather than write answers on a questionnaire. Indeed, questionnaires tend to create a short 'snapshot rather than a rich, in-depth picture of an area of concern' (Pattern, 2017, p.3), so the originally planned surveys were replaced with interviews given participants' preferences and reduced the chance of brief participant contribution. This maximised the research benefit.

3.2 Participants

The inclusion criteria for this study are geography teachers at School A. This created a pool of eight teachers, excluding myself. This exclusion is to avoid undue bias to AI as I acted as an optimistic agent for using AI in teaching and learning. Two teachers were absent from school during the study period, so could not participate. From this pool of six, five teachers gave consent to participate, of which one chose to attend only Stage 2 and not the interviews. Due to the nature of the study (see Section 3.4), the study is based on the four teachers (*n=4*) who attended all stages.

The positionality to participants was an important consideration in this research. I joined School A in September 2023, prior to which the school indicated support for this project. Before I formally invited colleagues to participate, I naturally discussed my research interests with colleagues which formed an initial collaboration (see Section 3.3). Given I was interested in AI, there was a possible risk that colleagues would feel compelled to use AI or highlight its benefits for the study. Indeed, 'transparency of positionality' and that being clear on one's 'intents as a researcher' are crucial (Bourke, 2014, p.7) and I employed this advice effectively the minimise

this risk in the current study. For example, informal discussions, together with the formal documentation, outlined clearly that this was an exploratory study to discover if AI could be used in this context, and if so, how. In addition, I highlighted that negative results were just as important and relevant. As explored in Chapter 4, the range of results attained reflects the success of this approach. Additionally, I undertook the research as the teacher with the lowest number of teaching years. Given that every participant holds, or has held, a teaching and learning responsibility position—including multiple in leadership positions—my positionality enabled me to gain a range of views that reflected, as far as possible, the true opinions of the participants. Therefore, the potential risks of positionality are mitigated effectively.

Within Chapter 4, the findings from the study include references to each participant. As all participants gave permission to be quoted directly in research outputs against a pseudonym, the respondents are labelled as Teacher A to Teacher D.

3.3 Collaborators

Collaboration was key before and during the study. During the planning stage, I collaborated with senior leaders to ensure that the study was acceptable to the school. For example, the Vice Master approved the project, whilst the Head of Research helped develop my focus on creativity, which is a current whole-school focus. In addition, I collaborated with the Head of Geography to design a project that placed minimal time burden on participants. Equally, I took guidance from the Head of Department on Stage 2 (the intervention) to ensure it had the maximum positive impact for participants. During the research, I collaborated with colleagues to guide the intervention, which contained the sharing of ideas among participants.

After and beyond the study collaboration was also important. For example, senior leaders encouraged me to present an adapted version of the intervention (Stage 2) at a whole-school TeachMeet, which gained positive feedback from multiple colleagues. The Department continues to develop its use of AI and geography teachers now share prompt ideas and AI-generated resources frequently, a collaboration which began during the study. I also intend to disseminate results via publication.

3.4 Research instruments (including advantages of disadvantages)

This study is based on qualitative research. The reason for this was that the research questions seek to explore, via inductive reasoning, how AI is used in this context and to uncover the barriers to further usage. Indeed, findings from qualitative research may be 'usefully indicative of what one might find in similar situations and contexts' (Cobern and Adams, 2020, p.77) and so qualitative research such as this could lead onto similar studies in other schools. Although there are many benefits of mixed methods approaches (McKim, 2017; Dawadi *et al*., 2021), the addition of quantitative methods would not have led to material benefits in pursuit of answers to the research questions. For example, a quantitative survey of potential barriers to use may have unveiled the most common barriers, but would not have added value to why this is the case or how these may be mitigated. Although Dawadi *et al*. (2021) advocate for a mixed-method approach, they highlight how additional methods have the potential to place undue time pressure on research projects. In School A, participants indicated a preference for qualitative methods (see Section 3.1), and to avoid potential time-related issues, qualitative methods were chosen.

The main research instrument was the interview. The principal reason for this is that an interview 'allows for greater depth than is the case with other methods of data collection', despite some 'subjective and bias on the part of the interviewer and interviewee' (Cohen *et al*., 2018, p.508). In arguing for focusing on fewer, high-quality interviews, Jenson (2012, p.39, original emphasis) suggests that 'dignity and care' can be given to each and ensures that interviewers have '*taken their time*' to interpret participants' views. Although Cohen *et al.*'s (2018) concerns are valid, a concentration on fewer interviews mitigates this as the researcher can fully consider the views of each respondent (Jenson, 2012). Research methods should be chosen based on which address the 'research question best' (Alshenqeeti, 2014, p.44) and I argue this model is the most effective in answering the research questions of the current study. Table 1 outlines that each respondent is interviewed twice (once at both Stages 1 and 3), leading to eight interviews in total. Whilst this is a relatively small number of interviews, it is representative of the geography department at School A, as described in Section 3.2, and meets Alshenqeeti's (2014) guidance as the methods are appropriate for the research questions.

Stage	Instrument	How the instrument addressed the research question(s)	Strengths	Weaknesses
1	Initial interview with teachers (audio-recorded with field notes taken to support analysis).	RQ1 – participants discussed how they currently used AI. RQ2 – participants discussed their views of AI and creativity. RQ3 – participants highlighted the reasons why they did not use AI more.	Enabled teachers to discuss ideas with me. There were multiple original opinions presented, creating 'unique' perspectives so individual interviews were useful (Brannen, 2012, p.16).	Semi-structured nature allowed for some deviation from the research question(s) at times. At the beginning of some interviews, audio recording appeared to make some respondents 'self-conscious' and temporarily made one

				seem to 'inhibit their' answers initially (Atkins and Wallace, 2015, p.6). This was reduced as the interviews continued.
2	(a) Intervention seminar	The intervention included a presentation (Appendix D) and handout (Appendix E) to coach colleagues on the use of AI and outlined the statutory, policy and ethical boundaries.	Introduced teachers to examples of AI usage in geography. I led the sessions, meaning information was context-specific and enabled participants 'engagement *in* and *with* research' (Menter *et al.*, 2011, p.14, original emphasis).	Many different proficiencies in AI, meaning that some participants learned more than others. Teachers with more experience of AI may have not benefitted as much from the session.
	(b) Group discussion	RQ1 – ideas on how to use AI were shared. RQ2 – thoughts on how to use AI creatively were shared. RQ3 – potential barriers were outlined and discussed.	Allowed for constructive criticism and development of ideas. Enabled participants to recognise uses specific to School A's geography curriculum.	Group discussion was not audio-recorded, meaning there was a reliance on field notes.
3	Follow-up interview with teachers (audio-recorded with field notes taken to support analysis).	RQ1 – participants highlighted if/how their use of AI had evolved. RQ2 – participants reflected on how they used AI creatively. RQ3 – participants reviewed the limitations on their AI usage.	Illuminated if/how the use of AI had developed following the intervention. Participants were able to discuss novel uses in-depth with me.	Some overlap with the initial interviews, limiting the time spent on novel uses. There was a risk that some participants felt compelled to show novel uses of AI after the intervention, which, following Bourke (2014), caused me to consider my positionality. I

				mitigated this by highlighting the importance of genuine responses to participants.

Table 1: Research instruments.

The intervention at Stage 2 comprised two parts. Part (a) comprised a presentation (Appendix D) I led to participants, about how AI could be used in school and how AI may develop creativity, based on the available academic and professional literature, together with the limitations to usage. Participants were also provided a handout (Appendix E) that summarised the session. Indeed, sessions led by teachers in this way can be productive especially if the time-burden is not high (Bayram and Canaran, 2018), as in the current project. Part (b) was a group discussion that enabled participants to discuss ideas and collaboratively resolve obstacles, as shown in Table 1. Whilst the intervention was useful, the impact could have increased if the research took an action-research approach (see Lambirth *et al*., 2019), but repeated cycles were not possible given time and institution-specific operational constraints.

Stage 3 enabled the investigation and evaluation of the outcomes of the intervention. In effect, the interviews at Stage 3 focused on how teachers had used AI, the implications for creativity and emerging barriers to use across the course of the project. The criteria against which these outcomes are evaluated are summarised in Table 2.

Research question	Criteria
1	**Success** – all participants used AI more, or for new applications than before the intervention **Partial success** – some participants used AI more, or for new applications than before the intervention

	Failure – no participants used AI more or for new applications then before the intervention
2	**Success** – AI was used to support, develop or enhance creativity by all participants **Partial success** – AI was used to support, develop or enhance creativity by some participants **Failure** – AI was not used to support, develop or enhance creativity by any participant
3	**Success** – the project uncovered new barriers, or significantly developed understanding of existing barriers **Partial success** – no new barriers were found, but the understanding of existing barriers was developed **Failure** – no new barriers found and understanding of existing barriers not developed

Table 2: Criteria of intervention outcome evaluation ('new' refers to novel within the context, e.g. not appearing within the initial investigation at Stage 1).*

3.5 Ethical issues

There were two main areas of ethical concern with this study: first, the data collection of the project itself, and second, the use of AI encouraged via the intervention. Initially, the study was approved by the Central University Research Ethics Committee (CUREC) (Reference Number: EDUC_C1A_23_326) and was authorised to operate under Approved Procedures (AP) 15 and 25. As the project evolved to focus on teachers, AP15 was the main guidance followed and students were not recruited. Ethical choices are essential to the teaching profession, and to geography (Hammond and Smith, 2023); this section describes a range of these considerations.

The data collection posed some ethical concerns. As described above, before recruitment began, the Vice Master was briefed in person and provided an information sheet (Appendix A), as well as copies of the documentation for participants (Appendices B and C), before providing consent for the project to begin. Recruitment of participants was via an in-

person approach, whereby eligible teachers were briefed, provided with an information sheet (Appendix B), a consent form (Appendix C) and given time to consider their involvement before deciding. This was crucial to ensure eligible teachers did not feel pressured into taking part. This consent, together with the ability to leave the study without reason is important in all projects (BERA, 2018; 2024), and the current study aimed to maintain this flexibility. For example, some teachers declined to take part, and one attended only one Stage. As in any school, teachers lack an abundant amount of time outside of existing commitments, so activities at Stage 1 and 3 were organised at mutually agreeable times, taking under 30 minutes (one teaching period) each. Stage 2 took place during a department meeting, on the advice and consent of the Head of Department. Teachers who chose not to participate were provided with the session material for their professional development, but were not obliged to attend or contribute. All participants were not 'in a social position vis a vis the researcher' (BERA, 2024, p.17), but because all participants had greater teaching experience than me (see Section 3.2), they were able to speak more freely as I was not in a relative position of power. Equally, the questions within the interviews focused on the research topic (Appendix F) to avoid encountering undue ethical concerns.

Second, the use of AI created some ethical issues. During the study, BERA (2024) released updated ethical principles. For example, as highlighted in Section 2.3, BERA (2024, p.12) outline how 'fundamental [ethical] principles apply' with digital research, and the current study had already implemented these. Indeed, AoIR (2002, p.3) suggested that there are 'guidelines—not "recipes"' when dealing with ethical issues in digital research and this notion remains true today (AoIR, 2019). To address this, basic ethical principles of abiding by School

A's AI rules (for instance, not using AI for report-writing) were outlined within the intervention. In addition, School A and government guidance (see DPA, 2018; ICO, 2022; DfE, 2023b; DfE, 2024) were consulted and followed, namely by instructing teachers to avoid inputting personal data into AI models, as discussed in Section 2.3.1. These precautions ensured that the intervention remained ethically sound.

3.6 Methods of data analysis

Reflexive thematic analysis was used to analyse the data. Braun and Clarke (2006) outline the methodical steps involved in the sequence of thematic analysis (TA), which were followed to analyse the data in the current study. For example, all the recorded interview data were transcribed, coded and analysed, following Braun and Clarke (2006). Field notes were used to support the transcriptions, and all research data was stored securely on University-approved Nexus365 software which will be transferred to the project supervisor upon submission. Paper copies have been destroyed. This resulted in over 26,000 words of transcriptions that I coded. The codes were then separated from the transcripts, leading to a table of over 340 codes from the Stage 1 interviews (see Appendix G) and another with over 400 codes from Stage 3 (see Appendix H). The codes were 'specific and precise', which allowed me to 'demarcate and capture (with the code labels) a rich diversity of meaning within the dataset', leading to the 'widest scope for theme development' (Braun and Clarke, 2022, p.59).

Furthermore, data analysis was completed carefully. Indeed, in 'reflexive TA, coding is a *process*... and codes and labels are *outputs* of this process' (Braun and Clarke, 2022, p.53, original emphasis) and this study used transcription and coding as an opportunity to

understand the data, leading to effective identification of themes as subsequent analysis of these. As suggested by Braun and Clarke (2022), taking this time with the data enhanced the analysis. The themes (see Appendix I) established represent the data and reflect the successful use of the research instruments to answer the research questions. Therefore, the findings represent the data.

4. Findings and Discussion

This chapter provides the findings of the project, organised by research question. AI is used to variable degrees and for a variety of purposes, with a higher degree of use following the intervention. Equally, whilst AI can support teacher and student creativity, there remain a variety of operational and broader, ideological barriers to further usage. These empirical findings connect to existing research and move conversations forward by adding to the literature on teachers' experiences of AI.

4.1 RQ1: How is AI used by geography teachers?

Geography teachers' use of AI is not homogenous. Indeed, geography teachers' use of AI models differs in two main ways. First, teachers use the technology to varying degrees, meaning that some practitioners use the technology more than others both before and after the intervention. Second, the task that AI is used for—or the purpose of using AI—varies greatly. Before the intervention, most teachers reported a lower quantity of and fewer applications of AI use than after the intervention. Therefore, the intervention in this regard was partially successful. The following section relates this finding to the literature.

4.1.1 Variable degrees of use

Before the intervention, participants did not commonly use AI or had only occasionally tried it. Whilst the barriers to usage are explored in Section 4.3, the varying use of this technology is notable. Although other technologies, such as Google Classroom or slideshow software are used daily by every participant, perhaps informed by school policy, AI usage was far more heterogeneous. For example, Teachers A and D used AI sparingly:

> Referring to possible uses of AI, Teacher A reported '*I've only trialled it without implementing these strategies at this stage, so it's very limited*' (Interview), whilst Teacher D reported they used AI '*not a lot*' (Interview)
>
> In contrast, Teachers B and C had some additional experience with AI. For instance:
>
> Teacher B had '*started using AI this year, last year*' and Teacher C also began using it '*last year*' and both highlighted an assortment of professional uses of the technology (Interview)

Variation in AI usage is unsurprising. Earlier forms of technology have been adopted by teachers at different rates, for reasons ranging from teacher tenure to the level of experience a teacher has at a given school (Russell *et al*., 2007). Whilst Russell *et al*.'s (2007) study was conducted over a decade ago and includes investigations on the use of email, the findings of the current study uphold their conclusions as teachers' uptake of technology, in this case AI, remains varied. The current study moves this conversation towards contemporary technology. More recent studies have explored teacher's opinions on AI, with one project finding that, whilst teachers see AI as a potentially useful tool, an absence of understanding how to use it professionally restricts their usage (Chounta *et al*., 2022). Taking this further, in a study of over 1,000 teachers 1 in 4 teachers have not used AI before, with the majority ('60.2%') reporting they had 'limited knowledge' about the technology (Alwaqdani, 2024, p.9) although this study was set in the Middle East and results may differ across the world. Chounta *et al*. (2022) and Alwaqdani's (2024) findings paint a picture of a technology in transition: there are benefits to employing AI, but these have not been realised by all practitioners yet. Indeed, the situation in School A echoes this, with Teachers A and D not using AI much before the intervention, whilst Teachers B and C had more experience with the models.

Following the intervention, participants used AI to varying degrees, but most used it more often. Teachers A and D made the most progress in their AI usage, perhaps because they started from a lower base of usage. Asked about specific examples, Teacher A reported many new applications, including:

> '*[Writing] model answers or exemplary answers*' and coaching Year 9 students using AI '*in report structuring*' to assist with '*writing up a script*' for '*more engagement in a presentation style and an oral presentation*' (Interview)

Similarly, Teacher D noted:

> '*I have actually used it quite a lot more*' and reflected that they now used AI '*relatively regularly*', and would '*definitely continue to use it*' (Interview)

And Teacher C used AI to help Year 10 students interpret quantitative data:

> '*It was really good, they really liked it. It made something which could have been dull more interesting for them and it made it quite easy. Accessing that data [without AI] can be a bit dull, can't it?*'

The progress made by Teachers A, C and D advocates the success of this intervention area. In these cases, participants noted that they had developed their AI usage at Stage 3, compared to Stage 1. Perhaps the subject-specific nature of the intervention was especially useful for teachers who were comparably less experienced with AI. Professional development courses on AI often did not provide 'applicable skills or knowledge for real-world classroom settings' (Lee *et al*., 2024, p.214), and this was considered in designing Stage 2 of the project. On the contrary, the intervention highlighted concrete examples within School A, which appears to have been fruitful for Teachers A, C and D. Lee *et al*. (2024, p.218) suggest training that permits 'teachers to apply AI concepts directly in their teaching practice are more effective', and the improvement made by Teachers A and D following the intervention appear to validate this.

However, participants who were more experienced with AI did not increase their usage as much. For Teacher B, the intervention did not lead to increased usage of AI. When asked how they used AI following the intervention, Teacher B reported:

> '*I haven't really actually used AI as much. Part of the reason for that is I believe that, particularly with ChatGPT... they seem to have... a block on new content, and a lot of the time it will say things such as we can't provide this information, or, the data is out-of-date and for geography it's really essential that as much as possible, you're using as up-to-date information as you can*' (Interview)

Teacher B refers to 'a block on new content' as a limiting factor for their usage of AI, leading to 'out-of-date information'. Although the AI model was formerly limited to data provided almost two-year previously (Southern, 2023), at the time of writing OpenAI ChatGPT (2024b, n.p.) reports that it is aware of 'information up to October 2023' and for paid users, ChatGPT can now browse the internet in search of current answers (Pocock, 2024). For Teacher B, these updates should reduce the concern about information availability moving forward. Whilst the threat of inaccurate information is explored in Section 4.3, Teacher B reflects that their use of ChatGPT was limited by the model's time-restricted knowledge. Teacher B used AI less than other participants at Stage 3, perhaps due to the drawbacks identified with research tasks. Despite this, Teacher B conceded that AI has great potential within school, and more technical training—perhaps from technology companies— would help further advance usage. A lack of this training is a barrier to usage, which is explored further in Section 4.3. Therefore, AI was used to varying degrees at Stages 1 and 3; most, but not all, participants used it more following the intervention.

4.1.2 Variable purposes of use

The purpose that AI was used for is equally varied. At Stage 1, the range of uses was generally narrower than at Stage 3, where most participants reported a broader variety of applications. In this vein, the intervention was partially successful because most participants used or identified AI usage for new tasks.

The literature suggests that introducing AI into secondary schools is challenging, from data protection (DfE, 2023b) to the worsening of 'existing inequalities' (Farrokhnia *et al*., 2023, p.9). Although the task of schools is to coach students in the age of AI (Antonenko and Abramowitz, 2024), there is work to be done to 'improve teachers' trust' in the technology (Nazaretsky *et al*., 2022, p.915). Before the intervention, participants used AI for a narrow range of tasks, corroborating Nazaretsky *et al*.'s (2022) suggestion that teachers' technical and pragmatic understanding of AI in education could be developed. For example:

> Teacher B used it 't*o create some questions based on climate change' and 'used it for doing research*' and to help '*update the content*' for a Year 11 topic on Lagos (Interview)
>
> Similarly, Teacher C used AI with a Year 9 group to generate '*exam questions', whereby the AI would 'write the answer for them, and then take that answer and to mark it. And criticise it and because of course what it will generate off is just hopeless*' (Interview)
>
> Whilst Teacher D employed AI to assist in '*pinning together a methodical step-by-step set of processes for the formation of certain things which you could quite easily fact check*' within the A-Level course (Interview)

Although there is some diversity of these Stage 1 uses, the tasks are fundamentally similar. For Teacher B, AI was used to create 'some questions' as part of a small-scale resource creation and for 'research' purposes, whilst similarly, Teacher D utilised AI to help explain complicated processes. In contrast, Teacher C's use is somewhat divergent because this participant used AI in lessons to help refine examination technique, but it remains a

straightforward task, as the output can be obtained from minimal prompting. Ayanwale *et al*. (2022, p.9) found that the 'confidence level' teachers had in AI could 'predict their readiness to teach AI'. At Stage 1, participants rarely systematically used AI in preparation for or during lessons before the intervention, and this finding could reflect a lower self-belief in the ability to use the technology. If this is the case, the findings appear to echo Ayanwale *et al*.'s (2022, p.14) conclusion that such 'confidence' is important in enabling AI usage. To reach this point, it is necessary to pursue an 'increase in their [teachers'] level of trust' in the technology (Nazaretsky *et al*., 2022, p.928)—perhaps a critical element of the 'confidence' Ayanwale *et al*. (2022, p.14) describe—and this was one goal of the intervention. Teacher C's remark that the output was 'hopeless' may be useful for critiquing examination answers, but may also disguise a distrust of AI models given their sometimes-imperfect nature.

The intervention aimed to increase the variety of tasks for which AI was deployed. To a large extent, this was successful. Most participants (excluding Teacher B, as described above) reported an increased range of purposes for which they used AI following the intervention. Indeed, most participants reported using AI in more integrated and comprehensive ways, in the production of significant resources to administration. For example:

> Teacher A reflected that there was '*a great opportunity [to use AI]... in taking some fieldwork data collection, and in order to be more efficient in terms of setting appropriate questionaries or, survey types or some other methods, sampling of types of data'*. Overall, *'AI was able to provide some informative responses that we could incorporate for our data collection so that worked quite well*' (Interview)
>
> Whilst Teacher C developed their coaching of AI in lessons, advising students to be '*quite prescriptive*' with prompts as '*if you're sloppy with your language, it won't—it can't—cope*'. This is a development of their AI usage as students were coached to '*think, then, like examiners*' in how they interacted with the technology. Such specific

> prompting allowed Teacher C to empower students to use AI to produce outputs from '*three bullet points and I want this done in 120 words*', to '*pie charts, bar graphs, radial graphs*' and '*answers for past GCSE questions*' (Interview)
>
> For Teacher D, AI was useful in '*administrative tasks that I've had to do in the department*', for instance, to formalise '*shorthand notes*' that, following an '*edit*', could be added to a meeting '*agenda*'. Teacher D also noted using AI for supporting lesson planning for a new Year 13 topic, where ChatGPT was '*genuinely useful to frame the ideas*' on a '*few specification points which were just quite nebulous and then the textbook was useless*' and paraphrasing text that was '*too wordy*' (Interview)

These uses highlight a diverse range of AI applications. For Teacher A, becoming 'more efficient' was important, but for Teacher C the purpose of employing AI in the classroom is viewed as an important facet which students must learn, and the creative dimensions of this are explored in Section 4.2.2. Perhaps the intervention further reinforced the 'perception of AI as a relevant instruction' method (Ayanwale *et al.,* 2022, p.9) and helped inspire these further-reaching applications. For Teacher D, there is some echo of Teacher A's consideration of increased productivity, but Teacher D's reflections go further than this to highlight how AI has tangible benefits for teachers, for instance assisting to 'frame the ideas' of a topic. In this vein, AI can certainly benefit teachers (Farrokhnia *et al.*, 2023; Monteith, 2023), but the improvement varies by practitioner. Although Berg and Plessis (2023, p.998) theorise that AI models 'can provide specific materials and support mechanisms, such as lesson plans', the current study holds that it can support in 'specific' ways, but not generate full 'lesson plans' in this context. Whilst Berg and Plessis' (2023) findings are relevant in their initial teacher training (ITT) setting, this study suggests that, presently, AI is useful to experienced geography teachers for specific episodes and activities. Therefore, at Stage 3, AI was generally used for an increased range of purposes.

4.2 RQ2: How can AI be used creatively by geography teachers?

AI can be used by geography teachers to inspire their own creativity, or the creativity of their students. Before the intervention, teachers described how AI could help them explore outside their own sphere of knowledge, or further student progress by enabling them to visualise unfamiliar concepts. Despite some challenges, after the intervention, most teachers reflected on novel ways that AI enhanced their creativity, whilst AI can help enhance student creative decision-making. Therefore, the intervention was partially successful in this regard.

4.2.1 AI & teacher creativity

Before the intervention, participants rarely recognised the creative value of AI. Perhaps the only contribution to this effect was the notion that AI could allow for some novel thinking. Talking about asking AI models about topics outside one's specialism, Teacher B suggested that:

> '*It's quite hard for us to think outside our own sphere of knowledge... maybe it will come and say I'll say, oh, I hadn't thought about that. So there is that creative side*' (Interview)

Teacher B's ideas reflect a possible creative use of AI. As creativity is a 'disciplined' (Lucas *et al*., 2013, p.17) process to create 'novel, appropriate ideas' (Vincent-Lancrin *et al*., 2019, p.23), as explored in Section 2.2, the situation Teacher B reflects on is creative as it produces applicable perspectives that are new to the user. Despite this opportunity, participants noted that their AI use, generally, was not to inspire or develop creativity and that this pursuit may take a substantial amount of time. For example, when asked about AI and creativity, Teacher B noted:

> *'That takes time to build in. And I think a lot of the whole AI stuff at the moment, the reason we do the small things like research, is because it doesn't really require us to*

> *think too hard about how that fits in. It's just a research task, it's just a bit faster. But when it's something like how are you going to bring creativity in, we would actually need dedicated CPD time'* (Interview)

Creativity and AI need to be considered carefully when teaching. Despite the whole-school focus on creativity, the role of AI has not been considered at an institutional level. Equally, individual teachers appeared unsure as to how AI could complement creativity. Indeed, the notion that 'it takes effort and time to achieve new ways of thinking' is not new (Zimmerman, 2006, p.57) and it holds that using technology creatively in school needs more consideration. Whilst it may be true that AI can save teachers time (Bryant *et al.*, 2020), such a report seems practically sensational considering these findings. Lee and Perret (2022, p.12784) argue that 'teachers may have difficulty finding a fit and time' to include AI, and these findings, for using AI creatively prior to the intervention, corroborate this in geography. Equally, participants who, before the intervention, did not use AI often generally employed AI for tasks that did not easily lend themselves to creativity. For instance:

> Teacher A used AI '*mainly through ChatGPT and looking at some ways for standardising some responses for exam questions and also tinkering around some ways that it could be used for feedback*' (Interview)
>
> Whilst Teacher D used AI to '*help fashion relatively short, sharp physical explanations of physical geography processes*' (Interview)

Therefore, at Stage 1, participants may not have considered how AI may aid creativity. Teacher A and Teacher D's responses suggest that AI was initially being used to complete relatively straightforward tasks comparable to the simple 'research task' that Teacher B described. Indeed, AI being used as a research tool limits its power as models, such as ChatGPT, at present 'cannot generate original and creative ideas' (Rahman *et al*., 2023, p.8) alone,

meaning that these uses of AI, where there is little subsequent thought from the teacher, did not lead to creative products.

Following the intervention, participants suggested that AI-generated images could be a source of creativity. In some instances, creative output was not achieved because the product was not appropriate for the context. When asked about AI and creativity, Teacher A reported that:

> *'We tried to use AI to provide some visual images on the topic of climate change and the greenhouse effect and what that might look like. Sadly, however, I don't believe, although it could be a restriction in the parameters that we put in... that what was produced by AI didn't quite meet or didn't add value to and wasn't worth pursuing'* (Interview)

A limitation of AI's creativity is the value it can add. In Teacher A's example, AI-generated images on 'climate change and the greenhouse effect' were not creative as they 'didn't add value to' lessons on the topic. Despite some evidence that 'the potential for using images generated by artificial intelligence for educational purposes is high' (Aktay, 2022, p.51), these findings suggest that the creative use of these images, at present, is limited because they do not demonstrate concepts clearly or accurately enough. User inputs could be a factor, which may lack specificity, or the technology itself. Further training and exploration could improve this.

The creative value of AI-generated images is also limited by image originality. Whilst all participants noted the role of AI-generated images in at least one interview, not all connotated image creation as potentially creativity. Perhaps a reason for this is that such images are not original. The University of Plymouth (2022, n.p., original emphasis) appear to take the view that

‘**AI art isn’t original** – AI generators use and merge pre-existing images to satisfy a user command’, meaning that AI-generated images cannot be creative as they are not ‘original’. One would be right to question ‘But how far removed is this from human art which is an evolution of existing styles?’ (University of Plymouth, 2022, n.p.), which leads us to ask what it means to be ‘original’? For Runco and Jaeger (2012, p.92), ‘originality... is often labelled novelty, but whatever the label, if something is not unusual, novel, or unique, it is commonplace, mundane, or conventional’, and certainly, the association with the ‘unusual, novel, or unique’ is the strong base for the definition of originality; to be original is to create something new, that has not been seen before in this context at least.

AI images could be viewed as ‘original’. Certainly, ChatGPT believes that ‘images I create will be original, generated based on your specifications and requirements. They will not be copies or edits of existing images but will be created anew for your particular needs’ (OpenAI, ChatGPT, 2024a, n.p.), whilst Google Gemini (2024, n.p.) similarly suggests that ‘the images created by Gemini in Google Slides [for example] are original and not copies of existing images’. In this vein, it would be valid to consider AI images ‘original’ under Runco and Jaeger’s (2012, p.92) definition in the sense they are ‘novel’ and ‘unique’—because they are not the same as any other image—and for anyone who has attempted to create an image with AI, almost always ‘unusual’. Therefore, AI-image creation was not found to be creative with this small sample size of teachers because there was no case found where such images would add value, apart from for students as will be explored in Section 4.2.2. However, AI-generated images can be original and it is, therefore, possible that AI can enable creativity if these were to add value to teaching.

One final way AI can be used to enable teacher creativity is by greatly enhancing efficiency. To do this, participants reflected on specific examples where the use of AI was a novel approach which added value to a task. Talking about Year 10 fieldwork to Brick Lane, Teacher D reflected that:

> *'Our questionnaire was entirely ChatGPT designed and did a job that I had sort of earmarked to take about an hour and a half in about four minutes for us and was that was actually pretty good. It put it into grid form for us. And with some quite gentle coaching of its prompts.. [it produced] a questionnaire that we were happy with'* (Interview)

Teacher D's use of AI can be considered creative. Under Lucas *et al.*'s (2013, p.18) model, Teacher D was 'imaginative' in that AI was used for a task that was previously completed by a human, 'inquisitive' and 'persistent' in that inputs carefully engineered, 'collaborative' in that other teachers were consulted and 'disciplined' in that a suitable set of questions—in the desired 'gird form'—were reached. However, this use of AI goes further than satisfying Lucas *et al*.'s (2013) model; it also represents a creative sequence. For Sternberg (2003), there are a series of choices that lead to creativity, and Teacher D's decision-making follows this. Equally, Lubart's (2017, p.294) view that 'creating' forms part of creativity similarly suggests that Teacher D's use of AI is creative, whereby the AI model is effectively Teacher D's 'creative partner' corroborating the view of Mazzone and Elgammal (2019, p.34), but in this case, the efficiency of AI developed creativity by enabling a creative process. In this vein, Teacher D's engagement with AI promotes such models as 'more than tools' as they co-produce the product via a collaborative sequence, like the way AI art can be produced as described by Mazzone and Elgammal (2019, p.34). After recounting uses of AI in the classroom for data manipulation, Teacher C reflected that:

> *'When you do a bibliography, if you put ChatGPT in there... all you're doing is using another tool'* (Interview)

Teacher C's notion that ChatGPT is just 'another tool' is perhaps somewhat understated. In this case, AI is being used to the extent that it needs to appear in the reference list. Extrapolating this, Teacher C's ideas quantify and parallel Teacher D's usage in that AI is adding enough value to need referencing. This highlights the current and potential power of AI: recently available software is useful enough to materially add novel value to work produced in school and beyond. If this is the case, as Teachers C and D suggest, then AI models are enhancing creativity because they enable the user to undergo a sequence of steps described by Sternberg (2003), Lubart (2017) and Mazzone and Elgammal (2019) as creative. In this way, teachers' use of AI can be creative due to the series of creative steps teacher-AI collaboration takes, in addition to the co-produced creative output.

4.2.2 AI & student creativity

Creative teacher use of AI can lead to creative student use of AI. Whilst a full exploration of student AI usage is outside the scope of this project, generally, participants perceived that student usage was often more developed than teacher usage. When asked about students' use, Teacher A noted that:

> *'Students use it at the moment. I think they use it a lot more than I do... I think we're definitely at that point where the students, I feel are more progressive in using it than many of the staff'* (Interview)

Before the intervention, students' creative use of AI was similarly limited. Some students reportedly used AI creatively to design images in pursuit of visualising concepts. Whilst this could develop their wider thinking, encouraging this was difficult. Teacher B highlighted

that students sometimes use AI creatively as an alternative to drawing, such as on the topic of earthquakes, perhaps in emulating the process of dual-coding:

> *'I said to them they could do an AI-generated image if they wanted... I didn't want them to just get a generic image of an earthquake-proof building and go here it is. And I've now done some annotations versus a student that is good at drawing and really wants to design something original. It feels like we are putting students in different brackets, it's like, oh, I can draw and I feel confident I'm gonna make something original, which is awesome. Versus a kid that's like, I can't really draw, so I'm gonna find this, but then I don't do something original. And therefore, it's a bit of an easier task.'* (Interview)

Teacher B suggests that whilst this use of AI could be creative, it did not have enough student input to develop a creative process. Indeed, Lucas *et al*.'s (2013, p.18) model incorporating the need to be 'persistent' is not satisfied by inputting simple prompts and accepting the output. Similarly, the cooperation between AI and humans described by Mazzone and Elgammal (2019) suggests a co-constructive relationship that stretches further than the one described by Teacher B. Therefore, students' creative use of AI in geography initially lacked development.

Following the intervention, participants noted that students used AI to generate thoughtful images creatively, and that AI could be used for decision-making. Whilst some participants reported that some students remained unconvinced of AI (a barrier which will be explored further in Section 4.3), some students did use AI creatively. For example:

> Highlighting the creative use of AI in a poster assignment, Teacher D reflected that AI was used for '*image generation to create their own slideshows with like moving gifs and like blood diamonds with blood dripping down the slides and things... which is kind of creative, I suppose it is creative'*. Equally, '*in the latter part of this year*' Teacher D recalled '*seeing them [students] use AI creatively, or certainly AI additions or add-ons, in*

addition to some of the programmes they normally use to create their work, [and develop] the aesthetic of their work' (Interview)

For a unit on work on Darfur, Teacher B noted that students could use AI to '*look at solutions and think about what would be the most appropriate solutions*', with AI assisting students to 'e*valuate those solutions... to understand whether you know drip irrigation versus different farming needs would be more effective*' (Interview)

These examples highlight that AI can be used creatively by students. For Teacher D, students are using AI to create a more visually appealing product. This creation echoes Creely *et al.'s* (2020) notion that devices can modulate creativity; in this case, AI is enabling the creation of a more well-designed piece of work. Equally, AI is being used to co-construct a piece, similar to how AI and humans can cooperate creatively (Mazzone and Elgammal, 2019) and reminiscent of how teachers began to use AI creatively following the intervention. Some of the work described by Teacher D was group work, and given that creativity is highlighted as a 'social process' (Elisondo, 2016, p.194), this application of AI certainly contains creativity as students worked together to create.

For Teacher B, students using AI as a critical sounding board is creative as it will challenge evaluations of 'appropriate solutions'. Whilst this may not lead to a creative output similar to Teacher D's students' posters, it may lead to 'divergent thinking', where the student employs 'flexibility... [and] originality' (Ferrándiz *et al*., 2017, p.41) as part of a creative process to interrogate approaches, and appears to run parallel to how Griffiths' (2023a) used AI to explore weather patterns. This would require engineering of prompts, with the use of 'prescriptive... language', which Teacher C suggests could be a 'creative process' in itself (Interview). Indeed, 'multiple iterations and modifications' of user inputs can help refine and develop creative thinking (Hutson and Cotroneo, 2023, p.12), and this type of repetition is

recognised as important by Teachers B and C. Such divergent thinking can lead to creativity because 'creating' and 'collaborations' are constituents of creativity (Lubart, 2017, p.294), with student-AI 'collaborations' leading to the development of novel perspectives. Therefore, AI can enable or enhance student creativity, similar to teacher creativity.

4.3 RQ3: What are the barriers to AI usage by geography teachers?

Although participants used AI in many ways, there remain barriers to usage. Before the intervention, participants noted that barriers included their lack of experience with the technology to concerns about inaccurate information. After the intervention, this shifted towards apprehension over access and misuse. Wang and Cheng's (2021, p.3) study of barriers to AI use in Hong Kong draw on Ertmer's (1999) work, finding, in their words, that there are 'first-order barriers' which were 'extrinsic to teachers, and second-order barriers represent teacher's internal obstacles'. Whilst this division was useful in their context, the current study concentrates on teachers who, given the background of School A, had plentiful access to free AI tools so the former group of barriers is not appropriate. Instead, the barriers fall into two categories: operational barriers, which were practical, day-to-day limitations on usage; and, broader, ideological obstacles, meaning that there were more far-reaching personal concerns about using AI for tasks. This section examines these categories before and after the intervention. In doing so, the project uncovered new barriers to AI usage and significantly developed understanding of existing barriers. Therefore, the project can be considered a success in this regard.

4.3.1 Operational barriers

Before the intervention, participants reported two main operational barriers. For participants with more experience of AI, a lack of specific training and time to practice was commonly cited as a principal obstacle to further use. For instance:

> Discussing the role of continuing professional development (CPD), Teacher B remarked that '*I don't think we're given enough time*' to engage fully in some CPD sessions and '*CPD in terms of understanding how to use AI effectively*' would be useful (Interview)

Issues with the implementation of CPD are not uncommon. Within the literature, 'lack of time' is one cited headline issue with CPD activities, together with 'workload, poor management process, and absence of motivational strategies' (Saeed and Akhtar, 2017, p.2), as well as the potential for 'demotivation' (Pasique and Maguate, 2023, p.9). Although the current study validates concerns around the temporal opportunity for CPD exercises, participants generally appeared willing to undergo training on AI. Perhaps the small sample of opt-in participants may disproportionately represent a group with a comparably stronger desire to further their practice, whilst the personal nature of the interview method may have reduced the possibility of self-reported negative views. For these reasons, whilst the broader findings from Saeed and Akhtar's (2017) and Pasique and Maguate's (2023) should be approached cautiously, the lack of time to be taught about AI best practices is one fundamental barrier.

For participants with less experience with AI, there was the additional barrier of not understanding the technology, because they had not tried it. For example:

> Teacher A reflected that they felt '*uncomfortable*' using AI, and that they needed '*some more understanding about using the technology and ways to improve maybe the way I engage with the technology so [previously] I didn't feel that confident with it*'. In addition, '*when you trial something, unless you keep insisting at it to try and improve,*

sometimes you can sort of keep it away and get too busy doing other things, so couldn't quite pursue as much as it should have' (Interview)

On a similar note, Teacher D reported that '*my experience is that it requires either a top-down, SLT just to go this is what this is what we're doing, this is what we want to use it for, this is how you could use and we'd like to see evidence of you doing it*', whereby AI usage in '*mandated*', or a colleague '*is well into it and they are then able to show others in the department how it can be used effectively*' (Interview)

Teacher A and Teacher D's reflections suggest that lack of experience is a barrier to AI usage. For Teacher A, 'more understanding' was needed to utilise the technology fully, and similarly, Teacher D suggests that AI usage being 'mandated' or encouraged by peers is important to overcome this barrier. Teachers' understanding of AI is a potential obstacle (Wang and Cheng, 2021; Lin *et al*., 2022), and some teachers have a 'lukewarm attitude' to using AI (Wang and Cheng, 2021, p.6). Given the opt-in nature of the interviews and professional positionalities involved, participants who completed all three stages of the project were willing to try AI, so the opinions of these participants were perhaps warmer than those of Wang and Cheng's (2021) wider study.

After the intervention, some participants reflected that time remained a barrier. For instance:

Teacher B suggested that '*genuine time*' to experiment with AI and also '*more training... by specialists*' would encourage further usage (Interview)

In this way, the barriers following the intervention run parallel to temporal obstacles raised before it. Creating opportunities for CPD is certainly an issue (see Saeed and Akhtar, 2017; Pasique and Maguate, 2023), and for Teacher B, perhaps additional time to trial AI post-intervention would be beneficial. Teacher D echoes this, remarking that 'it's just about having the time have a play with the AI' (Interview), which was a factor raised throughout the project.

Furthermore, Teacher B suggests that some additional technical training on AI would be useful. Indeed, the intervention within this project was designed to be a small-scale development of AI usage within one department, so there may be an appetite for future school-wide initiatives.

One last operational barrier was access to AI applications. Although teachers at School A enjoy internet access, with school policy supporting the use of AI for tasks that do not involve personal data, and access to Google Gemini (formerly Google Bard) via the Google Education Plus edition, the intervention unveiled an issue with access to models. For example:

> Teacher C enjoyed using ChatGPT's '*version 4*' with a group of Year 10 students, but noted that '*the big but, of course, is after about 15 minutes of use, you get chucked out because you've got to pay for it*' and when attempting to use Google Gemini instead, found that students '*can't access it*' (Interview)

Teacher C illuminates some practical access restrictions. For use involving students, age is a limiting factor with some models. Google (2024a, n.p.) states that users must be '18 or over to use Gemini with a work or school account', but interestingly, only '13... with a personal Google Account'. Indeed, AI models have vastly different conditions of use (Shepperd, 2024) and this poses one barrier to use. As School A runs Google software, the age barrier with Gemini is likely to change as the company plans to launch a 'teen experience' version of the model that avoids 'content that may be inappropriate to teen users' (Kirtikar and Hendricks, 2024, n.p.). Perhaps the larger obstacle is the issue of cost, which runs across School A and beyond. Willis (2023, p.110) rightly warned that 'existing inequalities of income, mobility and education are not automatically erased by new technologies, but in many cases are exacerbated and reinforced', and the findings of the current study support this: if full access is behind a paywall, only institutions that can afford the costs will reap the benefits. Indeed, the

risk of AI worsening inequalities may increase is echoed by many scholars (see Bulathwela *et al*., 2024; Farrokhnia *et al*., 2023; Willis, 2023) and the inaccessibly of some tools on economic grounds as reported by Teacher C reinforces this. Therefore, one operational barrier to AI usage is access.

4.3.2 Broader, ideological barriers

Participants also reported broader, ideological barriers to AI usage. Before the intervention, these included concerns about inaccurate information, student reliance on AI and data protection. After the intervention, apprehension surrounding inaccurate information remained, but new obstacles such as student perceptions of AI and the threats of potential misuse developed. This means the project was a success in unveiling new obstacles, and developing understanding of existing barriers.

Prior to the intervention, participants noted a concern around inaccurate outputs. For example:

> Teacher C reported that encountering incorrect outputs happens '*all the time*' (Interview)
>
> Similarly, Teacher B reflected that AI may provide students with '*information that isn't quite accurate, but they don't have the knowledge to understand that*', leading to students having notes that are '*wrong*', whereas teachers can '*understand [and correct] when it gives us an answer and we're like that's not right*' (Interview)

These reflections highlight the proliferation of incorrect outputs. For Teachers B and C, incorrect outputs appear often. Whilst teachers who had less experience with AI or used it less for research purposes did not report this issue as frequently, Teacher B and C's experiences build on other studies. For instance, Athaluri *et al*. (2023) rightly contend that models can

output plausible but fabricated information, whilst Sison *et al*. (2023) suggest users triangulate outputs. Certainly, AI can act in the way Athaluri *et al*. (2023) describe, and teachers should be quick to correct outputs that appear imprecise, as Sison *et al*. (2023) advise. Contrastingly, although AI is unlikely to be a 'weapon of mass deception' (Sison *et al.,* 2023, p.15) to teachers who diligently correct outputs, it may create problems for students, as Teacher B highlights. Therefore, inaccurate outputs are one broader barrier to AI usage.

Second, student reliance on AI is a barrier to AI usage. Some participants expressed concerns about not wanting to encourage students to use AI because they feared students would develop a dependency on the models. For example:

> Teacher A noted that '*sometimes I need to then reestablish the ground rules in the classroom to ensure that the students aren't fully reliant or relying too heavily on the AI technology to help formulate the responses. And so they can be found out pretty quickly because if they're using ChatGPT, it's generally more of a professional language that's used and which I can tell is beyond what language some of my students are capable of doing*' (Interview)

Students becoming 'reliant' on AI is problematic and may discourage teacher usage. For instance, if students submit work they are not 'capable of', this may lead to concerns around plagiarism if the work is not appropriately original (see JCQ, 2024a) and make teachers reconsider using the technology. More alarmingly, student dependency may compound the issue of inaccurate outputs. In effect, students may accept false information without challenge leading to issues in future, similar to AI correcting work but not misunderstandings (Marzuki *et al*., 2023). Whilst some students have an awareness that AI information may be misleading (Ali *et al*., 2021), these findings suggest that teachers in School A are concerned with student dependency and inaccurate information. Equally, Ali *et al*.'s (2021, p.10) work is based on 'a

social media simulation', where young people may more easily infer truth from fiction than on complex geographical topics, where subject knowledge is comparably more important and less prevalent. Therefore, concerns about student reliance on AI is another barrier to usage.

Third, data protection is a key barrier to usage. Whilst DfE (2024, p.26) suggests implementing restrictions on the 'inputting of personal data' to AI models, participants seemed aware of this necessity. For example:

> Teacher A expressed the concern that they were '*a bit unsure about the programme behind the scenes, I know there's been some big talks about some of the major AI companies and what their intentions were to start of this phenomenon, technology phenomenon*' (Interview)
>
> When discussing the potential efficiency gains of AI in tasks that require teachers to '*summarise a large chunk of data on a student*', Teacher D noted that experimenting with this would not be possible because they were '*scared about GDPR*' (Interview)

Outlining information could be a beneficial use of AI. However, school policy, perhaps informed by data protection legislation (see DPA, 2018), prevents AI from being used in this way. Indeed, ChatGPT can 'summarise extensive literature' (Rahman *et al*., 2023, p.9), and would be capable of handling a 'large chunk of data' from School, but the companies' 'intentions' are significant. Whilst there is the option to 'opt out' if the user decides against ChatGPT's parent company using 'your content to train our models' (OpenAI, 2023, n.p.), Google (2024b, n.p.) employs Gemini inputs to 'provide, improve, and develop Google products and services'. Although the data may be used to enhance the user experience, Teacher A seems unconvinced of the true 'intentions' of these companies and inputting student data is currently inappropriate (DfE, 2024). If models can guarantee that 'data is not reviewed by anyone to improve AI models, used to train AI models, or shared with other users or institutions', as

Google (2024c, n.p.) plan for Gemini's Education version, this may change. However, data protection remains a key broader barrier to teacher AI usage.

Following the intervention, imprecise information remained a barrier to AI usage. For example:

> When asked about problems of AI usage, Teacher A reported that '*sadly, I've seen that misinformation being perpetuated*' and the need remained to '*check that it is accurate, reliable information*' (Interview)
>
> Similarly, Teacher B reflected that AI models often output that '*I can't give you this [up-to-date] information or stuff, so I've found it less useful these days*' (Interview)

Teacher A's reflection illuminates a further obstacle of misleading information. Misinformation creates an inaccurate image of reality (Cook *et al*., 2015), and this is particularly concerning if the information is 'perpetuated' by students who have a flawed understanding. This is a barrier to AI usage as teachers are concerned about the impacts of information that is not 'accurate' or, in Teacher B's case, a lack of recent data. Whilst the literature highlights many examples of algorithmic bias (see Bhatnagar and Gajjar, 2024; Datta *et al.*, 2015; Obermeyer *et al*., 2019), participants did not overtly suggest this to be an obstacle to use. Perhaps this phenomenon is not as relevant for AI uses within School A that involve objective facts or administration, or participants did not use AI frequently enough to recognise algorithmic bias. Therefore, inaccurate or outdated information remained a barrier to AI usage.

Fears surrounding AI misuse also posed obstacles to AI usage. Whilst participants were concerned about this to differing degrees, the concept of misuse was identified as a barrier. For example:

Teacher A referenced '*rather distasteful AI use from students towards staff members or fellow students*' which '*caused a distrust and discomfort within a workplace due to the inappropriate use of the technology, something which all schools need to be aware of and policies put in place to ensure appropriate use*' (Interview)

Teacher B noted '*I've just had a couple of students in detention because clearly their work was ChatGPT*' (Interview)

Whilst Teacher C was less concerned, reflecting that '*Ok, some people get away and cheat. I don't think I personally, I don't think that's the issue. I think the issue is it leading to people not being creative, people being reliant*' (Interview)

Teachers A and B's ideas suggest student misuse is a barrier. For Teacher A, this could cause others 'discomfort', whilst, for Teacher B, students submitting AI-generated content as 'their [own] work' is problematic. Although Teacher C does not see academic misconduct as the most prominent 'issue', there is some recognition from participants that AI could be misused. Although there are systems in place to detect AI intervention (JCQ, 2024a), confirming this in school may be difficult (Woods, 2023) and handling AI use in university assignments is equally challenging (Perkins *et al*., 2023). School A has not yet altered detection or guidance policies around formative assignments, and there are no defined penalties for AI misconduct. As a result, Teacher A and B's concerns highlight both an apprehension to use AI more, and perhaps a call for guidance in managing misuse. Indeed, 'reducing the overall reliance on assessments where AI tools may be used to mimic human writing, or by using AI-inclusive assessments' has been recommended (Perkins *et al.,* 2023, p.89), and School A may wish to consider a similar approach to formative assessments in response to this obstacle. Therefore, student misuse of AI is a barrier to further AI usage.

Despite the potential for misuse, student concerns are also a barrier to usage. For example:

> Teacher C noted that students worried about '*cheating*' and '*unfamiliarity*' with the models, and some have '*a view of not wanting to use it*' as they '*see it as some form of cheating, or something they would criticised for using despite reassurances that this is ok*'. In one class, '*a quarter*' used non-AI tools despite encouragement to use AI (Interview)

Teacher C's revelation suggests the opposite of the misuse cases above. Instead, students' apprehension creates an obstacle to usage as some students—in one class 'a quarter'—resist using AI despite encouragement. Almaiah *et al.* (2022, p.3663) find that 'social anxiety' can be caused by 'frustration and confusion' resulting from 'the usage of different tools in the educational environment' in a group of university students. Whilst Teacher C does not go as far as Almaiah *et al.* (2022), these findings suggest that there is some hesitation among some students at School A to use AI. This is a barrier to AI usage because if students are fearful of and reject AI, teachers may avoid using it. Wang *et al*. (2022, p.12) conclude that 'AI learning anxiety has negative influences on both intrinsic and extrinsic learning motivations, but AI job-replacement anxiety has a positive impact on extrinsic learning motivation', and this finding may illuminate a method of overcoming the obstacle of user apprehension. If schools emphasise the importance of learning about AI to secure and develop future careers, students, and perhaps unconvinced teachers, may be more willing to experiment with the models. Nonetheless, the intervention was successful because it uncovered the novel barrier of student concerns about AI.

5. Conclusions and Implications

This study aimed to investigate how AI could be used by geography teachers. To do this, practitioner research, encompassing three main stages, was deployed to answer the research questions. The second stage incorporated the intervention, whereby I coached participants on how AI could be used in the classroom and provided resources, such as a presentation and handout. The first and third stages employed interviews as the research instrument to illuminate to what degree teachers used AI before and after the intervention, and what barriers there were to use. Given the whole-school focus on creativity across the duration of the project, I also investigated how AI could be used creatively to support teachers.

The study unveiled new barriers and developed understanding of existing obstacles to AI usage. Although general and creative use increased by some participants, but not all, the intervention was highly successful in uncovering operational and broader obstacles to AI use. Therefore, the intervention was a partial success. AI models built specifically for geography teachers, and for some participants, more technical training would be beneficial. Equally, these results arise from a small sample of participants at one school. This research opens avenues for comparable studies at other schools, or larger studies across multiple departments and schools.

The project was effective in answering the research questions set. First, RQ1 aimed to highlight the purposes for, and the degrees to which geography teachers in School A use AI. Technology is used to develop teaching and learning in geography (Walshe and Healy, 2021), and the current study uncovered how AI can assist teachers within School A. The findings suggest that teachers use AI to vastly different degrees, and for a broad range of reasons, with

most using the technology more, and for a wider range of applications, following the intervention. Although a rich quality of data was collected, the study only explored one department, so studies of other departments or schools may be a fruitful avenue for further research.

Second, RQ2 was designed to uncover how AI could support creativity. As the whole-school focus in School A was on developing creativity in teaching and learning across the duration of the study, the project focused on how AI could be used creatively by geography teachers. Whilst the boundary of ChatGPT's imagination is clear (Rahman *et al*., 2023), these findings suggest that AI can be used by teachers to develop their own creativity, or to enhance and coach student creativity. The relationship between AI and teachers is therefore argued to be collaborative, similar to how AI can assist artists (Mazzone and Elgammal, 2019), but here, it helps teachers and students of geography. Before the intervention, participants used AI creatively to think outside their own sphere of knowledge or to further student progress by enabling them to visualise unfamiliar concepts. The intervention was partially successful because, at Stage 3, most teachers reflected on novel ways that AI enhanced their creativity, whilst AI may also develop student creative decision-making.

Third, RQ3 recognised the barriers to AI usage by geography teachers. The intervention was the most successful in this regard, because it allowed teachers to troubleshoot issues, which also resulted in novel obstacles subsequently arising. There are many obstacles to AI usage (Wang and Cheng, 2021), and this study argues these constitute operational or broader, ideological barriers. Prior to the intervention, teachers reported operational barriers such as not having tried AI models before and broader issues, such as worries about reliance,

inaccurate information and data protection. Following the intervention, operational constraints such as access and time were uncovered, whilst broader concerns included fears about imprecise information, misuse and student concerns.

This project has greatly developed my own professional practice. For example, the planning of the intervention enabled me to learn more about how AI works and the potential usages within school. This has enabled me to use the technology more effectively, and coach students in using AI efficiently to benefit learning. For example, I now regularly use AI for a range of purposes from resources to example answers. The conversations surrounding the project, including the intervention, allowed me to coach colleagues on how AI is being used in other schools and settings, which gained positive feedback from colleagues and managers. The inclusive approach of the project enabled collaborative professional learning, whereby participants shared their experiences with me, creating and developing the study. I was invited to share my work with the school community via a TeachMeet, to disseminate the ideas gathered with teachers across the school and further promote collaborative professional learning. This presentation was praised by senior leaders. I am also a founding member of the School's AI Working Party, which aims to create and develop AI policy. My contributions to this group are based on the work presented in this project and I look forward to building on these successes at the doctoral level.

Finally, the study also has implications beyond School A. I intend to publish these results, to add to the geography education literature. The findings expand on conversations in the literature and open avenues for study on the consequences of AI usage in secondary education, and into the student perspective of AI usage. For example, the finding that some

teachers and students are apprehensive about the technology could be explored further. As mentioned above, larger studies could compare AI usage in greater depth.

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7. Appendices

Appendix A: Letter to the Headteacher

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

15 Norham Gardens, Oxford OX2 6PY
Tel: +44(0)1865 274024 Fax: +44(0)1865 274027
general.enquiries@education.ox.ac.uk
www.education.ox.ac.uk

Contact information redacted

Addresses redacted

Artificial Intelligence (AI): How can we use Artificial Intelligence in Secondary School Geography?
Ethics Approval Reference: EDUC_C1A_23_326

Dear *redacted*,

I am writing to enquire about conducting some research in school in this academic year. I am a Master's Student at the University of Oxford, supervised by *redacted*. In my research study, 'Artificial Intelligence (AI): How can we use Artificial Intelligence in Secondary School Geography?', I will explore how Geography teachers can use AI to a greater extent.

The research will take place with teachers of Geography and/or teachers involved in AI policy and/or implementation at *redacted*. My research focus is on how AI can be used more in learning and teaching. It will look to build on current AI policy at *redacted* and further the work of the AI Working Party.

By participating in the research, the school would be contributing to research that will uncover the best practice for AI use in the secondary school.

The commitment from the school would be to allow me to discuss Geography teachers' use of AI individually, in groups or via questionnaire. I would then run an intervention seminar to showcase best practice uses of AI. Following this, I would meet with teachers to discuss how their use of AI has changed. I would audio-record teachers who consent to this and photograph examples of best practices. The time burden for participating teachers is of the utmost priority: participation is voluntary and teachers can choose how and when to participate.

Oxford University has strict ethical procedures on conducting ethical research with teachers and students, consistent with current British Educational Research Association guidelines. Before beginning the research, I would inform teachers about the research and offer the teachers the opportunity to refuse to participate. Throughout the research, teachers will be able to refuse to participate at any time, up to one month after their participation.

All teachers and the school would be made anonymous in all research reports. The data collected would be kept strictly confidential, available only to my supervisor and myself and not used other than specified in the Study Information Sheet without the further consent of all involved being obtained. The final report will be submitted to the University of Oxford as outlined in the Study Information Sheet and may be published more widely, for example in peer-reviewed journals,

book chapters, academic blogs or at conference presentations. All recordings would be destroyed at the end of the research period, and kept in locked conditions until then. I have an enhanced DBS check verified by *redacted*. I have enclosed copies of the information for teachers and an example consent form for teachers with this letter.

If the school would like to take part in the study, or you need more information about what is involved, please contact me. Whether or not you feel it would be appropriate for your school to participate, I would be grateful if you would complete the pro-forma below, and return it to me in the stamped addressed envelope enclosed in this letter.

Thank you for your time and attention. I look forward to hearing from you.

Yours Sincerely,

Redacted

Artificial Intelligence (AI): How can we use Artificial Intelligence in Secondary School Geography?

Contact information redacted

☐ We do not wish to participate in this project.

☐ We would like to find out more about this project.

☐ We would like to take part in this project.

If you would like further information, or are interested in taking part, please give the name of a contact person for your school, and details of the best way to contact him or her.

Contact name: _____

Contact email: _____

Contact telephone number: _____

Thank you for your help.

Appendix B: Participant Information Sheet

UNIVERSITY OF OXFORD
DEPARTMENT OF EDUCATION

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general.enquiries@education.ox.ac.uk
www.education.ox.ac.uk

Contact information redacted

Artificial Intelligence (AI): How can we use Artificial Intelligence in Secondary School Geography?

INFORMATION SHEET FOR TEACHERS

Central University Research Ethics Committee Approval Reference: EDUC_C1A_23_326

In partnership with researchers at the University of Oxford, *redacted* has agreed to take part in a research study investigating how artificial intelligence (AI) can be used in secondary school Geography. We would like you to be part of this research. We very much hope you would like to take part, but before you decide, it is important that you understand why the research is being done and what it will involve.

Why is this research being conducted?

This research is to build on the school's current objective to further deploy artificial intelligence (AI) software in school. By its commercially novel nature, the forms this research may take are broad. Nonetheless, the research aims to build on the school's AI Working Party's work to increase the use of AI by teachers of Geography.

The benefits of this include more efficient methods of teaching and learning in Geography and better pragmatic use of technology the school is attempting to encourage teachers to use.

More information about the research can be obtained by contacting the research team (contact details *redacted*).

Why have you been invited to be involved in this research?

We are inviting you to take part because you teach Geography at this school and/or are involved with AI policy and/or implementation at this school

We are inviting under 20 teachers to take part.

Do you have to be involved?

No. You can ask questions about the research before deciding whether to participate. If you do agree to participation, you may withdraw yourself [and your data] at any time, without giving a reason and without any effect, by advising the researchers of this decision. The deadline by which you can withdraw any information they have contributed to the research is one month after your participation in the research. If you withdraw before this deadline, all of your data will be deleted from the study.

What will happen if you take part?

You will be invited to take part in an interview and/or focus group and/or discussion that are planned to take a maximum of 30 minutes each. You may also be asked to complete a questionnaire. You can opt-in to none, some or all of the events. The sessions will be timetabled at mutually agreeable times, as far as is reasonably possible, so as not to present an excessive time burden.

What are the possible disadvantages and risks in taking part?

There are no obvious disadvantages.

Are there any benefits in taking part?

There will be no direct or personal benefit to you from taking part in this research. However, it could illuminate how you may use AI in your role in the future, to further develop teaching and learning.

What information will be collected and why is the collection of this information relevant for achieving the research objectives?

The data collected may include:

- Consent forms
- Audio recordings
- Photographs
- Fieldnotes
- Task results (questionnaires, group notes etc.)

All of these data will be stored on either school-approved Google Workspace software or University-approved Microsoft 365 for Business software. Paper copies will be destroyed.

The researchers will retain Consent forms for 3 years after publication of the work of the research.

Researchers will ensure all other data collected in the research has identifying information removed as soon as possible after collection. Audio and/or video recordings, notes, and all other data will be stored on either school-approved Google Workspace software or University-approved Microsoft 365 for Business software. At the end of the research, recordings will be erased. The researcher and supervisor will have access to the research data.

Regular summaries of our findings will be given to the school and will be available to interested parties on request. I will not identify the school, teacher or any students in any reports of the research.

Will the research be published? Could my child be identified from any publications or other research outputs?

The findings from the research will be written up. This will initially be for academic assessment for the University of Oxford's Master of Science in Learning and Teaching degree. The report and/or sections of it may also be published in peer-reviewed journal(s), academic blogs, book chapters and/or conference presentations or similar. Participants' contributions will be anonymised.

A copy of my thesis/ dissertation will be deposited both in print and online in the Oxford University Research Archive where it may be publicly available to facilitate its use in future research.

Data Protection

The University of Oxford is the data controller with respect to your personal data, and as such will determine how your personal data is used in the research.

The University will process your personal data for the purpose of the research outlined above. Research is a task that we perform in the public interest.

Further information about your rights with respect to your personal data is available from https://compliance.web.ox.ac.uk/individual-rights.

Who has reviewed this research?

This research has received ethics approval from a subcommittee of the University of Oxford Central University Research Ethics Committee. (Ethics reference: EDUC_C1A_23_326).

Who is organising and funding the research?

Redacted is organising this research, which is funded privately.

Who do I contact if I have a concern about the research, or I wish to complain?

If you have a concern about any aspect of this research, please contact *redacted* or *redacted* and we will do our best to answer your query. We will acknowledge your concern within 10 working days and give you an indication of how it will be dealt with. If you remain unhappy or wish to make a formal complaint, please contact the Chair of the Research Ethics Committee at the University of Oxford who will seek to resolve the matter as soon as possible:

Dr Elizabeth Wonnacott, **[Education DREC Chair]**; Email: student.curec@education.ox.ac.uk

15 Norham Gardens, Oxford OX2 6PY

What should I do next?

Please fill in the enclosed form and return it to the researcher if you would like to take part in this research. Please remember that you may withdraw yourself at any time (up to 1 month after your participation) , without giving a reason, by notifying the researcher.

Further Information and Contact Details

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact:

Contact information redacted

Appendix C: Consent Form

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www.education.ox.ac.uk

Contact information redacted

CONSENT FORM FOR TEACHERS

Central University Research Ethics Committee (CUREC) Approval Reference: EDUC_C1A_23_326

Artificial Intelligence (AI): How can we use Artificial Intelligence in Secondary School Geography?

		Please initial each box
1	I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2	I understand that my participation is voluntary and that I am free to withdraw at any time up to one month after my participation, without giving any reason, and without any adverse consequences or penalty.	
3	I understand that research data collected during the study may be looked at by authorised people outside the research team. I give permission for these individuals to access my data.	
4	I understand that this project has been reviewed by, and received ethics clearance through, the University of Oxford Central University Research Ethics Committee.	
5	I understand who will have access to personal data provided, how the data will be stored and what will happen to the data at the end of the project.	
6	I understand how this research may be written up and published.	
7	I understand how to raise a concern or make a complaint.	
8	I understand that researchers will observe lessons and other aspects of my teaching, as detailed on the information sheet, and discussed and agreed with the researchers.	
9	I consent to being audio recorded	
10	I understand how audio recordings / photos will be used in research outputs	
11a	I give permission to be quoted directly in research outputs and for my name to accompany any quotation **OR**	
11b	I give permission to be quoted directly in research outputs against a pseudonym **OR**	

AP15 Template Consent Form for Teachers, version 1.2, February 2023

11c	I give permission to be quoted directly in research outputs but only fully anonymously **OR**	☐
11d	I do not wish to be directly quoted	☐
14	I agree to take part in the study	☐

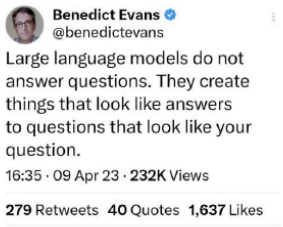
Name of Participant
Date dd / mm / yyyy
Signature

Name of person taking consent
Date dd / mm / yyyy
Signature

Appendix D: Intervention Presentation

AI & Geography

1



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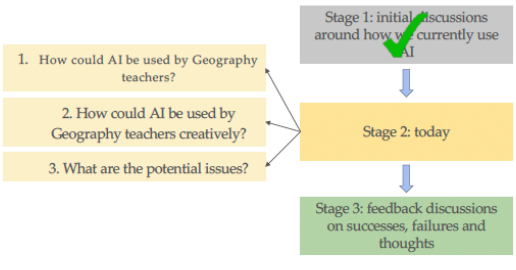

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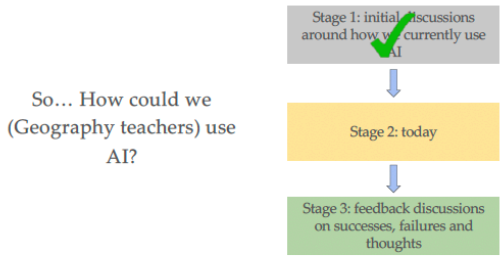

4

Brian Kerr (2023) - Case Study

'I asked the platform to develop a **niche case study on the use of fuelwood in West Bengal** – a topic in which my own geographical knowledge was lacking. Imagine how stunned I was when it provided me a neatly packed list of key points relating to the social, economic, and environmental impacts of using fuelwood in the region.'

5

Paul Logue (2023) - Explain, summarise, simplify, prompts

1. Explain it to me
2. Use bullet points and categorisation for it to produce notes for you
3. Don't understand something? Simply it!
4. Allow prompting to become your best friend

6

Alice Griffiths (2023) - Climate Change Morals

Discusses using an AI to evaluate a moral issue, such as climate change.

7

Alice Griffiths (2023) - Exam answers

Use Chat GPT to produce answers to exam questions

8

Alasdair Monteith (2023) - tips

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'1. Just start using it
2. Demonstrate good practice to students
3. AI for summarising case studies
4. Retrieval practice
5. AI and differentiation'

9

David Alcock (2023) - Flipped Learning

ChatGTP could enable greater use of flipped learning approaches, freeing up class time for skills-based teaching

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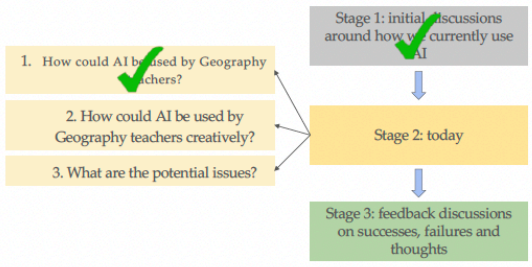
10



11

Creativity

Many definitions

Creativity as a whole-school focus

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12

Creativity

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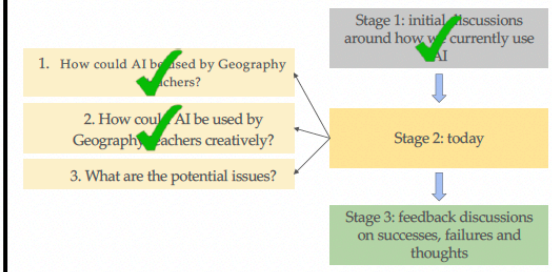
Lucas et. al. (2013) OECD report suggests that creativity is important within school. Notion of 'dispositions':

- Inquisitive
- Persistent
- Imaginative
- Collaborative
- Disciplined

Teaching creatively and/or teaching for creativity

13



14

Ethics & safety

Department of Education (October & November 2023)

In general, the guidance suggests that schools and colleges should:

- protect personal and special category data
- not allow or cause intellectual property, including pupils' work, to be used to train generative AI models, without appropriate consent or exemption to copyright
- review and strengthen their cyber security by referring to the cyber standards
- ensure that children and young people are not accessing or creating harmful or inappropriate content online, including through generative AI - see keeping children safe in education

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15

Ethics & safety

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The Joint Council for Qualification has updated guidance on artificial intelligence usage in (non-exam) assessments:

'students must submit **work** for assessments **which is their own**. This means both ensuring that the final product is in their own words, and isn't copied or paraphrased from another source such as an AI tool, and that the content reflects their own independent work'

16

Ethics & safety

The education sector needs to:

- prepare students for changing workplaces
- teach students how to use emerging technologies, such as generative AI, safely and appropriately

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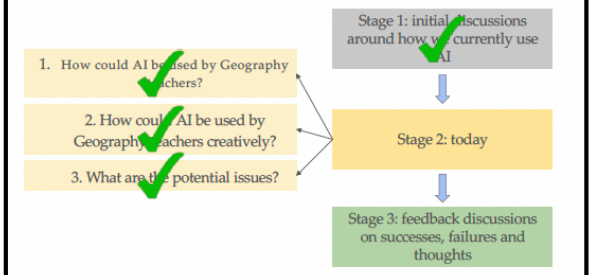
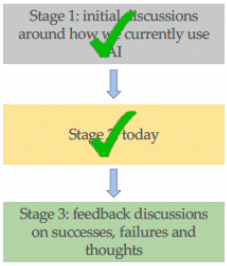
17



18

Next step: try it out!



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Further Reading

Geographical Association

QuizGecko

Speechify

Questionwell

EducationCopilot

Chang and Kidman (2023) AI in Geography Education

FarroKhnia et al (2023) SWOT Analysis of ChatGTP

Kate Stockings' Blog

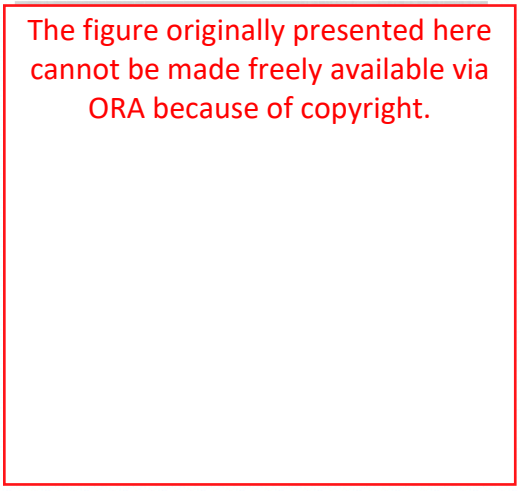
NCSC ChatGPT and LLMs

Presentation & handout image source Google Duet AI

21

Appendix E: Intervention Handout

A Teacher's Guide to using Generative Artificial Intelligence (AI)



Artificial intelligence recently gained widespread attention, following the commercial release of chatbots and free artificial intelligence tools. This guide aims to highlight how teachers could use GenAI to increase efficiency, reduce workload and improve student outcomes.

The principles

GenAI is just like any other teaching tool. It is just as powerful as you allow it to be. There are so many forms of GenAI, that current educational research suggests that it would be useful to establish some key principles to consider when using an AI.

1. **Explore**
   The best way to learn about any digital tool is to use it for yourself. The prompts provided could be a useful starting point, but not all will work for you. Feel free to try your own!
2. **Verify, then trust**
   Remember that AI can suffer 'hallucinations', leading to 'outputs that are nonsensical or altogether inaccurate' (IBM, 2023). If your subject knowledge conflicts with the AI output, trust your own understanding unless *traditional* research proves the AI correct
3. **Check, check, check**
   Given the criticality needed, make sure to (briefly) check all outputs before use
4. **You (could) give it information, and ask it to use this as a source**
   Providing the data for the AI to use greatly reduces the chance of surprising outputs
5. **Acknowledge AI usage (teachers & students)**
   Current educational research suggests using AI responsibly is a workload reducing and efficiency increasing tool that will continue to develop over time. As with any resource, be open about where AI has been used

Prompts

Current artificial intelligence tools respond to the inputs, or prompts, that you provide to them. From this, they will give outputs. Often, the first output is not the perfect answer to your question. Asking the AI to rephrase or completely recreate an output can lead to more desirable results. Being more specific with a prompt can help, too.

AI for pedagogy

'For a Year 9 Geography Class studying climate change, please could you create a 20 question revision sheet? Please also provide an accessible list of answers after the questions'

'For a Year 12 Geography Class studying a topic on rivers, please could you read the below information and create a 15-question vocab test? Please also provide the answers'

'I am going to provide you with a text on the economy of India. For a Year 7 Geography Class, please use the text to generate a possible 15-minute task for the students. Please also provide some extra tasks for students who finish early, as well as some hints for students to get started'

AI for professional development

'I will provide you with some information on how weathering takes place, from an A-Level Physical Geography textbook. Please could you briefly, in under 10 bullet points, summarise what weathering is and how weathering occurs?'

'I would like to understand the key takeaways from this document. Please could you create a summary for me?'

Tools

ChatGPT **and** Google Gemini (previously Bard)

**Image on 1st page credit Google Gemini*

Potential ideas

Use AI to…

To create a homework worksheet for Year 7	**To create a lesson plan for a cover lesson**	**To create an image from text to boost creativity for the Year 9 Superpowers unit**	**To create a list of questions from a transcript of a YouTube video on Urbanisation for Year 10**
To create a letter about a trip for our RGS Lecture	**To create a revision list for a Year 9 test on Food Security**	**To generate alternative exam questions about India for Year 7**	**To suggest improvements on an example examination answer for Year 9**
To summarise some information about how latitude impacts temperature and/or pressure and/or wind belts	**To create a quiz on key words for the Year 12 Hydrology and Geomorphology unit**	**To expand on existing text about a river for Year 8**	**To summarise meeting notes for a curriculum meeting**
To write an email to a Colleague summarising notes from a recent CPD session	**To break a document into sections for a spreadsheet tracker of a specification**	**To generate inventive ways of teaching content on Icy World to Year 7**	**To generate a 20-mark answer for Environmental Management, which students could analyse and improve in Year 13**

Framework of implementation (UNESCO, 2023)

UNESCO 2023 Framework		What does it mean?
Aspect	Acquisition	
Human-centred mindset	Benefit-risk analysis	Humans remain at the centre of teaching and learning. AI is used by humans to enhance teaching
Ethics of AI	Ethical principles	AI is used safely and ethically. Teachers model ethical usages to ensure AI is used safely
AI foundations & applications	Basic AI technique and applications	As teachers begin to use AI, applications are used and developed as appropriate
AI pedagogy	AI-assisted teaching	Teachers may begin to use AI to enhance their pedagogy, or administration practices
AI for professional development	AI as an enabler of lifelong professional learning	As the software develops, teachers may wish to use AI to enable professional development

Appendix F: Indicative Interview Questions

How do you use artificial intelligence (AI) in lessons at the moment?
How do you use AI to plan lessons?
How does AI help you research or learn content?
How do you think students use AI?
What are you opinions on AI at the moment?
Which applications of AI are you working on at the moment?
How, if at all, would you like to see AI use develop?
If you could use AI more, what would you use it for?
What are the barriers to increased AI use for you?
Which types of AI do you use at the moment?
Which types of AI would you like to use more of in your role?

Appendix G: Stage 1 Codes

List of Codes – Stage 1

A	B	C	D
Feedback	ChatGPT	Answers to exam Qs	Not a lot
Trialed it	Bard	Mark answers	Short-sharp physical
Needs more understanding about technology	Climate change	Criticize the answer	geography processes
	Revision	Not good enough	explanations
How to engage – help	Research	Students improve answer	Students then critique
Iterative – need to keep practicing	Upper Remove	Reset the prompt	Step-by-step
	Lagos	Targets	Chat GPT summaries
Students use it more	Case Study	Key words	Easy to fact-check
Homework – risk	Informal Settlements	Better answers	Expands on underexplained ideas
Risk – use in class	Statistics	Year 9 – development	
Rules	Migration v Natural Increase	Development indicators	Make it better
Reliance – students	Data access	Sort and rank	Reports?
Writing not strong	Better than gov't website	ChatGPT 'to do it all'	Summarise ideas
Language used	Saved time	Manipulating data	Concerns around GDPR
Student confidence	Accuracy	Time savings (60 min to 15 min)	Data protection
Research	Hallucinations		Tornadoes
Responses	Inaccurate quoting of articles	Providing the AI data	Ask it to provide data
'Grounding'		Shortcut	Google Docs
Risk – shortcuts	Ask for data from WB, IMF, UN	Manipulate data	Scan pages digitally
Reliance		Analyse data	Ask AI to use this information
Structure of answers	Sources	Once a month	Decent job
Unsure	Reliability	Improving exam answers	Needs to be well prompted
Risk – algorithm, companies' intentions	Superpowers project	Need to be trained to be critical of machines	Understanding the specification
	Different results to internet		
Accuracy of information	Chat GPT	Research	Input the specification
Reliability	Bard	Encourage	Ask it to produce questions
Vested interests	Students – limited	One academic misconduct is enough	Given some breakdowns of specifications
CPD Workshop	Wants to use it		
Exam responses	Resources		

Google Bard/Gemini	New data	'Mugging me off'	Studying case studies in more depth
Roll out	AI to help with this	ChatGPT to help	Giving evaluative points
Students 'more progressive'	But – trust	1/3 have used and other 2/3 haven't bothered	Not all of them are good
'Catch up'	Stopped research		Most of them are
	Not 100% trusting	Cited as a source	They are all good
	2022 data on GPT	Honesty	I can fact check that with my own knowledge
	No data from World Bank	Internet	
	Issues of access	Wrong - 'all the time'	Test-writing
	Faster	Have a giggle about it	Useful
	Easy comparisons of countries	Difficult for students to identify incorrect information	Forget that I've done it
			Useful
	Powerful sorting	Reliance on teachers	Paleomagnetism
	AI is 'much faster'	Is it too much to expect them to? Danger/risk	Explain in a short sharp sentence
	Is this accurate?		
	Different data?	Risk – 'read it as gospel'	Reactive in the moment
	Questions from students about AI data?	Data manipulation	How can I help them
		Needs to understand	Email questions
	AI generated images	Training needed	How can I explain it simply
	Not sure	'Revelation'	I haven't used it in planning
	More inclusion of students who can't draw	Chat history – reflecting	Other than in tornadoes
		Time saving	Students' then critical of it
	Don't want a generic image	'I don't know enough about it'	Starter
	Use annotations on AI image?	I'm not sufficiently tech savvy	Be critical
			'I haven't found a mistake'
	'No really cheating'		'A pretty good rundown'
	Creative	No one has told me	AI fearful
	Haven't used it enough in class		Existential
		Istanbul, urban futures disaster	Climate change
	Reliance on ChatGPT		Fear more than climate change
	Drawbacks	Hopeless	

	Needs to be taught how to use it Note taking tool Need subject knowledge Worse than copying and pasting Inaccurate Making quizzes Reducing time Need to 'keep on tailoring it' Answers Answers not good enough for A Level 'Good for short quizzes for younger years where generic answers are fine' Creativity Solutions – creativity Links Creativity - 'what if' scenarios Solutions with AI - creative Questions to AI to develop AI looks at hindrances of possible solutions Favellas – creative Redesign with AI AI critiques – creative Thinking outside our own sphere of knowledge - creative	How precise one needs to make the question Get there in the end 5/6 attempts Tailour your own search Give it data and then do something with it Information sources shown on Bard Images – Bard Images Purpose? Trying it out Barriers – students are 'a bit cynical about it'. It's fun, but initial negative messaging It doesn't understand the questions It is actually limited Not going to do terrible well Generates more work No sophistication Literature Forcing it into something that pre-exists Revision 'Rubbish' questions Wrong level Prompts? Year 10 – difficulties	AI will be useful Not sure what happens after that Only Chat GPT No Bard/Gemini or MS Copilot 1st and free Don't use it enough Bard/Gemini - age restrictions at present How is it useful? 'Cool neat toys' Is it making my life better in any way? Someone needs to teach me how Department Early adopters of technology Were one of the better departments Admin Google ecosystem Keen I was leading it and able to I was working in that ecosystem and just pulling everyone with me Top-down SLT Evidence

	'Oh, I hadn't thought about that' Dedicated CPD time Not enough time Creativity as a longer-term project Creativity is difficult Creativity as time consuming Outside providers Drive AI in the department Solutions-based 'Fun stuff' Ideal animal – creativity Adaptions with AI More thought on creativity Risks Compex issues – no simple answers Conflict - bias Climate change – bias Misinformation – risk Fitting viewpoints Wider reading – not done Countered at home or by AI – concern Algorithms as a risk AI opens more possibilities Risk with content Pastoral risks Manipulate images	Year 7 – more successful Idea of hints Population – lower order questions? Recall? 'Assumes having everything written down' already I just feel a bit ignorant Ethics Was that the look like in practice to me? For me as a teacher? Reminding myself to do Useful Exam questions 'Thinking like an examiner' What do different answers look like? Booklets from other schools Results	Mandated Or somebody is 'well into it' and show others how it can be used effectively Interest is not enough GIS in the past Age Not an early adopting department anymore Age External influence CPD courses Good course Notes Feedback 'Most of the time it's mandated' Embedded and engrained Professional development Enjoy learning about AI Interesting Nothing geography-specific

	Misinformation or viewpoints - risk Change something that was said Risks Professional development – not an avenue Information synthesis for professionals Needs to be accurate CPD CPD courses Should be professionally developing ourselves Not enough time Following up Show outside CPD Given time How will AI help me? I need to read it I need to read Open to understand CPD for how to use AI effectively Useful But needs time Personalisation – AI would be good but it is too long of a process Admin tasks Personal data – risks		Edu-twitter and Geography edu-twitter 'Nothing on modelling good use of AI in Geography' 'Relatively well tapped into the… people who post tangible examples of geography education' Pace of technological change Pace of technology Waves Shape of waves Death and AI

	Trips Research Resource creation Better for companies? Sign up for updated resources Opportunities for companies Regularly updated information Differentiated		

Appendix H: Stage 3 Codes

List of Codes – Stage 3

A	B	C	D
Field work – efficiency	Less usage	Year 10	Transcription
Checking outputs	Block on new content	Fieldwork	Data
Structuring questions	Not up-to-date	Brick Lane data	Time
Sequence	Needs to be representative	Excel	ChatGPT
Data presentation	and accurate	Understand data	Administrative tasks
All fieldwork	Accurate analysis	Bored	Using it in support
Presentation of data	Development	ChatGPT	Planning of Environmental
Guide	Time constraints	Radial graph	Management
AI as a guide	Old information – barrier	Data processing	Spec points – nebulous
Access	Accurate reflection	They loved it	Better than textbook
Structuring	Careful of data that gives	Chucked out	Alternative
Lower Remove	inaccurate representations	Limited time usage	Water quality
Script	Still a use for AI	Gemini	Chat GPT as main/initial
Presentation	Lack of data is unhelpful	Different	research tool
Engagement	Student access is a barrier	No graphs	'Genuinely useful'
Streamline	Not enough training	Age restrictions	Other methods too
Staff training	Need to embed effective use	Costs	Strategies for improving
Scaffolding	of GC or AI more	Data processing	water quality
Optimal output	PSHE or form time?	Google Sheets	Structure of lesson planned
Students' lead	Need to understand it	AI	by Chat GPT answers
Tools and strategies	Students using it a lot	Old	Brick Lane Fieldwork survey
Student and staff	AI work obvious at the	Lesson on data presentation	Entirely completed by AI
partnership	moment, but won't be soon	Timed out	90 min of work to 4 min
Student group	AI as a support, not just a	Age restrictions	Pretty good
Geo Group	way of answering Qs	Access	Grid form
Enrichment	Needs more structure	Cost	Gentle coaching of its
Incorporation	Put into own words	Students' view – negative	prompts
Trial and error	Students don't see value in	Cheating	Produced a questionnaire we
	putting into own words	Worried about criticism	were happy with

Climate change	Why?	Stopping	Helped me hone the title
Creativity – climate change	Use of time	Confidence	Struggling to get something
image didn't add value	How to understand?	Unfamiliarity	easily digestible
Restricted creativity	Teachers v students use is	Excel	Careful prompting
Trial and error	different	Labelling things	10 alternatives
Lower school?	Summarizing their own notes	Students concern	Picked one
'Embedding across all	would be good	Bibliography	Used it
curriculum'	Reflecting on exam grades	'Tool'	Administrative
Opportunity to embed	More thought	Excel	Used Chat GPT to create
'Become more of a norm'	Students do use it	Philosophical question	department meeting notes
'Normal practice'	Behaviour policy	Proper research	Didn't retain nuance so
Evolving	Detention	Argument	needed editing
Professional development	Follow-up	Google	Saved time
TeachMeet	Age-group specific	Week without Google	Review of trips
Weekly agenda Departments	Training for students	A-Z Map	Cut 350 words to 200
need to meet	Experts for training within	Week without Google	Haven't used it in lessons
Collaboratively looking at a	school	Academic ownership	But 'relatively regularly' in
particular topic	More training needed	Confidence	planning and administration
Time as a limit	Developer-led initiatives	Free and unfettered access	'Starting to grow with it'
Evolving – difficult to keep up	Talk to students	needed	Euros data task
'Widening of the gap'	'Get some experts in'	Paywalls	Finished
Staff	Make it exciting	Students concerns – not	Time
Students	Expectations	having access the whole	Table, pasted, filled
Parents	Google checking for	time	Fact check
Whole school community	likelihood of AI usage	Budgets	Ask for sources
Distasteful use by students	AI detection?	Benefits	How to use it for data
Distrust	Experts not teachers	Providing it with data	Deployed similar strategies
Misuse	IT department	Data presentation	Task needs changing
Discomfort	CS department	Creative – think creativity	Only 1 student, then others
Policies	Google	about prompt language	Drawing graphs by hand
All schools	Training effectiveness		Using atlases

Socially Ethos Values Embedding of these Meaningful Consistent Whole school Questions about acceptable behaviour Culture Understanding Student leadership 'Upstanding citizen in a globalised world' Test Teach students to 'do their own checks and balances' Biases Vested interests Behind the scenes Understand the technology Accuracy and reliability Checking Misinformation Lower School risks Questioning and challenging Whole-school initiatives From the top Wellbeing Incorporated into Bios	Focus on skills Forward thinking school Expectations – academic misconduct Ownership of work Understanding Teachers challenge potential AI intervention Ask questions to prove ownership More challenging to 'catch' more able students School policy Tackle small behaviour quickly AI designs – earthquake projects Not that inventive Phrasing of prompts Images – paid for Access – pay for some features Can't allow it to enhance disadvantages Decision-making ideas and justifications Feed information HDI – AI as something to bounce idea from/to Decision making e.g. in Darfur	Exam questions – creative process Creative process Think like examiners How do I get it to work? Creative process 'Like a baby' Skill Originality Cheating Think carefully for themselves Language Shorter Precise Succinct Difficult Repetition Confidence 'Access is my biggest barrier' Gemini and Bard Data Jeremy School AI Very clever Scope Has to be spot on Fieldwork booklet Decision making Shortcut for work Uncreative	Redundancy Educational value Using atlases Surprise Tangents Opens their eyes Journey Chat GPT loses the 'wonder, immersion and exploration' Can analyse, but loses the 'wonder' of data gathering Rules – do not use Chat GPT Like atlas lessons Productive Year 8 - creativity My Footprint poster AI image generation – creativity 1st time 'Kind of creative' Creative - 'literal aesthetic design of their work' 'Moving at pace' Only since Christmas this kind of use Research tool 'I'm not sure' Not a 'particularly creative teacher'

Challenge negative behaviour Information sessions Pastoral Timetable PSHE once a week Assemblies Pastoral Benefit to cohort of Year 7s 'Set the standards' Acceptable Getting caught Self-regulated End of school year Plan to use it next year Collaboratively Instill more of this Pushed 'Champions in the field' Champions pushing ideas forward Raise the awareness Staffing Curriculum Incorporated Allocating roles	Skills Solutions Evaluating the solutions using AI and data Different solutions Perspectives? 'No idea on how to do it' More training 'By specialists' Teach differently 'Genuine time' Creating effective resources – needs time Collective resources Professional challenge	Regurgitating Putting information basically in a different format that it's told to Lazy thinking Teachers' responsibility Cheating More of an issue is leading to people not being creative And reliance Do they need to construct graphs themselves? Saves time on unneeded tasks Multiple choice Answers Are the answers correct? None of the answers are right It doesn't understand the maths Like to use it more Time Fieldwork Trial and error	Most older students – less creative? Exams – lower scope for creativity Questionnaire for Brick Lane – creative 'Definitely changed the way I will ever put together fieldwork' Completely designed the Qs for us – was creative in that sense Influences data collected Quite a central part of data collection Produced something creatively Minor amendments Structure of lessons Order of points Categorising Ability to write geographically Split factors Sinister My default is not to think how can AI help? Trust

			Don't defer to AI as a 1st port of call for any task Prompted by others Second barrier – time Mental block Professional pride Better job? Time to try it Then: Does it save me time? I don't know Some things save more time than others Essay questions? See through frameworks – AI good No hallucinations 'Not at all' 'I can't think of a single example' - non-risk? Trust What are you doing with it? I haven't used it for numbers Words Frameworks better Not asking for case study Wouldn't trust it for that

			Rather do it from textbooks Used it for ideas 'Using it as an additional brain'

Appendix I: Thematic Map

RQ1

Variable degrees of usage

Before intervention: some 'trialled'/'not a lot', others with more experience

After intervention: new uses, one used less

Variable purposes of use

Before intervention: research, exam qs, explanations

After intervention: more production of materials, data pre sentation, administration and supporting lessons

RQ2

Teacher creativity

Before intervention: needs more time to plan, thinking outside sphere of knowledge

After intervention: experiments with images, novel uses that added value

Student creativity

Before intervention: images, wider thinking, difficult

After intervention: assists with creating, could be used to develop decision-making

RQ3

Operational barriers

Before intervention: lack of training, not having tried it

After intervention: time, access

Broader, ideological barriers

Before intervention: inaccurate information, student reliance, data protection

After intervention: imprecise information, misuse, student concerns