An investigation into the impact of Artificial Intelligence on pupil engagement in Year 9 geography lessons.

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Abstract

Generative AI (GenAI) has the potential to significantly impact various aspects of pedagogy within geography education. This dissertation aims to explore how the emerging technology of GenAI might influence pupil engagement. A mixed-methods case study was carried out across nine Year 9 tectonic hazards lessons at a secondary school in England, using Martin's Motivation and Engagement Scale (Martin, 2003), pupil-voice questionnaires, teacher reflective logs, and semi-structured interviews with three teachers. The intervention utilised GenAI to offer structured choices, adaptive scaffolding, and instant formative feedback, with tasks requiring pupils to explain, critique, and revise GenAI outputs. Quantitative data showed modest improvements in motivation and participation, while qualitative findings revealed increased visible participation and sustained on-task attention. Pupils appreciated personalised next-step feedback and opportunities to influence their learning pathways. Evidence of cognitive engagement was mixed: scaffolding supported access and strategy use, but some pupils used GenAI merely to obtain answers, leading to limited cognitive engagement. Agentic engagement was strongest when activities provided genuine choice and questioning. The study concludes that GenAI does not directly generate engagement; instead, it enhances well-designed pedagogy when integration supports autonomy and feedback. Practical implications include designing for structured choices with clear success criteria and training pupils to critically analyse GenAI outputs. Limitations include a single-site, small-N design and a brief timeframe. The research adds subject-specific evidence from geography classrooms and proposes design principles for future work and practice.

1. Introduction

The emergence of Generative Artificial Intelligence (GenAI) in the form of large language models (LLMs), such as Chat Generative Pre-Trained Transformer (ChatGPT), has already had a profound impact on our world – a precursor to even more significant consequences to come. For educators, the growing influence of GenAI presents a significant challenge, altering the way we approach pedagogy and education in a broader context (O'Dea, 2024). Given the potential shift that GenAI could bring to education, it has sometimes been overlooked as a participant in the debates surrounding the technology (Seldon and Abidoye, 2018). This lack of emphasis on education has begun to shift with the increasing depth of research, as educators increasingly focus on the transformational potential of GenAI (Hickman and Ghosh, 2024).

Interest in the educational impacts of GenAI has increased, but gaps remain, particularly in geography education, where guidance for implementation is lacking (Lane, 2025). A literature review showed that only 32% of US-based research focused on K-12 education (Wang et al., 2024, p. 14). Research in secondary education is often more complex and limited in scale, with many studies involving fewer than 50 participants, which restricts their statistical power (Akhmetova et al., 2025). Additionally, the deployment of GenAI varies across educational levels, with impactful studies often conducted in online environments, which differ from face-to-face classroom environments (Chen et al., 2020).

Research on GenAI in education has primarily focused on its application for specific tasks, such as marking assessments (O'Dea, 2024). However, this approach misses broader questions about how GenAI might change the overall learning experience. Some studies emphasise its potential for personalising learning and enhancing adaptive teaching (Holmes, 2019).

One emerging debate contrasts optimist and pessimist views on GenAI's role in education. Holmes (2019) argues that GenAI could significantly personalise learning and adapt paths in real time, potentially improving pupil achievement. If it can transform adaptive teaching, it would be a powerful tool (Downs and Campbell, 2024).

However, there are those with more critical perspectives on this debate, who contend that an overreliance on GenAI could lead to superficial forms of learning. Selwyn (2019) develops this critique by arguing that AI could foster a culture of passive learning amongst pupils, reducing the application of high-order thinking. GenAI may inadvertently encourage superficial forms of engagement, where speed and efficiency are prioritised over depth and critical reflection.

This dissertation contributes to the debate on GenAI's impact on education, focusing on its effects on pupil behaviour, particularly in engagement and motivation. Pupil behaviour, which encompasses observable actions such as effort and attention, aligns with Fredricks et al.'s (2004) multidimensional model. Motivation, as defined in Self-Determination Theory (SDT), is enhanced by autonomy, competence, and relatedness (Ryan and Deci, 2000).

Engagement is a complex and challenging concept to define (Klem and Connell, 2004), yet it is crucial for educational success, as it reflects motivation across behavioural, cognitive and affective dimensions (Fredricks et al., 2004). Given that engagement is positively linked to achievement (Lei et al., 2018) and can create a positive feedback loop (Finn, 1989), this study is timely. However, research on GenAI's influence in areas beyond science, technology, engineering, and mathematics (STEM) and higher education is limited (Akhmetova et al., 2025). As Griffiths (2023, p. 71) warns, "as geography teachers we ignore AI at our peril." Thus, this research examines how GenAI affects pupil engagement and motivation in Year 9 geography lessons, exploring both novelty-driven reactions and sustained effects, while identifying the conditions under which GenAI supports or undermines engagement.

1.1 Research aim

This study examines the effect of GenAI on pupil engagement in Year 9 geography lessons at an independent school in England. It aims to develop an understanding of how GenAI impacts the various dimensions of engagement (behavioural, cognitive, and emotional) (Fredricks et al., 2004), while exploring the views of pupils and teachers on GenAI within geography education. The following research questions orientate the research:

1. In what ways do GenAI tools shape pupil engagement within geography lessons?
2. How do pupils perceive the use of GenAI in geography lessons?
3. Does GenAI shape particular aspects of engagement, focusing on motivation and participation?

These questions allow the study to provide insight into the potential of GenAI to enhance engagement in geography education, whilst offering practical recommendations for GenAI pedagogy. Given the limited body of literature on the use of GenAI in secondary school geography education, this study is expected to contribute by providing classroom-based evidence that can inform teaching, learning, and policymaking.

2. Literature Review

The impact of emerging technologies, particularly GenAI, on pupil engagement has become a growing focus in educational research. This study adopts a critical realist perspective, recognising that observable behaviours such as engagement are shaped by underlying mechanisms (Lourie and McPhail, 2024). Critical realism enables links between what is observed in class, such as on-task behaviour, and why it occurs, for example affective engagement. By considering the ‘empirical’ (observed), the ‘actual’ (context), and the ‘real’ (underlying processes) (Bhaskar, 2008), this approach supports a mixed-methods design capable of capturing both visible behaviours and less tangible cognitive or emotional processes.

The literature review identifies patterns within existing research and explores causal structures underpinning engagement in GenAI-influenced classrooms. The central argument is that GenAI does not cause engagement independently; its impact is mediated by classroom and pedagogical variables. Poorly designed tasks risk diminishing potential benefits.

Three themes frame the review: theories of pupil motivation and engagement, the role of GenAI in education and its application within geography. Engagement, closely linked to achievement (Finn, 1989), involves behavioural, cognitive and emotional dimensions (Fredricks et al., 2004) and is often studied alongside motivation, which shapes how pupils approach learning (Skinner and Pitzer, 2012). Understanding their interplay is crucial for evaluating interventions such as GenAI.

Research suggests GenAI can facilitate personalisation (Holmes, 2019) and differentiation (Downs and Campbell, 2024), but also risks promoting passivity (Selwyn, 2019). Evidence beyond the novelty effect remains limited. Within geography education, studies have explored model answers (Harding, 2024), lesson planning (Hickman and Ghosh, 2024), and adaptive teaching (Downs and Campbell, 2024), but often privilege pedagogy over pupil experience.

With policymakers accelerating educational technology (EdTech) strategies (DfE, 2023), geography faces an important moment. Whether GenAI enhances engagement or reduces it to passive interaction remains uncertain, underscoring the timeliness of this study.

2.1 Pupil Engagement and Motivation

Pupil engagement and motivation have long been recognised as key factors influencing achievement in a school context (Galloway, 1998). Without engagement in and motivation for their studies, a pupil’s experience and interaction with learning are more likely to be passive, subsequently leading to lower levels of achievement, as learning will be restricted (Dehaene, 2020). This particular field of research has been growing (Fredricks et al., 2004) as researchers and educators increasingly emphasise the importance of these two concepts.

Atkinson's (1964) Achievement Motivation Theory focuses on the personality traits of the pupil and how perception of success and failure drives pupils' motivation to engage with their learning. Particular attention is paid to how a pupil's perceived chance of success impacts their motivation to engage (Galloway, 1998). Whilst Atkinson's influence on research is an important one and has had an impact for an extended period of time (Wigfield and Eccles, 2000), it has been critiqued for not appreciating extrinsic factors and their impact on motivation.

Building on these foundations, deCharms' (1968) Origin-Pawn concept emphasises the role of perceived agency in shaping intrinsic motivation. DeCharms carried out a four-year longitudinal study aimed at developing personal causation in low-income, inner-city elementary school children in the USA. The study focused on training teachers to implement 'origin-enhancing' exercises in their classrooms. Instead of relying on pupils completing self-reported questionnaires, they wrote six short stories in response to verbal cues. DeCharms believed projective narratives would be more effective than direct questioning in revealing motivation. Overall, the study found a correlation between pupils with 'origin experiences' and increased engagement and academic performance (deCharms, 1992). DeCharms' theory serves as a precursor to Ryan and Deci (2000) and has influenced subsequent research (Deci et al., 2017).

Ryan and Deci's (2000) SDT complements the theories of Atkinson and deCharms, emphasising the role of intrinsic motivation (fulfilment of autonomy, competence and relatedness) in ensuring sustained pupil engagement. SDT offers a more comprehensive framework compared to earlier motivational models.

Finally, Fredricks et al.'s (2004) framework on engagement is seen as key in educational psychology (Christenson et al., 2012). The research views engagement as multidimensional, including behavioural, emotional and cognitive elements. This literature review will examine the benefits of employing a tripartite framework of engagement, while also addressing the critique from an SDT perspective that certain elements of the theory lack specific detail. The main contention is that the behavioural dimension does not adequately explore whether motivation stems from extrinsic or intrinsic factors. This is pertinent to this study because it considers the potential impact of GenAI tools, which may affect the quality and depth of pupil engagement.

2.1.1 The nature of Motivation: Intrinsic and Extrinsic Drivers

The conceptualisation of the terms 'motivation' and 'engagement' has proven to be challenging (Galloway, 1998). This fertile definitional debate has led some academics to consider the terms as they are often considered interchangeable (Fredricks et al., 2004). Ryan and Deci (2000, p. 54) provide a foundational definition of motivation by suggesting that it involves an individual being 'moved to do something', a conceptualisation that, while slightly broad and vague in nature, indicates a deeper psychological process driving engagement. This is where Skinner and Pitzer (2012) further an understanding of the definition by suggesting that it encompasses the psychological processes that lead to action and engagement. This immediately prompts the consideration of what drivers can be the catalyst for these psychological processes.

Atkinson (1964) and Ryan and Deci (2000) acknowledge that these drivers of motivation are crucial to understanding pupil engagement but place differing emphases on them. Atkinson argues that pupils’ motivation is driven by the need to succeed or avoid failure. Engagement will be high if pupils believe they will succeed, whereas if they believe they will fail, they will purposefully disengage from the learning process. Within a lesson, this could also influence the tasks pupils choose when given a choice, with certain pupils opting for the task they perceive as easier. Some have criticised Atkinson’s conclusions because of the lack of empirical evidence that pupils with high motivation will actually choose the easier task on offer in a lesson to avoid failure (Galloway, 1998). This lack of empirical evidence undermines the validity of his model, raising questions about whether it can be applied to complex learning environments where motivation and engagement are influenced by a broad range of psychological and contextual factors.

Ryan and Deci’s (2000) Self-Determination Theory examines intrinsic (internal interest and enjoyment in learning) and extrinsic (doing something because of a range of different, separable outcomes, such as rewards and punishments) drivers of motivation. If pupils feel they have autonomy and agency within the classroom regarding their learning pathway, it can enhance engagement because it increases intrinsic motivation. This can also be achieved by teachers providing positive feedback for effort rather than purely the outcome of a piece of work. This increases and reinforces a pupil’s confidence in their competence to complete tasks and thus engages them more.

Comparing Atkinson's achievement motivation theory (1964) with SDT highlights different explanatory perspectives on why pupils engage. Atkinson views achievement behaviour as a joint function of the motive to achieve success and the motive to avoid failure, weighted by expectancy and incentive value. By contrast, SDT treats motivation as varying in quality along an autonomy spectrum (from externally controlled to intrinsic), and explains sustained engagement through satisfaction of autonomy, competence and relatedness (Ryan and Deci, 2000). From an SDT perspective, it is not the amount of pressure or reward that matters, but whether classroom practices support these needs and enable internalisation. Controlling success and failure incentives typically yield short-term behavioural engagement, while potentially increasing anxiety; whereas autonomy-supportive, task-focused feedback and meaningful choice are more likely to produce sustained engagement. In geography, this is a practical distinction. If the focus of an activity on tectonic hazards, for example, is about passing or getting a good grade, it may generate behavioural engagement but limited depth of cognitive (deeper thinking) and affective (enjoyment and love of the subject) engagement. Instead, if the same task is approached through pupil autonomy, discipline-based next steps, explaining processes, using place and scale as evidence, and teacher-mediated dialogue, engagement may be more sustained as it provides intrinsic motivation.

Ryan and Deci are not alone in their belief that a wider set of motivation drivers exists. Wigfield and Eccles (2000) offer a more multidimensional framework in relation to these drivers. Instead of focusing solely on achievement, they discuss a range of 'values' that influence pupil engagement alongside expectations for success: attainment value, intrinsic value, utility value, and the cost or negative aspects of engaging in the task. This provides a more nuanced analysis of engagement than Atkinson’s and is much more in line with Ryan and Deci's thinking.

There are differences between the multidimensional frameworks put forward by Wigfield and Eccles (2000) and those of Ryan and Deci (2000). A key aspect of Ryan and Deci’s framework, largely absent from Wigfield and Eccles’s, is the effect autonomy can have on pupil engagement and motivation. Autonomy occurs when a pupil feels a sense of ownership and responsibility for their studies. This intrinsic motivation supports pupils to engage more fully with their learning. The importance of autonomy in encouraging motivation and engagement is a perspective supported by deCharms’ Origin-Pawn concept (1968), where pupils are said to be more engaged and motivated when they feel they are experiencing an ‘origin’ experience in their learning:

> When a person has an origin experience she is highly motivated in the most positive, approach sense. She experiences herself as the cause of desired changes. (deCharms, 1992, p. 326)

This emphasis on personal causation, where pupils feel a sense of agency and ownership over their studies, suggests that autonomy is essential to deep and meaningful engagement, aligning closely with key aspects of SDT.

Overall, deCharms’ (1968) theory counters Atkinson’s (1964) because it argues that if a pupil believes there is personal causation in their learning, they will engage and be motivated, regardless of the potential outcomes. This highlights a similar issue that Atkinson’s model shares: both are narrow in focus and explanation compared to multidimensional frameworks.

For this thesis, debates about motivation and engagement sharpen the design questions: how should GenAI be built to cultivate meaningful, sustained engagement? GenAI can individualise learning (Holmes, 2019) and, by enabling choice and responsibility, strengthen intrinsic motivation (deCharms, 1968; Ryan and Deci, 2000). When pupils select different pathways towards a shared objective, GenAI can confer genuine autonomy over how progress is achieved. The risk, however, is that overly prescriptive systems automate decisions and push pupils into passive, “pawn-like” roles (deCharms, 1968), weakening engagement (Selwyn, 2019). The design implication is clear: prioritise autonomy-supportive features (structured choice, adjustable challenge) so GenAI fosters motivation and engagement rather than undermining them.

2.2 Engagement as a Multidimensional Construct

Moving beyond Atkinson’s (1964) narrow view, recent work treats engagement as a multidimensional concept. Fredricks et al. (2004) identify emotional (interest and belonging), behavioural (participation), and cognitive (investment and strategy) dimensions, arguing that no single driver explains engagement or motivation. Even this remains partial: Reeve (2012) adds agentic engagement – pupils’ proactive contributions to shaping instruction. This extension is salient here because GenAI can elicit agentic moves by enabling pupils to choose pathways and pose self-generated questions (Holmes, 2019). For example, interacting with a ‘marine biologist’ agent to steer an inquiry. Accordingly, this study treats engagement as a four-part construct and examines how GenAI design affords, or constrains, agentic participation alongside emotional, behavioural and cognitive facets.

One of the problems that multidimensional constructs aim to address is that not all forms of engagement are visible or observable. It is far easier for teachers to observe behavioural and emotional engagement than cognitive engagement (Skilling et al., 2016). This complexity is why a critical realist (Bhaskar, 2008) approach to studying engagement is important, as it seeks to triangulate information to provide a clearer understanding of the engagement taking place, whether visible or invisible.

Alongside multidimensional constructs, Martin’s Motivation and Engagement Wheel (Martin, 2003, 2007) differentiates between adaptive (self-belief, valuing, learning focus, planning, task management, and persistence) and maladaptive (anxiety, uncertain control, failure avoidance, self-sabotage, and disengagement) patterns across both motivational and engagement behaviours. The Wheel is created using data from a survey measured by the Motivation and Engagement Scale (MES). Using MES in this study enables the tracking and measurement of pre- and post-changes in motivation and engagement against the adaptive and maladaptive subscales listed above. This will be useful in determining whether GenAI has a positive impact on each facet of motivation and engagement.

Conceptually, as SDT specifies why engagement shifts and the Wheel provides indicators showing any potential changes, the two theories complement each other. In relation to this research’s methodology, the MES data align with the critical realist approach by providing empirical indicators that can be triangulated with pupil and teacher accounts to infer the underlying generative processes.

Alongside these motivational frameworks, formative assessment offers a practical mechanism for developing engagement. Black and Wiliam (1998) argue that when teachers elicit evidence of learning and use it to adapt teaching, feedback becomes one of the most powerful drivers of improvement. Shute (2008) refines this by specifying that effective formative feedback should be timely, specific and actionable. When viewed from the perspectives of SDT and multidimensional engagement, such feedback can support competence needs and focus pupils’ cognitive and behavioural efforts towards purposeful learning.

2.3 Theoretical Implications for GenAI in Education

This literature review aims to utilise the discussed theories to elucidate the potential implications GenAI may have on engagement. A key limitation of these foundational theories is their lack of consideration of the influence of digital technologies on pedagogy. This is partly because they predate the rise of GenAI, as the interaction between the digital world and education has evolved. They still, however, provide important theoretical underpinnings to the potential implications GenAI might have on engagement and will help guide the GenAI-focused intervention at the heart of this study.

When considering the role GenAI could have in allowing pupils a more differentiated (Downs and Campbell, 2024) and unique learning experience (Holmes, 2019), it is deCharms’ (1968) and Ryan and Deci’s (2000) theories that prove most insightful. Both place a large emphasis on the role of autonomy as a key driver of engagement and motivation. In a GenAI-mediated learning environment, where GenAI plays a role in pedagogy, there is potential to allow pupils to encounter truly ‘origin’ experiences, where pupils feel ownership for their learning outcomes. This could have an impact on their intrinsic engagement, especially as Ryan and Deci (2000) suggest that the quality of engagement is higher when driven by this motivation.

However, as noted previously, Selwyn (2019) warns that GenAI may have the reverse impact on engagement by creating passive learning environments. In this scenario, the intrinsic motivation discussed by Ryan and Deci (2000) would be diminished along with agency. This occurs when pupils proactively contribute to their own learning by shaping tasks (Reeve, 2012). This warning suggests that GenAI should be treated like any other form of pedagogy – a tool to add to a teacher's arsenal, but one that should be used thoughtfully and carefully.

Reeve's (2012) four-component model of engagement offers a useful additional dimension in comparison to Fredricks et al.'s (2004) model – specifically, agentic engagement. This refers to the impact pupils have on their learning rather than simply responding to teacher-provided tasks. This includes the ways in which pupils enhance and personalise their learning pathways. In a GenAI context, this could be a significant aspect, as pupils would be able to interact with GenAI to increase their agency and engagement.

Another element that Reeve (2012) includes, which aids our understanding of the potential implications of engagement in a GenAI-mediated classroom, is the opportunity for competence development. Pupils would be able to interact with the GenAI tools to receive immediate feedback, fostering pupil confidence in their own abilities while correcting mistakes and any misunderstandings quickly.

Nonetheless, Martin (2003) offers a caveat to such a positive assessment. His Wheel emphasises the importance of pupil attitudes. If a pupil's Wheel is dominated by maladaptive attributes, this would negate the potential for any intervention, whether GenAI or otherwise, to have a positive impact.

Finally, Atkinson's (1964) achievement motivation model still provides some insight, even with the valid criticisms highlighted previously. If GenAI can be harnessed to provide pupils with feedback in a low-key and instructive manner, this may alleviate concerns pupils have about failing when interacting with a task. This GenAI-created supportive learning environment could take away some of the anxiety-driven barriers that currently exist.

The literature on engagement and motivation provides support for the critical realist framework of this study (Bhaskar, 2008). To fully understand GenAI's impact, it is essential to examine the observable actions, while also attempting to delve deeper into the underlying, unobservable mechanisms that cause these actions. To add depth to this study, a multidimensional framework, such as that proposed by Ryan and Deci (2000), is key because it considers both participation in the classroom and internal motivation concepts, including autonomy and competence.

2.4 The Impact of Digital Technology and GenAI on Teaching and Learning

2.4.1 Historical Evolution of Educational Technology

GenAI is frequently described as the most significant disruption to teaching and learning in a generation – the 'Fourth Education Revolution' (Seldon and Abidoye, 2018) – marking a shift from a teacher-led model dominant since the nineteenth century (ibid). EdTech's evolution has been rapid, from 1980s classroom computers to 2000s VLEs, alongside the rise of e-learning, technology-enhanced learning, online and blended learning (Fawns, 2019). Blended learning, widely adopted to promote active learning, combines in-person teaching with online environments; flipped learning moves content acquisition outside lessons to free class time for application and higher-order thinking (Ashraf et al., 2021). Its promise aligns with motivation and engagement theory: blended approaches can increase learner control and personalisation (Van Laer and Elen, 2017), with autonomy a central determinant of sustained intrinsic motivation (deCharms, 1968; Ryan and Deci, 2000), supported by design features that foreground pupil choice (Almusaed et al., 2023).

Caution is warranted, though. Automation can desocialise learning and erode interpersonal skills (Selwyn et al., 2023), so digital integration must be deliberately designed to protect the communal fabric of classrooms (Ashraf et al., 2021).

Geography has been at the forefront of such innovation (Hagge, 2023). Without more consistent adaptation, pupils risk being underprepared for life beyond school (Ontong and Khule, 2020). Studies report positive effects on learning outcomes (Choi, 2021), and tools such as digital maps (Collins, 2018), StoryMaps (Duan, 2023), and Virtual Reality (VR) (Hagge, 2023) enable rich, shared experiences of digital cartographies and spaces. Enthusiasm is common (Hagge, 2024), yet uptake is constrained by practical issues and uneven teacher confidence (Duan, 2023), variable ICT skills (Ashraf et al., 2021), and tool stagnation, for example, limited platform updates diminishing VR’s appeal (Hagge, 2023). Without targeted training and ongoing professional development, a widening opportunity gap is likely (Choi, 2021).

Against this backdrop, the distinctive impact of GenAI, especially LLMs, is only beginning to be felt (Suleyman, 2024). The next section situates GenAI within educational contexts, examining current use and pedagogical implications.

2.4.2 Positioning GenAI in Education

Pedagogical philosophies are constantly evolving (Serrano, 2024) and never has this adaptability been more needed than in a world where GenAI is becoming increasingly important in education (Chen et al., 2020). GenAI tools such as ChatGPT signal a potential transformation in how learning is facilitated, with the ability to react and adapt to pupil input (Ahmed, 2025), and have proven particularly effective in supporting pupils' academic writing development (O'Dea, 2024).

However, while these tools offer promising developments, the integration of GenAI into education has prompted ethical concerns. Firstly, concerns exist regarding user privacy, particularly in relation to data capture and third-party processing, which may impact the willingness of schools and pupils to engage with GenAI (Akhmetova et al., 2025). Secondly, there is a worry that it will promote plagiarism in pupil work (O'Dea, 2024). In this dissertation, these reservations are framed as part of a wider risk of surface engagement and over-reliance, with pupils submitting GenAI-generated responses without internalising ideas and concepts.

GenAI has been found to support learning and teaching in three key areas: content development, by assisting teachers in the planning stages of lesson design; enhanced learning experience, by facilitating more personalised instruction; and personalised support, by providing individual feedback and responses (Ahmed, 2025). These functions provide the foundation for many GenAI-based classroom interventions, including those used in this study.

To evolve pedagogy effectively in response to these potential paradigm shifts (O'Dea, 2024), it is crucial that research is conducted into the role and impact of GenAI. According to a comprehensive systematic literature review by Wang et al. (2024), the majority of recent studies have focused on the design and application of GenAI systems in education. This broadly aligns with another such review by Chen et al. (2020), which identified the main theme of research as the use and implementation of machine learning and artificial intelligence. According to Wang et al. (2024), the impact of artificial intelligence in education (AIED) constitutes the second most prevalent area of research, and it is this sphere that this dissertation will add to.

The review by Wang et al. also found that the plurality of applications focused on adaptive learning and personalised tutoring. This aligns with the literature considered earlier in this review, where Holmes (2019) suggested that GenAI could lead to a more personalised learning environment for pupils. However, Chen et al. (2024) found that current research did not seek to link technology to theory. There is a need to resolve this issue if we are to gain a more comprehensive understanding of the impact of GenAI technology on education and thus develop effective GenAI applications.

Another issue in the current research is the limited attention paid to physical classroom settings, particularly teacher-led co-present lessons, with most research focusing on digital, online learning environments (Chen et al., 2020). This is a gap in the literature that this research aims to contribute to, as it remains the dominant learning context for pupils within education. With the focus on a physical classroom setting, this research will assess the influence of GenAI on pupil engagement (behavioural, emotional and cognitive) based on established motivational theory, as such aligning with existing theoretical frameworks explored earlier in this review, including Fredricks et al. (2004) and Ryan and Deci (2000), and supporting the ultimate aim of linking GenAI use to motivation and engagement.

GenAI, such as ChatGPT, represent a significant advancement in AI’s application to education. These tools have the ability to interact with questions and complete language-based tasks (Kasneci et al., 2023). Some academics describe this as a potential paradigm shift in teaching and learning, although it is currently too soon to determine if this is indeed the case (O'Dea, 2024). This research will focus on GenAI as it is accessible to both teachers and learners in classroom settings.

There are both ethical and pedagogical considerations in assigning a significant role to GenAI in our education systems. Plagiarism and academic integrity have long been issues associated with the use of technology in education contexts and is indeed among the more pressing concerns linked to GenAI. Pupils may use GenAI to complete tasks without engaging in the intellectual challenge required to do so independently (Ahmed, 2025). There are also concerns about user data privacy and what pupils might input into the GenAI (Akhmetova et al., 2025). While this challenge is significant, it is not insurmountable and requires a framework to promote the ethical use of the technology to minimise its impact (ibid).

A related issue is that GenAI-use policies vary between and even within institutions, leading to confusion among pupils and teachers that restricts the ethical and effective use of the technology (Ahmed, 2025). Such inconsistency creates ambiguity about what is permissible, prompting risk-averse practice and uneven access across classes.

Another issue identified in the literature concerns the social and psychological effects of GenAI replacing human interaction and social contact (O'Dea, 2024). The concern over desocialisation has already been discussed, but it is part of a wider discussion about the need to place human interaction and oversight at the centre of AIED (Wang et al., 2024). However, the improving interactions of GenAI chatbots may be able to provide pupils with support (O'Dea, 2024), countering the impact of desocialisation.

This raises the ethical question of what role the teacher should play in a GenAI-mediated classroom. The literature emphasises that instead of making teachers unemployed, their role would evolve to include using GenAI to maximise pupil learning (Hickman and Ghosh, 2024). The current state of GenAI means that teachers would need to use their professional judgement and their ability to prompt the GenAI to provide the resources they need for their lessons. In this scenario, pupil learning would benefit from teachers having access to more adaptive learning resources. For example, teachers would be able to input newspaper articles and have the GenAI create a simplified version to help pupils access the content, whilst also being provided with differentiated questions to support assessment for learning opportunities (Downs and Campbell, 2024). This suggests that collaboration between the teacher and GenAI will become a key aspect of the profession moving forward (Fawns et al., 2022).

Child protection and privacy concerns should be a key part of the discussion, with GenAI using user data to adapt the responses given (Chen et al., 2020). It is essential that institutions have robust security systems in place to safeguard user data and comply with regulations such as the General Data Protection Regulation (GDPR) (Lane, 2025). Given these ethical and pedagogical considerations, this study adopts a critical stance on GenAI integration, seeking to evaluate not only its potential benefits for engagement but also the necessary conditions for its ethical and effective use in geography education in a secondary school context.

2.4.3 GenAI’s influence on engagement dimensions

GenAI’s influence on engagement is central to this study, and it is timely given the emerging evidence base. This section evaluates potential gains and risks while grounding claims in motivation and engagement theory.

Scholars highlight personalisation and adaptivity as major benefits (Huang, 2025), with tailored pathways widely linked to stronger engagement (Nguyen et al., 2024). By affording meaningful choice and responsibility, GenAI can support autonomy and intrinsic motivation, consistent with SDT (Ryan and Deci, 2000) and deCharms’ Origin-Pawn distinction (1968). Interactive tasks can also deepen relatedness and meaning; for instance, a decision-making simulation about a volcanic eruption can give pupils genuine responsibility for their choices and their consequences. For deCharms (1968, 1992), such autonomy fosters “origin” experiences; for some pupils, this ownership may be newly accessible through adaptive tools (Roe and Perkins, 2024). GenAI can additionally deliver instant, differentiated feedback on exam responses, illustrating its transformational potential (Huang, 2025).

Risks remain prominent, though. Heightened activity does not guarantee deep learning; poorly designed systems may foster dependence, surface-level approaches, and passive, “pawn-like” engagement (Roe and Perkins, 2024; Hu et al., 2025; deCharms, 1968). The onus is therefore on teachers to embed active, autonomy-supportive designs so pupils shape, not merely receive, the learning process, aligning with agentic engagement (Reeve, 2012; Lu et al., 2025). Evidence on cognitive, behavioural, and emotional outcomes is mixed: some studies report gains in cognitive engagement through scaffolding and adaptivity (Hu et al., 2025), while others find erosion of higher-order thinking due to over-reliance on the technology (Lu et al., 2025). This inconsistency underscores the need for school-based, subject-specific research.

GenAI can also deliver instant, differentiated feedback on exam responses, calibrating follow-up questions to individual strengths and weaknesses and illustrating its transformational potential (Huang, 2025). When feedback is immediate, informative and usable, it can reduce anxiety and build competence, aligning with Atkinson’s Achievement Motivation Theory (1964) and studies on formative assessment (Black and Wiliam, 1998; Shute, 2008).

2.5 Geography Education and GenAI

Geography education has a history of being an early adopter of a range of classroom technologies (Hagge, 2023). These innovations have varied, including digital maps (Collins, 2018), storymaps (Duan, 2023), and the use of the ‘metaverse’ (Hagge, 2024). GenAI represents the continuation of this technological journey within the subject (Griffiths, 2023). The rising importance of GenAI is reflected in the academic literature, where teachers utilise GenAI to help create model answers (Harding, 2024), enhance the quality of adaptive teaching opportunities (Downs and Campbell, 2024), and plan lessons and resources (Hickman and Ghosh, 2024).

According to the literature, there are concerns about the accuracy of content created by GenAI (Lane, 2025). This poses a particular concern in geography, a subject that is based on real-world examples and knowledge. Even if the information is supported with facts and figures, it can be outdated, which again undermines the efficacy of this innovation (Harding, 2024).

Despite these concerns, some academics highlight opportunities for enhancing pupil engagement – a key aspect of this research. As discussed earlier in this literature review, the potential to personalise learning for pupils has had a positive impact within geography education. GenAI enables geography teachers to quickly create high-quality resources tailored to pupils' abilities (Downs and Campbell, 2024). Adaptive learning strategies can help pupils feel competence within a subject and can help develop intrinsic motivation (Ryan and Deci, 2000). Using GenAI to do this can increase its effectiveness (Lane, 2025), while also helping to manage teachers' workloads (Harding, 2024). This increase in engagement and enthusiasm is not limited to GenAI use alone, as other digital technology strategies, such as Google Earth, have had a positive impact (Hagge, 2023), with pupils preferring them over more traditional approaches (Brady et al., 2023).

GenAI has also been able to support decision-making tasks, thereby increasing the interaction between pupils and the issues being addressed (Lane, 2025). This will help increase pupil engagement, as it allows them to have an origin experience, whereby they have ownership of the learning process and will subsequently engage with the task in a more intense manner (deCharms, 1992). This will facilitate agentic engagement, as pupils will be able to shape their learning experience through feedback, questioning, and choice (Reeve, 2012).

However, these benefits rely upon effective teacher training to ensure successful application. Training must be comprehensive, showing teachers how to leverage the technology to their advantage (Harding, 2024). With GenAI, it is important that the skill of 'promptcraft' is fully explained to staff (Downs and Campbell, 2024).

‘Powerful knowledge’ (PK) as a concept has influenced some research and practice in geography education since its introduction by Young (2008), impacting pedagogy (Maude, 2016). Pedagogically, places an emphasis on the pursuit of knowledge and what this knowledge then allows the pupil to do with it (Young, 2008). PK in geography refers to specialised disciplinary knowledge that gives pupils explanatory power beyond everyday experience, enabling them to analyse, explain, and evaluate geographical phenomena, whilst also allowing them to participate in informed debate (Maude, 2016, Maude and Caldis, 2019). GenAI could amplify PK by challenging pupils to engage with the subject in a powerful way, encouraging them to analyse processes or debate contentious topics, such as migration. GenAI could achieve this by allowing pupils to access information quickly and then providing instant feedback, challenging their analysis and application of the knowledge. This could increase engagement by improving pupils’ self-belief in their competence, which, according to SDT, would have a positive impact (Ryan and Deci, 2000). However, there is a risk that GenAI could dilute PK. Issues, such as hallucinations (Lane, 2025), threaten the reliability of information that PK requires.

This movement towards more digital pedagogies should not occur without criticality, with some of the literature contesting its effectiveness. For example, pupils studying digital maps performed similarly in assessments to those who used only paper maps (Collins, 2018). It can also be argued that there are benefits to pupils completing tasks in a more traditional manner, one being improvements in memory recall when pupils draw diagrams themselves (Powell, 2023). This highlights the importance of carefully balancing digital innovation with disciplinary integrity in geography education.

3. Methodology

3.1 Introduction

This research employed a mixed methods design. I combined quantitative and qualitative methods to capture both measurable changes in engagement and more nuanced perspectives from both teachers and pupils. This approach improved the overall validity and rigour of the findings compared to what a single method design could have achieved in this situation (Creswell and Creswell, 2017). This was especially important in education research, where issues were often complex and multifaceted (Sammons and Davis, 2017). Triangulation of data allowed for more meaningful and valid conclusions to be drawn from the data (Cohen et al., 2013). To capture engagement, the methodology consisted of interviews with teachers to seek insight into behavioural changes, pupil surveys to seek insight into pupils' shifts in motivation and sense of agency, and teacher reflective logs (TRL) to evaluate classroom observations.

To gain a more complete understanding of the influence of GenAI and engagement, a critical realist approach was employed. This framework was based upon three related domains: the 'real' domain, which consisted of mechanisms taking place that we could not see, the 'actual' domain, which consisted of the events and processes that happened when mechanisms took place, and the 'empirical' domain, which consisted of what could be observed and experienced (Bhaskar, 2008). This approach supported the mixed-methods methodology because the empirical data could help explain the mechanisms at play. This is called retroductive reasoning, whereby a researcher identifies patterns, explores underlying mechanisms, and tries to understand the contextual factors that influenced these mechanisms (ibid).

3.2 Research Context

This research project was situated in one school. School A is a co-educational, independent secondary day and boarding school in England. It had over 500 pupils, ranging in age from 11 to 18 years, at the time this research was conducted.

This research is a case study, focusing on a Year 9 geography class, and provides readers with real-world data and information, rather than just theory, which helps explain the occurring phenomena (Cohen et al., 2013). The case study participants consisted of 20 pupils and 3 staff members, who constituted the entire geography department at the school. The selection was informed by practical accessibility and developmental appropriateness, as Year 9 is the only senior school form not to have started an external examination course. Participants needed to be at least 13 years old to comply with OpenAI’s usage policies for ChatGPT. U.S. companies must comply with the Children’s Online Privacy Protection Act (1998) (COPPA), which establishes strict rules regarding the collection of data from individuals under the age of 13. Subsequently, this meant that the sampling method used was convenience sampling (Cohen et al., 2013).

Owing to the already small sample size, I conducted insider research. There were benefits to this approach, as I was granted access that may have been difficult to obtain otherwise (Unluer, 2012), while simultaneously having knowledge of the school's context, which reduced logistical issues (Mercer, 2007). There was a negative aspect of this familiarity and accessibility, as participants may have modified their responses to win approval from me, their teacher. Such an influence on participant responses is known as the Hawthorne Effect and could have undermined the investigation's results (Cohen et al., 2013). Even with this disadvantage, increasing the sample size enhanced the depth of data collected, which was more important for this research. British Educational Research Association’s (BERA) (2024) guidelines were followed to reduce the impact of this issue.

However, despite a slight increase in sample size, generalisations are difficult to draw from such a small data set (Cohen et al., 2013). This was a limitation of the research, explaining why careful consideration was given to the internal and external validity of the investigation. Internal validity is the degree to which claims can be credibly supported by data from the investigation (ibid). The study attempted to address this issue through the triangulation of MES data, post-intervention pupil surveys, TRL, and teacher interviews. Construct validity was ensured by aligning MES subscales and qualitative codes to SDT and Fredricks’ multidimensional engagement model. External validity is the extent to which the study’s findings can be generalised beyond the Year 9 geography context (ibid). In an attempt to improve this, descriptions of context and tasks were thorough, whilst all claims were positioned alongside theoretical literature.

Whilst small in scale, this research provides meaningful insights into the influence of GenAI on pupil engagement, which will be a key aspect of the future of education (Seldon and Abidoye, 2018).

3.3 Summary of Intervention

The intervention took place over nine 1-hour lessons on the topic of Tectonics. A summary of the different GenAI interventions (Int) and their justifications is presented in Table One, with a focus on both pedagogical justifications and the theoretical link the strategy had to learning. When pupils interacted directly with a GenAI, a personalised 'GPT' was used. GPTs can be created through ChatGPT, using prompt engineering. This is when the GPT is coded using language instructions from the user. Through this method, all GPTs for this study were given the same framework, with the school's GenAI policy and the Department for Education's "Keeping Children Safe in Education" (2024) guidelines loaded into the memory. This ensured that all responses from the GPTs met the relevant safeguarding protections. For each Int, the GPT was prompt-engineered to meet the pedagogical justification of the lesson.

TABLE 1 – Summary of Interventions

Lesson 1	**Lesson topic**	What are the different plate boundaries?
	GenAI intervention	GenAI created images for a selection of the key terms. Pupils used the list of key terms to try to match them with the images.
	Pedagogical justification and link to theory	Dual coding is a technique whereby learners engage with content in both visual and verbal methods (Paivio, 1986). This allowed pupils with multiple learning preferences to be catered for. This method supported cognitive engagement as pupils had to process the information shown in the images, applying key terms to them.
Lesson 2	**Lesson topic**	What are the different types of volcanoes?
	GenAI intervention	A GPT that challenged pupils to see links between 16 different key terms. This GPT was inspired by the New York Times game 'Connections'.
	Pedagogical	With pupils having to analyse and evaluate key

	justification and link to theory	terms, it helped to improve pupils' ability to see synoptic links. It also helped improve pupil retrieval of information they had already covered, enhancing their long-term retention (Roediger and Butler, 2011). As pupils were encouraged to think synoptically rather than simply recall at surface-level, it helped foster the development of cognitive engagement (Fredricks et al., 2004). Digital gaming can increase pupil engagement as they enjoy the learning (Hobbs et al., 2023). The enjoyment they experienced will increase pupils' agency, encouraging them to engage and shape their own learning (Reeve, 2012).
Lesson 3	**Lesson topic**	What are the hazards created by volcanic eruptions?
	GenAI intervention	Image creation using a GPT. Pupils formed groups and wrote a description of a volcanic hazard. They then input this into the GPT, and an image was created using the description. The GPT also provided feedback in accordance with the School's feedback policy.
	Pedagogical justification and link to theory	Once again, this supported dual coding theory (Paivio, 1986), asking pupils to link verbal descriptors with visual outcomes. The instant feedback nature of the task showed pupils how their writing had influenced the creation and should support self-efficacy, improving motivation and engagement (Hidi and Boscolo, 2007).
Lesson 4	**Lesson topic**	How does it feel to experience a volcanic eruption?
	GenAI intervention	Using Canva (a GenAI-assisted program), pupils created a story about someone experiencing a volcanic eruption. The GenAI helped to make this story more interactive.
	Pedagogical justification and link to theory	The creative freedom supported by Canva's GenAI software helped develop pupils' intrinsic motivation through autonomy and ownership of their learning (Ryan and Deci, 2000).
Lesson 5	**Lesson topic**	What are the impacts of an earthquake?
	GenAI intervention	A GPT designed a task where pupils wrote a newspaper article about an earthquake. The GPT adapted the resource to provide scaffolding, enabling all pupils to engage. When pupils had handed in their responses, the GPT marked the work against a mark scheme.

	Pedagogical justification and link to theory	Writing a newspaper article on the impacts of an earthquake helped to encourage emotional engagement as pupils researched and interacted with the human stories from the case study example (Fredricks et al., 2004). This task provided support for pupils through scaffolding, which helped them increase their learning potential (Lambert and Balderstone, 2012).
Lesson 6	**Lesson topic**	What is an earthquake and why do they occur? How can we reduce the impacts?
	GenAI intervention	Pupils created a plan to protect their school from an earthquake. A GPT designed the outline of what they needed to include. They then input their plan into a GPT, which pretended to be a fictional headteacher. The GPT graded their plan, providing feedback in accordance with the School's policy. This enabled instant, formative feedback that guided pupils' next steps.
	Pedagogical justification and link to theory	This GPT provided instant feedback to pupils, allowing them autonomy to choose their own learning path while also developing their competence through encouraging, yet critical, comments from the GPT (Ryan and Deci, 2000). The interactive and personalised nature of the GPT helped foster engagement with the task (Ahmed, 2025).
Lesson 7	**Lesson topic**	What caused the Tohoku earthquake in 2011, and what were the impacts?
	GenAI intervention	Pupils asked questions to a GPT that was instructed to behave like a survivor of a tsunami.
	Pedagogical justification and link to theory	This task was based on dialogic pedagogy, where pupils developed an understanding and meaning through interaction with the subject matter, thereby developing higher-order thinking and understanding (Alexander, 2017). Pupils developed an origin experience by deciding their own questions and having autonomy within the task (deCharms, 1992).
Lesson 8	**Lesson topic**	What were the long-term responses to the earthquake?
	GenAI intervention	An article on Tohoku, written 10 years after the earthquake, was summarised by a GPT to make it age-appropriate. Pupils then had to answer questions based on the text. The pupils were given three groups of questions, each varying in difficulty and task type. Pupils answered a total of 5 questions and were required to answer at least one question from each group. The GPT created these questions.

	Pedagogical justification and link to theory	By editing the article to produce an age and ability-appropriate version that supports pupil competence (Ryan and Deci, 2000).
Lesson 9	**Lesson topic**	Examination technique
	GenAI intervention	An exam question was introduced to the class, and they answered it under exam conditions. Pupils entered their answers into the GPT, and it provided them instant feedback following the School's WIN feedback policy. Pupils completed the 'Next steps' task provided by the GPT.
	Pedagogical justification and link to theory	Closing the feedback loop is a crucial aspect of assessment pedagogy, enabling pupils to respond to their feedback in a timely manner to ensure continuous learning (Black and Wiliam, 1998). This process promoted competence within pupils, helping to increase pupils' engagement (Reeve, 2012).

3.4 Data collection methods

3.4.1 Pre/post engagement surveys

To measure changes in pupil engagement, pre- and post-engagement surveys were conducted using a tailored version of MES (Martin, 2007) (see Appendix 1). This scale assessed multiple facets of engagement, including 'self-belief', 'task focus' and 'planning'. Using the survey both before and after the intervention allowed a direct comparison of engagement levels and provided quantitative evidence of the intervention's impact. This method was chosen to provide insight into behavioural and cognitive engagement.

3.4.2 Post-intervention pupil surveys (PIPS)

To capture pupils' perspectives on the interventions, surveys were distributed using Microsoft Forms after each lesson (see Appendix 2). These surveys included both quantitative and qualitative questions. Pupils were asked to evaluate their experiences with the GPTs, focusing on specific features such as interactive questioning and differentiated tasks. Likert scales were used to gauge feedback, alongside a more open-ended question that asked pupils directly how they liked GenAI to be used in their classes. This method provided a combination of structured, comparable data with the richness of pupil reflections. Surveys allowed participants to answer freely, and since they were self-completed, no additional questions were needed for clarification (Cohen et al., 2013). To reduce the burden of participating, surveys were intended to be completed quickly at the end of a lesson. Pupil surveys represent an active attempt to incorporate pupil input into shaping pedagogy, thereby having a positive impact on their learning experience (Hammond and Healy, 2022). It also enabled the collection of information on emotional and agentic engagement.

3.4.3 Teacher interviews

Interviews (see Appendix 3) were conducted with geography teachers at the School to gain insight into their perspectives on how GenAI influenced pupil engagement. This was an effective method to collect qualitative data (Seidman, 2013). Interviews were semi-structured to allow for flexibility, depending on participant responses, while still providing consistency in the main questions (Patton, 2015). This approach provided a richness of data on all four dimensions of engagement.

3.4.4 Teacher reflective logs (TRL)

Only one teacher participated in the actual intervention activities, and they maintained a TRL documenting their observations on pupil engagement. This participant was me. TRLs focused on motivation, attention, and participation. These logs provided data that helped illuminate subtle shifts in classroom dynamics.

This approach also utilised the participant's professional expertise, providing more nuanced insights. However, there was concern that the participant might try to produce answers that were potentially pleasing, thus impacting the integrity of the responses and the validity of the data (Patton, 2015).

3.5 Data analysis methods

Since this research employed a mixed methods approach, it generated both quantitative and qualitative data, which were analysed using appropriate techniques. To enhance the validity of the research, triangulation of data was employed, utilising a range of different data sources to enrich the analysis and examination of complex human behaviour (Cohen et al., 2013).

Key quantitative data were drawn from the pre- and post-intervention engagement surveys and analysed to identify patterns in motivation and engagement over time. This was accomplished using the MES, created by Martin, A. J. (1999–2024), which provided a solid theoretical foundation for part of this study. The MES survey data were collected before and after the interventions. The survey was designed to be completed by pupils themselves (see Appendix 1). To analyse this data and create a Motivation and Engagement Wheel, the data were exported to Microsoft Excel. Pupil answers were converted into numbers 1-7. Using the MES survey, answers were grouped according to the subscale of motivation and engagement being focused on (see Appendix 1). The average scores for these groups were then used to create a motivation and engagement wheel, presenting the data in a visual format.

PIPS (see Appendix 2) were collated and analysed using Excel. The quantitative data provided direct comparisons of how pupils reacted to the different interventions. Thematic coding was used to analyse the qualitative data. This was done using a hybrid coding approach that sought to combine deductive and inductive codes (Fereday and Muir-Cochrane, 2006); this highlighted unexpected themes and provided a more thorough understanding of the mechanisms taking place. For this research, the deductive codes were based on four broad domains (the 10 deductive codes are in brackets):

1. Fredricks et al.’s (2004) engagement types (behavioural, cognitive, emotional).
2. Ryan and Deci’s (2000) motivation factors (autonomy, competence, relatedness including collaboration).
3. Feedback and reflection (feedback utility).
4. GenAI-related experience (novelty effect, GenAI as a co-teacher, technical and access issues).

This research took a systematic approach to coding. Firstly, each interview, transcript, PIPS, and TRL was imported into Excel. In the first round of deductive coding, each question was scanned for keywords or descriptions that corresponded to one or more of the 10 deductive codes. Multiple codes could relate to the same excerpt. Themes that did not fit into the deductive coding framework were noted. At the end, three key inductive codes were highlighted:

1. Creativity.
2. Anxiety or feeling overwhelmed.
3. Teacher reservations.

A second round of coding was then applied to the data, including the inductive codes. This helped to ensure patterns were not missed.

Subsequently, all coded data was collated in Excel, showing the excerpt from the data and the code to which it was tagged.

3.6 Ethical considerations

Given this research's focus on pupil engagement and the introduction of GenAI in classroom practice, a plethora of ethical concerns had to be addressed. At the forefront was an appreciation of participants' rights and confidentiality, as well as concerns surrounding the use of GenAI in an educational environment. To address these concerns, informed consent was obtained from adult participants and parents of pupils, as well as assent from the pupils themselves. The research adhered to the BERA's ethical guidelines (2024) and the School's GenAI policy.

3.6.1 Informed Consent

Informed consent was a key aspect of the study's approach to these concerns. It was essential that all participants fully understood the purpose, scope, and methods of the study, as well as any potential consequences that might arise from their participation (Cohen et al., 2013). All potential participants were given an information letter and an opt-out form, and it was made clear that taking part was not compulsory. If anyone had declined to take part, no data would have been collected from that person. An email address was provided so that participants could ask any questions they had about the research. The aim of this was to actively cover five ethical principles as outlined by Hall et al. (2021): that participation was completely free and without coercion, that the research's benefits outweighed any drawbacks, that precautions were being taken to reduce potential risks, that anonymity and confidentiality were ensured for all participants, and that the researcher had no conflicts of interest. These information sheets were edited to suit the audience, whether it was teachers, pupils, or parents/carers/guardians (who needed to give consent).

3.6.2 Confidentiality and Data Security

Without confidentiality and anonymity, participants would have been vulnerable (Cohen et al., 2013); therefore, mitigating measures were implemented to minimise this risk. Firstly, data collected within the study were purposefully kept to a minimum to reduce participant exposure (Hammond and Rawlings Smith, 2023). All collected data were anonymised to protect participants' identities, and any identifying information was removed before analysis. All data were stored using encrypted devices and password-protected University of Oxford cloud-based storage systems. The informed consent and assent were collected digitally using Microsoft Forms.

3.6.3 Teacher-Researcher Ethics

As a teacher-researcher, I occupy a dual role that inevitably introduces power asymmetries (authority over grades) and positionality concerns (pre-existing relationships), each of which can shape pupils' consent, openness and participation (Hammond and Rawlings Smith, 2023). To alleviate these concerns, I discussed the research with the pupils, emphasising that participation was voluntary, that non-participation carried no academic or pastoral consequences, and that they could withdraw at any time. All conversations and actions were designed to support informed, unpressured assent.

3.7 Collaboration

Collaboration occurred in various ways. Initially, the research design was shared with the Geography Department. This prompted discussion of both practical issues and pedagogical philosophy. Both members of the department accepted invitations to participate in the research. Further collaboration took place as initial findings and training on the application of GenAI in the classroom were shared with the academic common room. This provided an opportunity to debate the use of GenAI in the classroom. Lastly, an abridged version of this research was submitted to the School's research journal to further disseminate the findings. Opportunities for collaboration throughout this research reflected a commitment to practitioner inquiry and professional dialogue (Cain and Allan, 2017).

4. Findings and Discussion

This section will be organised according to the research questions:

RQ1 - In what ways do GenAI tools shape pupil engagement with geography lessons?

RQ2 - How do pupils perceive the use of GenAI in geography lessons?

RQ3 - Does GenAI shape particular aspects of engagement, focusing on motivation and participation?

For each of these research questions, the quantitative and qualitative data will be presented and discussed. This will draw the results of this study back to its theoretical underpinning. A triangulation of different data sources will help to develop a critical realist approach, allowing for a deeper understanding and interpretation.

4.1 Research Question 1 - In what ways do GenAI tools shape pupil engagement with geography lessons?

4.1.1 Findings

4.1.1.1 Quantitative Results

Having had pupils conduct MES surveys before and after the intervention allows this research to examine changes in quantitative data relating to eleven different dimensions of motivation and engagement: self-belief, learning focus, valuing, persistence, planning, task management, anxiety, failure avoidance, uncertain control, self-sabotage and disengagement (Martin, 1999–2024). Figure 1 illustrates a comparison of the average pupil data from both the pre- and post-intervention MES surveys. Figure 2 illustrates the relative changes to each individual dimension, with adaptive indicators denoted in blue and maladaptive indicators in red. Tables 2, 3, 4, 5, 6 and 7 show the average change between pre- and post-intervention MES surveys for each question that constitutes the different MES dimensions. To view these Tables with complete questions, please refer to Appendix 1.

Figure 1 – MES Wheels showing pupil answers pre- and post-intervention

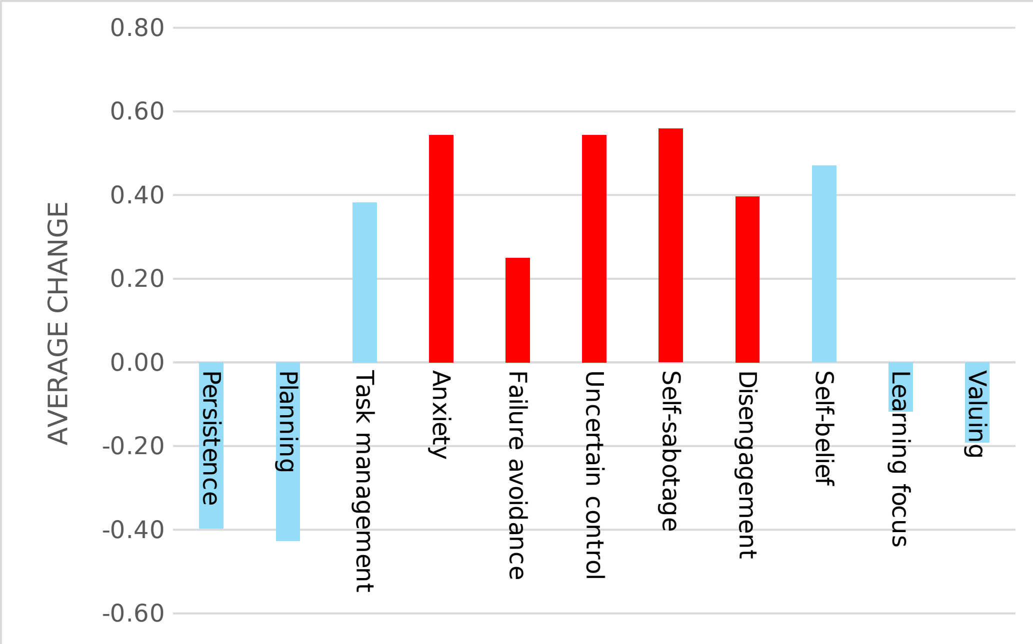

Figure 2 – Average changes to motivation and engagement indicators from the pre- and post-intervention surveys

Of the indicators that relate to positive motivation constructs (self-belief, valuing, learning focus, persistence), only 'self-belief' increases between surveys, going from 5.09 to 5.56 on average.

Dimension: Self belief	
Question	Change
13	0.1
23	-0.05
33	-0.05
40	2.05

TABLE 2 – Showing average change between pre- and post-intervention MES surveys for 'Self-belief'

The survey questions that formulate this dimension (Table 2) all focus on asking pupils whether they 'work hard enough' and whether they will be able to complete their schoolwork or homework. An increase of +0.47 suggests that pupils are more inclined to believe they can complete their work and perform well. The overall shift of +0.47 was driven by a 2.05 change in pupil response to Question 40. This meant that the average pupil response went from ‘disagree somewhat’ to ‘agree somewhat’. This would suggest that pupils can see a connection between their effort and their ability to stay on top of their work. In geography, self-belief is a crucial attribute, as pupils will encounter skills and topics that challenge them in various ways. Without the self-belief that they can achieve more by working hard, pupils will become apathetic and disenchanted.

Dimension: Valuing	
Question	Change
4	-0.05
14	-0.25
34	-0.2
41	-0.15

TABLE 3 – Showing average change between pre- and post-intervention MES surveys for ‘Valuing’

‘Valuing’ as a dimension decreased by -0.19. Table 3 shows that all four questions for this dimension experienced a decrease; however, this does not result in a shift in the average answer for each question. The greatest difference was in Question 14, where pupils still responded that they ‘agree somewhat’, but the average went from 5.75 to 5.5.

Dimension: Learning focus	
Question	Change
2	0.15
7	-0.2
25	-0.15
26	-0.25

TABLE 4 – Showing average change between pre- and post-intervention MES surveys for ‘Learning focus’

‘Learning focus’ experiences a slight decline of -0.12, but within this dimension, there were fluctuations in pupil responses (Table 4). Only for Question 7 do these changes result in a different average response, with it changing from ‘agree’ to ‘agree somewhat’.

Dimension: Persistence	
Question	Change
1	-0.15
9	-0.25
28	-0.45
36	-0.2

TABLE 5 – Showing average change between pre- and post-intervention MES surveys for 'Persistence'

The final indicator in this grouping, persistence, experiences a fall of -0.39. Table 5 shows that responses to all four questions decrease. The average response to both Question 1 and Question 9 changes from 'agree somewhat' to 'neither agree nor disagree'. The biggest shift in pupil response is for Question 28, which drops by 0.45, although the average response is 'neither agree nor disagree'.

Dimension: Task management	
Question	Change
3	0.1
17	0.4
32	0.5
44	0.25
Dimension: Planning	
Question	Change
21	-0.6
27	-0.2
30	0.35
39	0.2

TABLE 6 – Showing average change between pre- and post-intervention MES surveys for 'task management' and 'planning'

The task-based constructs experience contrasting and contradictory changes. ‘Task management’ increases by +0.38. All four questions see improvements in pupil responses, with Questions 17 and 32 increasing by +0.4 and +0.5, respectively. This results in the average response for Question 17 changing from ‘disagree somewhat’ to ‘neither agree nor disagree’.

This trend is countered by the decrease in ‘planning’ by -0.43. This is driven by more negative pupil responses to both Questions 21 and 27, with the former seeing a -0.6 fall. Average pupil response to both remains ‘neither agree nor disagree’ despite this.

Dimension: Anxiety	
Question	Change
10	0.5
19	0.15
37	0.6
43	0.45
Dimension: Failure avoidance	
Question	Change
11	0.45
20	0.15
31	0.35
38	-0.1

Dimension: Uncertain control	
Question	Change
6	0.95
12	0.7
16	0.15
18	0.5
Dimension: Self-sabotage	
Question	Change
5	0.75
24	0.65
35	0.5
42	0.5
Dimension: Disengagement	
Question	Change
8	0.35
15	0.55
22	0.1
29	0.55

TABLE 7 – Showing average change between pre- and post-intervention MES surveys for negative motivation and engagement dimensions

The three dimensions with the greatest changes between surveys are all negative, with ‘anxiety’ and ‘uncertain control’ both increasing by 0.54, and ‘self-sabotage’ increasing by 0.56. As they are negative dimensions, this shows an increase in maladaptive attributes.

The questions used to produce the data for ‘anxiety’ all relate to worries pupils have concerning the completion and assessment of assignments and examinations (see Table 7). Questions 10 and 37 ask pupils about their feelings specifically towards examinations, and these are the two questions that experience the biggest differences of 0.5 and 0.6, respectively.

The ‘uncertain control’ dimension change is driven predominantly by an increase of 0.95 from ‘disagree somewhat’ to ‘neither disagree nor agree’ for Question 6. There are also increases for all four questions, which focus on whether pupils feel they have been given agency through feedback and support to enable them to improve and/or maintain standards in the future.

‘Self-sabotage’s questions all increase by at least +0.5. These relate to whether pupils prepare for examinations or complete assignments in a timely and conscientious manner. Question 5 has the largest difference between surveys, at 0.75, with the average response shifting from ‘disagree’ to ‘disagree somewhat’.

Quantitative data were also collected through the PIPS that pupils completed. Pupils’ answers to the question ‘Did ChatGPT make the lesson more interesting?’ are shown in Figure 3.

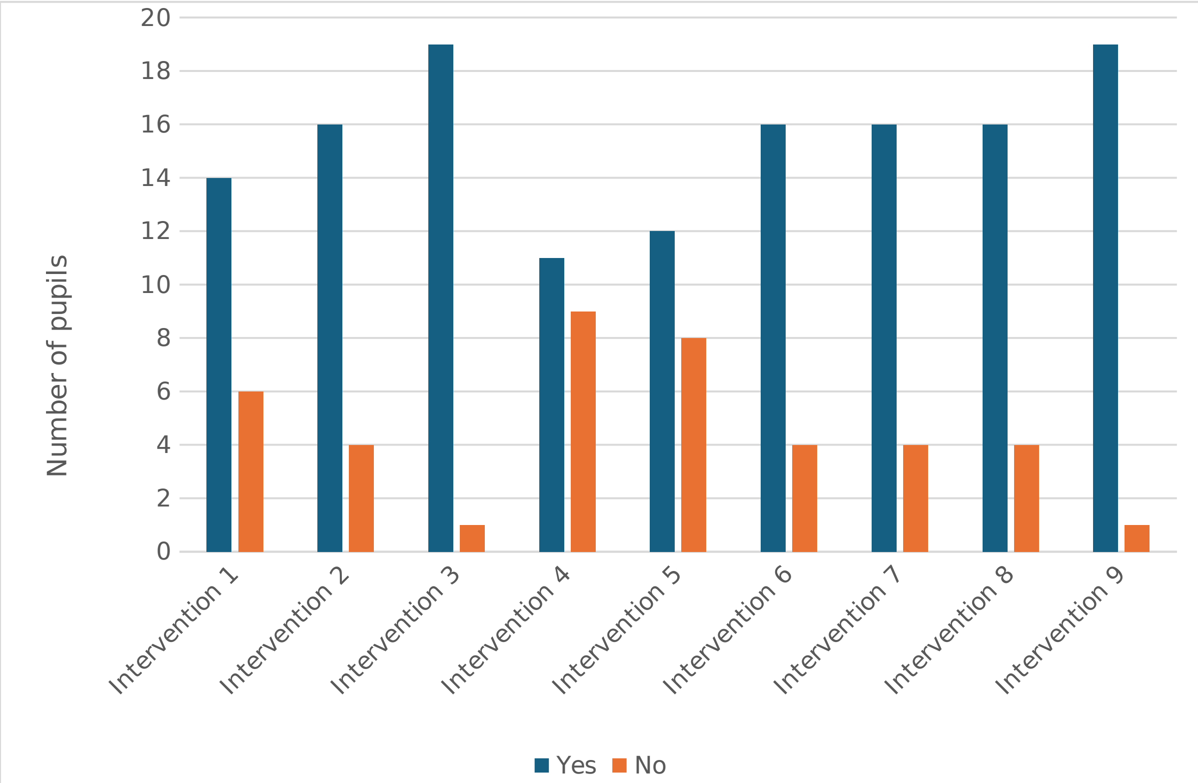

Figure 3 – A graph showing pupil voice for the question: 'Did ChatGPT make the lesson more interesting?'

Only three GenAI interventions received less than 75% approval from the class, with Int-4 and Int-5 registering 9 and 8 pupils, respectively, who stated that the interventions did not make the lesson more interesting.

The two interventions scoring the highest approval from pupils were both those that provided instant feedback: Int-3, which involved creating an image from the description of a volcanic eruption, and Int-9, which had pupils write an exam answer and then receive coaching and feedback on their answers. This allowed pupils to complete the feedback loop during the lesson.

4.1.1.2 Teacher observations and reflections

This section will consider teacher observations on behavioural changes, depth of pupil thinking, differential engagement across groups, and implications for pedagogy.

In most GenAI-mediated lessons, behavioural changes have been noted, with the TRL observing increased participation. When comparing these lessons to non-GenAI lessons, Int-2, Int-3, Int-4, Int-5 and Int-8 were judged to have ‘noticeably higher’ or ‘more active’ pupil participation. Int-9, where pupils interacted with an examination question feedback GPT, exhibited a highly focused work ethic, with minimal off-topic conversation.

The impact of GenAI-mediated lessons on the depth of pupil thinking showed contrasting effects. The TRL suggested that Int-9 was able to develop metacognitive reflection through the structure of the feedback given. This meant pupils developed a more comprehensive understanding of the content, rather than just being given the answer by the GenAI. However, this development of deeper thinking was not uniform across the interventions. In Int-3, where pupils had to describe a volcanic eruption, the TRL revealed that some pupils wrote minimal details in their descriptions and were quick to finish the task, thus demonstrating superficial thinking.

Similarly, levels of engagement were not uniform across the class. For Int-2, lower-ability pupils struggled to fully access the task, and the TRL noted that further scaffolding was needed for pupils to fully engage with the GenAI. With tasks such as Int-6, some pupils struggled with the collaborative nature, and the TRL suggested smaller or paired groupings as a more effective approach, as reflected.

4.1.2 Discussion

4.1.2.1 Theoretical Implications

This section analyses the data from a theoretical perspective using the key theories of Fredricks et al.’s (2004) multidimensional framework, the concept of competence within SDT, and Black and Wiliam’s (1998) principles of feedback. The data will be triangulated from MES surveys, PIPS, TRLs and teacher interviews. This triangulation reflects the critical realist distinction between the empirical, actual, and real, helping to connect observable behaviours to underlying mechanisms which shape engagement (Bhaskar, 2008). It will examine how GenAI tools help foster deeper analytical thinking and sustained task persistence, while also considering short-term increases in anxiety and self-sabotaging behaviours. Genuine pedagogical gains will be distinguished from mere novelty effects.

4.1.2.1.1 Links to Cognitive and Behavioural Engagement

During the interviews, teachers X and Y both commented that GenAI tasks, such as decision-making exercises and exam coaching, had the potential to provoke analysis, evaluation, and metacognitive reflection. In Fredricks et al.’s (2004) multidimensional model, these are markers of cognitive engagement, creating deeper pupil investment rather than just recall. This aligns with the concept of ‘powerful knowledge’ in geography, where information is used analytically rather than merely for recall (Maude, 2016). The ability of GenAI to promote deeper questioning of content means pupils will be engaging with the material in an effective manner. For example, when pupils used Int-9 to critique their analytical skills, they developed high-order critical thinking skills. This aligns with ‘powerful knowledge’ (Maude, 2016) within a geography education context, focusing on analysis and application. It also evidences that responsive feedback can strengthen pupils’ sense of competence. This directly links to the required aims of the IGCSE syllabus taught at the School, which demands that pupils are able to write critically, using evidence to support their arguments and conclusions (Pearson, 2018). This links to Fredricks et al.’s (2004) framework, which characterises engagement to be the extent to which pupils invest in purposeful learning. Int-9 required pupils to move beyond surface recall and instead develop their ability to analyse, evaluate, and, through the ‘next steps’ task, reflect in a metacognitive manner by reviewing the feedback from the GenAI and completing the relevant task. The +0.47 increase in ‘self-belief’ could be an indication that pupils not only engaged with these strategies, but also developed intrinsic engagement rather than being just a superficial novelty.

However, it is important to note that the MES survey data also showed a +0.54 increase in ‘uncertain control’ – a maladaptive facet in the model (1999–2024) – indicating that pupils felt less sure about how to use GenAI feedback to maintain or improve the standard of their work. This suggests that without teacher influence, GenAI feedback may leave pupils feeling adrift. This echoes concerns that poorly mediated GenAI can foster passivity (Roe and Perkins, 2024) or ‘desocialisation’ (Selwyn, 2022), underscoring the evolving role of teachers and the need for targeted professional learning on GenAI (Downs and Campbell, 2024).

Selwyn (2019) also warns that automated feedback cannot replace the nuanced, context-sensitive advice teachers can provide. He argues that personalised human interaction, whether it be adapted questioning or encouragement, is important for helping pupils make sense of feedback. Without this, pupils will not be able to understand the standards required and the specific improvements needed to enhance the quality of their work. In Int-9, this might suggest that pupils were unable to interpret the GenAI feedback, assess their own progress, or understand why the ‘next steps’ task would assist them in improving. The implication of this for a skills-based subject like geography is that teacher interaction in providing clarity and adaptive guidance is essential for supporting pupils in developing self-regulation and engagement across the various geographic disciplines. Geography teachers, for example, can adapt their teaching of complex or challenging topics so as not to overwhelm pupils, providing feedback that is partially grounded in the context of each pupil.

Fredricks et al. (2004) define behavioural engagement as pupils’ participation in academic activities, including effort, persistence, and on-task conduct. TRLs uniformly rated GenAI-mediated lessons as ‘mostly focused’ or ‘highly focused’. This was reflected in the MES survey data, which showed a rise of +0.38 in ‘task management’ and a +0.47 increase in ‘self-belief’, both indicating an improvement in behavioural engagement. Both indices are adaptive components in Martin’s Wheel (Martin, 1999–2024), indicating more constructive behavioural and cognitive engagement.

The instant feedback and response nature of GenAI, which creates a quick feedback loop and thus encourages pupils to complete the next task, may explain these increases, as might teacher observations. Rapid, adapted responses from GenAI are associated with a stronger sense of competence and agency, which helps to sustain on-task behaviour during demanding geography work (Wang and Xue, 2024). When dealing with complex processes in geography, as pupils encountered in the tectonics scheme of work used in this study, it is important for pupils' comprehension that any misunderstandings are quickly identified and corrected.

However, the findings showed that, while the impact of GenAI on behavioural engagement was positive, the overall impact was more complex. As shown in Table 7, the maladaptive engagement dimensions of 'failure avoidance', 'self-sabotage', and 'disengagement' all increased, perhaps reflecting the fear of failure tendencies described by Atkinson (1964). This was evident in the TRL for Int-3, where it was noted that although pupils were on-task and exhibited aspects of behavioural engagement, the quality of their responses revealed limited cognitive engagement. This also supports Fredricks et al.'s (2004) view that engagement is a multidimensional concept.

The increase in 'anxiety' may have been caused by one of the benefits of GenAI: instant feedback. A pupil's mistakes are immediately highlighted, which could lead to an increase in self-doubt, thereby reducing their opinion of their own competency. This increase in anxiety and emotional strain could also be a decisive factor in the +0.40 rise in 'disengagement'. Fredricks et al. argue that if emotional engagement is impacted, issues such as anxiety can reduce sustained engagement overall.

The increase of +0.54 in 'self-sabotage' indicates that pupils, on average, are more inclined to adopt avoidance tactics. This was noted during Int-3, when pupils created volcano images through written descriptions. As previously noted, the TRL observed that pupils were providing descriptions that lacked detail and were overly vague. This could be explained by Fredricks et al.'s framework, where pupils avoid cognitive engagement with a task if they perceive it to be too challenging. In this case, pupils may have felt they would not be able to meet the expectations set out by the GenAI. This again perhaps highlights that the lack of human interaction may cause pupil disorientation; an increase in ‘self-sabotage’ may be an indicator of this confusion and discomfort.

4.1.2.1.2 Links to Competence and SDT

According to the TRL, GenAI assistance enabled pupils to master geography tasks they had previously found daunting. It was noted, for example, that using Int-9 provided a ‘supportive and responsive learning environment’, and also ‘led to deeper engagement with the feedback process’ (TRL, Int-9). In the context of SDT, task-focused feedback can satisfy competence needs and support more durable engagement. This could explain the +0.47 increase in ‘self-belief’. By providing pupils with this ‘supportive’ environment alongside scaffolded responses, it helped develop pupils’ sense of capability, reinforcing their competence.

There is, however, a concern that without a strategy of ‘supportive’ pedagogy, pupils may experience a sense of decreased competence. Teacher Z argued that the main challenge was ‘balancing cognitive load as some concepts can feel inaccessible without scaffolding’. This highlights the need to consider adaptive scaffolding to support pupil persistence when designing GenAI for use within educational contexts. This is particularly relevant for geography education, with Teacher Y stating that already, ‘with more complex topics, the gap between high and low attaining pupils grows, and many disengage quickly due to lack of resilience’. Without proper scaffolding and careful design, GenAI has the potential to either perpetuate this trend of disengagement or lead to surface learning, as pupils merely seek answers rather than developing an understanding of the processes (Roe and Perkins, 2024). This poses a conundrum for the use of GenAI in geography education, given its combination of complex theories and processes alongside a range of skills. Consequently, Teacher Y believed that GenAI could have two rather contrary impacts on pupils’ sense of competence and overall engagement: some pupils would experience a boost in confidence due to instant feedback and the ability to quickly progress through activities; others may find that it only reinforces ‘low effort habits’.

Several of the GenAI interventions gave pupils the opportunity to proactively shape their own learning journeys. For example, the Earthquake Mitigation Plan (Int-6) and the Tsunami Survivor GPT (Int-8) both gave pupils freedom over how they approached the tasks and engaged with their learning. These activities exemplify agentic engagement, which is a key facet of autonomy within SDT (Ryan and Deci, 2000). The use of GenAI to assist pedagogy in this way had a positive impact on engagement within these lessons. In Int-8, the TRL notes that the interactive questioning capability was ‘most effective’ and that pupils crafting their own questions fostered ‘greater engagement with the content’, encouraging ‘critical thinking’. PIPS data also supported this, with 16 pupils stating the intervention had made the lesson more interesting, and 7 pupils stating that they found it ‘fun’. However, this feedback from teachers and pupils was not reflected in the MES survey data, with ‘valuing’ and ‘learning focus’ both decreasing by 0.19 and 0.12, respectively. This mixed picture again supports the perspective that engagement and motivation are complex concepts and are subsequently difficult to analyse effectively. The tension between visible behaviours and underlying cognitions is well-documented and provides further justification for this study’s triangulated design.

4.1.2.1.3 Links to Feedback Theory

Instant, actionable feedback is an important element of effective formative assessment. It prevents pupils from becoming frustrated when dealing with complex topics, allowing misunderstandings to be resolved quickly (Shute, 2008). Int-9 provided pupils with comments that were aligned with the School's marking policy. This meant providing pupils with a 'WIN' structure – a comment about what went well, what could be improved and finally a task to help develop the pupil's learning and understanding. Such immediate guidance is consistent with formative assessment literature that suggests that actionable, task-focused feedback is central to improving learning (Black and Wiliam, 1998, Shute, 2008).

During Int-9, the TRL noted that pupils remained highly focused throughout and excited to see how they could improve. This is supported by Ryan and Deci's competence and autonomy dimensions of the SDT. If pupils can see quickly and succinctly how they can improve, they are more likely to engage. In this example, pupils were also given ownership over their learning and the feedback process, which helped reinforce their intrinsic engagement with the task. Pupils further demonstrated their enthusiasm for this form of feedback through their surveys, with 19 out of 20 stating that GenAI added value to the lesson by making it more interesting.

4.1.2.1.4 Engagement or novelty?

In the teacher interviews, two teachers (X and Y) expressed concerns about whether GenAI was just an EdTech fad, with its impacts not fully considered. Teacher X originally expressed being 'wary' of using it because of this. Teacher Y was also cautious due to its potential negative impact on learning, concerned it could 'short-circuit the cognitive process'. However, both intimated that their early apprehension had been assuaged the more they used GenAI. Teacher X observed that in lessons where GenAI provided instant feedback, there was deeper, continued engagement with content through the use of challenging questions. Indeed, this is supported by the data overall, which show sustained cognitive and behavioural engagement, alongside rising competence using feedback loops. This would further suggest that if GenAI is manipulated effectively through adaptive teaching pedagogy, it can lead to growth in intrinsic motivation.

Figure 3 shows that in all but 3 of the intervention lessons, at least 75% of the class believed the use of GenAI had made the lesson more interesting. This suggests that GenAI has developed positive engagement with learning among the pupils. At the same time, MES survey data showed a -0.20 decrease in pupils ‘valuing’ their learning. This might suggest pupils are experiencing a short-lived engagement with GenAI due to the novelty factor of the technology, but this is not leading to long-term intrinsic motivation or engagement. This novelty effect was encapsulated by a PIPS response, which stated that it ‘added a new feel to learning’. While pupils widely reported that GenAI made lessons feel ‘new’ and ‘more interesting’, the literature cautions that some GenAI-mediated engagement can remain surface-level if design is weak. This may lead to pupils becoming passive and dependent on GenAI, reducing higher-order engagement (Roe and Perkins, 2024, Lu et al., 2025, Hu et al., 2025). From an SDT perspective, sustained effects are likely to flow through agentic engagement and competence-building feedback, rather than a merely situational interest. If GenAI is to become a more significant feature of pedagogy, as Seldon and Abidoye (2018) predict, overcoming the novelty effect will become increasingly important for educators.

4.1.2.2 Geography Education Implications

The findings for this research question suggest that GenAI feedback can be an effective way to deepen both behavioural and cognitive engagement in geography, but only when it is carefully designed and embedded within a framework of scaffolding and well-chosen tasks. This aligns with evidence that adaptive design and decision-making tasks can lift engagement, while poorly designed uses risk surface learning (Downs and Campbell, 2024, Selwyn, 2019). In practice, this means carefully designing GenAI to ensure it provides supportive feedback with adaptive teaching practices at its core. In this example, a responsive tutor for exam questions could enable pupils to conduct immediate reflection and revision.

At the same time, the increases in ‘anxiety’, ‘failure avoidance’ and ‘self-sabotage’ show the importance of the teacher in a GenAI-mediated geography classroom. Geography’s mix of complex processes and skills means that teachers play a key role in serving as interpreters and moderators for pupils during their learning journey. Effective professional development will be imperative to help teachers utilise GenAI while minimising the negative impacts highlighted.

4.2 Research Question 2: How do pupils perceive the use of GenAI in geography lessons?

4.2.1 Findings

4.2.1.2 Themes from pupil surveys

After each of the nine interventions, pupils completed a survey. A thematic analysis was conducted using the framework discussed in section 3.5. This is presented in Table 8 (see Appendix 4), along with quotations that illustrate examples of the analysed data. These themes highlight the complex and multidimensional nature of engagement and motivation.

		Intervention										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**	**%**
Thematic Code	1.Behavioural	4	2	2	1	1	1	3	3	5	22	9
	2.Cognitive	1	1	1	1	1		2	2	4	13	5
	3.Affective	10	7	9	5	10	3	8	8	2	62	25
	4.Autonomy			1	1			3	1	3	9	4
	5.Competence	2		1	3		2	1	4	3	16	7
	6.Relatedness	2	2	1		2	6	6	2	10	31	13
	7.Feedback use						4	1	1	14	20	8
	8.Novelty effect		2	5		2	1	3	2	2	17	7
	9.AI as co-teacher		1	1			3		1	10	16	7
	10.Technical issues		2		5	1		5		4	17	7
	11.Creativity		1	5	5	1	2	4			18	7
	12.Anxiety				2					3	5	2

Table 9 – Summary of coding frequency for PIPS.

Figure 4 – A word cloud for answers provided in PIPS.

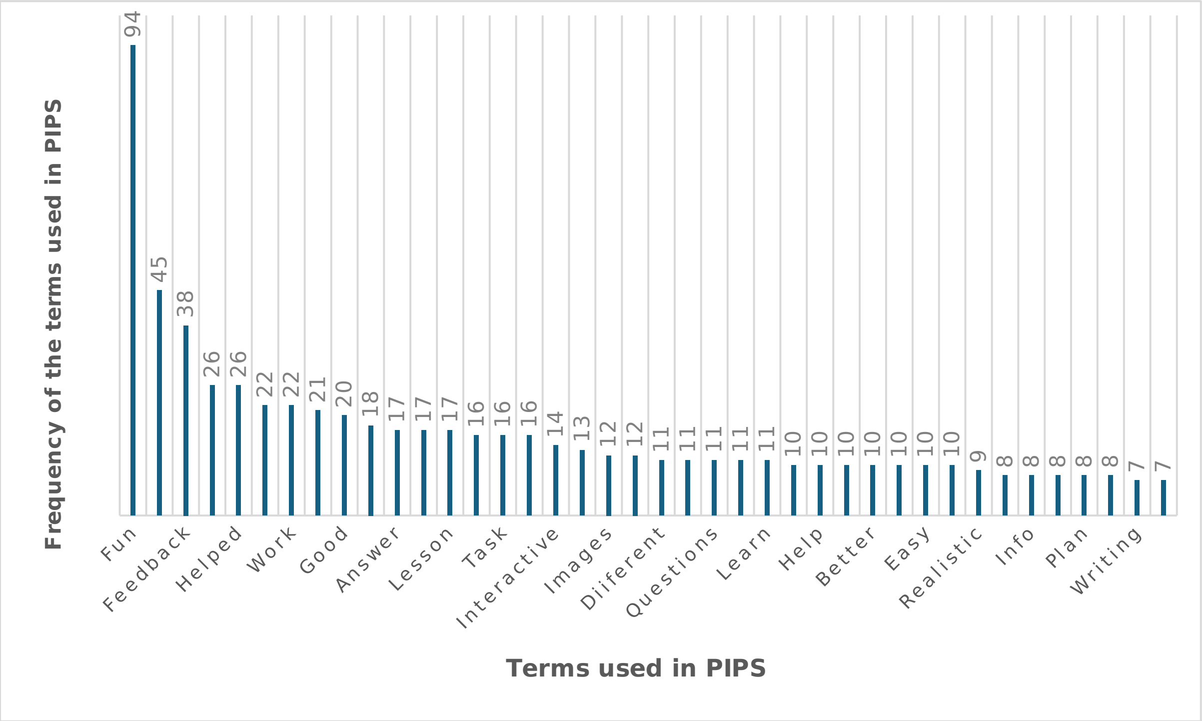

Figure 5 – A graph showing the frequency of the top 40 terms provided in PIPS.

The scrutiny of the thematic analysis presented in Tables 8 and 9, as well as Figures 4 and 5, is provided in the subsequent subsections.

4.2.1.2.1 Impacts on affective engagement

Throughout the pupil surveys, the concept of affective engagement was referenced 62 times (25% of codes). This is reflected in the frequency of terms such as "fun" (94 mentions), "interesting" (45 mentions), and "cool" (12 mentions). As Figure 4 shows, positive terms are more frequent in pupils' perspectives on the use of GenAI in the classroom. For each intervention, at least one pupil referenced that the use of GenAI was either 'fun' or 'interesting'. For Int-2, a pupil gave a more detailed response to the survey, explaining why pupils found GenAI encouraged affective engagement:

> ChatGPT made the lesson more interesting because it can add photos which helps me remember key terms and is better than a lot of just writing since that can be boring to just read and doesn't stay in my head. (PIPS, Int-2)

Pupils also found the interactive nature of GenAI to have a positive impact on affective engagement, with 36 references to this throughout the pupil surveys. For example, one pupil said, 'It was fun to interview a survivor' during Intervention 7. This was similarly reflected in Int-9, with a pupil stating, 'It was fun having quick marking for my answers'.

4.2.1.2.2 Supportive and motivating

Relatedness and peer support were referenced 31 times, accounting for 13% of the overall codes (Table 9). Pupils used terms such as 'helped' (26 mentions), 'helps' (16 mentions), 'helpful' (16 mentions) and 'help' (10 mentions) in PIPS.

Int-9 had the highest number of codes referencing this theme, with a total of 10 (Table 9). Figure 3 shows that 19 out of 20 pupils said it had made the lesson more interesting. A common sentiment, as one pupil commented, was that 'the next steps really showed me how to improve'.

The concept of GenAI as a ‘co-teacher’ was referenced 16 times (7% of codes). One pupil stated in their survey that, with its supportive guidance, ‘I was determined to improve using what the AI told me’ (Int-9). Some pupils felt that the AI was more of a collaborator rather than a co-teacher, with one stating:

> Because I interact with the AI like a friend and it gives me hints and it tells me when I’m wrong or not. (Int-2)

This supportive and motivating aspect of the GenAI did not result in pupils giving statements that referenced the theme of ‘competence’ though. This theme was mentioned 16 times (7% of codes). For Int-7, a pupil stated that GenAI had made the information ‘more understandable and easy to use’ (PIPS, Int-7).

4.2.1.2.3 Creativity

Overall, ‘creativity’ was referenced 18 times (7% of codes). According to the thematic coding, pupils did not reference this theme in their surveys for Int-1, Int-8 and Int-9. For Int-8, where the GenAI had summarised a newspaper article and provided comprehension questions for pupils, one pupil stated that they ‘didn’t know what the AI did in the lesson’.

When pupils were interacting directly with the GenAI, there was an increase in the frequency of comments referencing ‘creativity’. Int-3 and Int-4 both had the highest frequency at five references to ‘creativity’. Both these interventions involved pupils directly interacting with GenAI to create either an image (Int-3) or a Canva story (Int-4).

4.2.1.2.4 Novelty

The ‘novelty effect’ was referenced 17 times (7% of codes). Int-3 received the most comments, with 5 references, related to this theme. As previously discussed, this was an activity where pupils input a description and created an image using the GenAI. Overall, with 17 pupil survey answers coded as referencing ‘novelty’, it was the =6th most coded theme.

4.2.1.2.5 Confusion and uncertain control

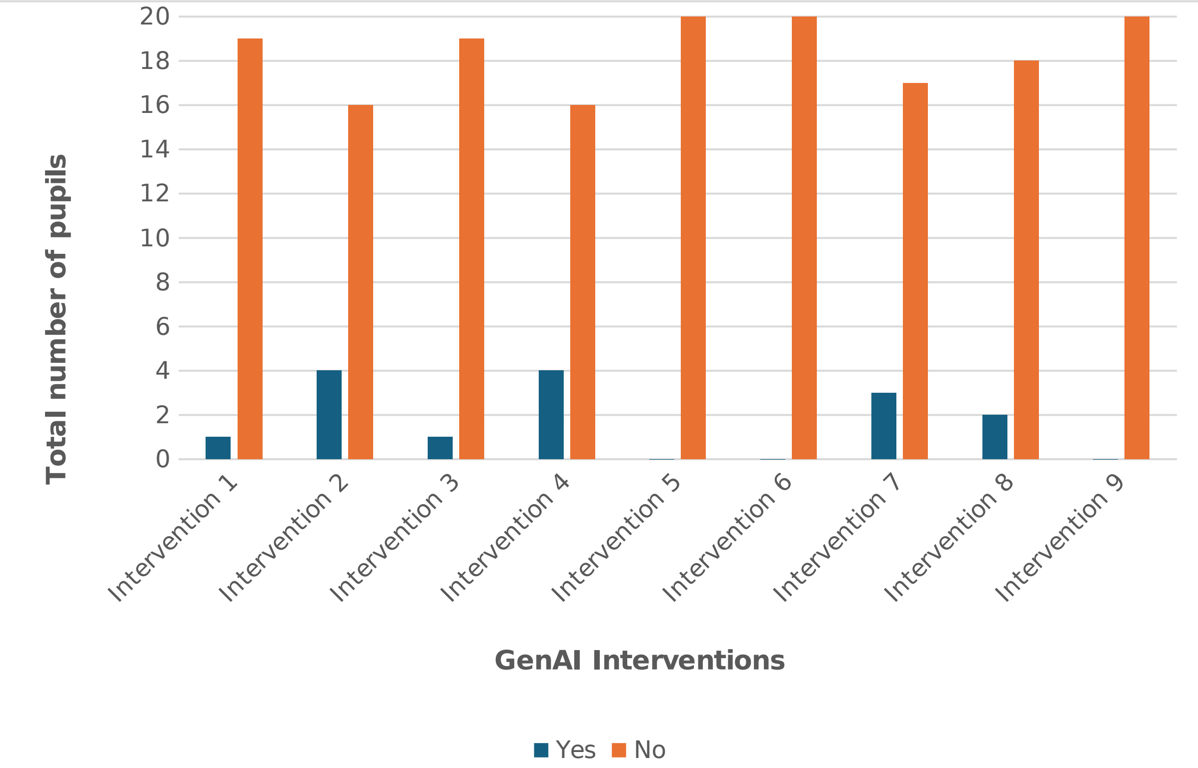

Figure 6 – A graph to show pupil survey answers for the question ‘Did anything about GenAI make it harder to participate?’.

Figure 6 demonstrates that for all interventions, at least 80% of the class felt that GenAI did not impede their ability to engage with the lesson. The lowest-scoring interventions were Int-2 and Int-4, where four pupils stated that the GenAI had impeded their learning. For Int-2, two pupils found the task ‘difficult’, with one elaborating that they did not fully understand the instructions given by the GenAI. Four pupils found Int-4 to be the least interesting, as shown in Figure 3, where 9 out of 20 pupils answered ‘no’ to whether GenAI had made the lesson interesting.

4.2.1.2.6 Frustration

Technical issues were referenced 17 times (7% of codes). This was most prevalent in Int-4 and Int-7 (Table 9). For Int-4, there were two main areas for pupil concerns. Firstly, two pupils stated that they did not understand how to use the GenAI (which also relates to issues within the theme of 'competence'). Secondly, three further pupils referenced issues with the effectiveness and quality of the GenAI. One pupil thought the GenAI images created were 'disappointing', whilst another pupil claimed the GenAI 'would not make the pictures and videos' it was told to create. For Int-7, pupil concerns centred on one issue: the limitations of ChatGPT for a 'free-to-use' customer. Pupils were frustrated by the lack of interaction they could have with the GPT before reaching their daily limit. This was reflected in a comment by a pupil who said 'I asked hardly any questions' (PIPS, Int-2).

4.2.1.2.7 Autonomy

Autonomy or choice in pupil learning was referenced 9 times (4% of codes) in the PIPS. Six comments related to two interventions, Int-7 and Int-9. For Int-9, a pupil said the GenAI "gave me different tasks to help improve". Overall, this theme was 10th out of 11 in terms of frequency of references.

4.2.2 Discussion

4.2.2.1 Theoretical implications

4.2.2.1.1 Links to SDT

Relatedness

Relatedness was the second most referenced theme with 31 mentions (13% of codes). Pupils' perceptions of GenAI were notably positive when its use foregrounded social connection and guided support. For example, in Int-6, one pupil said, "It's fun to work in groups using ChatGPT", while another stated that they interacted with the GenAI “like a friend” during Int-2. In SDT, relatedness, when pupils feel supported and ‘seen’ by their teachers, works alongside autonomy and competence to sustain engagement (Ryan and Deci, 2000). This study demonstrates that GenAI can play a role in developing a layer of pupil support, which may lead to an increase in relatedness. GenAI simulates the guidance needed, acting as a co-teacher. Teachers, though, should be wary of using GenAI to provide this support without careful curation. In this study, 6 out of the 9 interventions had between 1 and 4 pupils who stated that GenAI impeded their learning (Figure 6). Pupils still require and seek validation and support from their teachers and peers. This may explain why pupils were positive about using GenAI within groups for Int-6. That pupils yearn for human interaction is a concept well established by Selwyn (2019), who argues that pupils still need affirmation from human mentors and that, consequently, desocialisation must be avoided. It may also be the case that when guidance was too impersonal, perceived relatedness weakened, again reinforcing that the role of teacher mediation is still needed.

In geography, relatedness is not only interpersonal but also disciplinary and place-based. Pupils reported positive perceptions when GenAI was embedded in collaborative enquiry, for example, in Int-6 when pupils designed an earthquake disaster plan in groups, or in Int-7 when pupils worked together to question a GenAI-generated tsunami survivor. Such tasks require pupils to reason with evidence whilst interacting with GenAI. In these circumstances, a teacher’s class management remains central. There should be a careful balance between GenAI providing prompts and explanations and teachers offering validation, while also connecting pupils to powerful geographical knowledge. Pupils can then draw support from both one another and the teacher, with GenAI functioning as a supplementary resource rather than a substitute for human connection.

Autonomy

GenAI helped to develop autonomy by giving pupils control over their learning. This was highlighted in Int-7 with a pupil stating: “It’s fun to interview a survivor and come up with my own questions” (PIPS, Int-7). Although autonomy accounted for only 4% of codes, this does not imply its absence. From a critical realist perspective, autonomy may operate as an underlying mechanism that pupils are not fully aware of, which is why triangulation with task design and observations is necessary. In SDT, autonomy refers to a sense of ownership and responsibility for learning, which supports intrinsic motivation and more durable engagement (Ryan and Deci, 2000). In this study, interventions were designed to encourage agentic engagement, encouraging pupils to shape learning conditions rather than just responding to them (Reeve, 2012). Unrestrained autonomy, however, may have a negative impact on pupil learning experiences. As Table 7 shows, the MES scores for both ‘anxiety’ and ‘uncertain control’ increased by +0.54 after GenAI-mediated lessons, which could suggest that too much choice and freedom during tasks can be disorientating for pupils. One implication of this is that autonomy must be supported, not simply offered. Without clear scaffolds and teacher mediation, GenAI may be overwhelming for pupils, leading to an increase in anxiety, or overdependency that translates into passivity (Hu et al., 2025, Roe and Perkins, 2024).

In this study, autonomy was perceived most positively when choice was set within clear geographical purposes. Decision-making exercises, such as Int-6, and data-led enquiries, such as the newspaper task in Int-5, provided pupils with the opportunity to steer their learning while staying within the framework of the success criteria. GenAI helped pupils frame questions, test arguments, and request information, but autonomy was guided by the teacher's set parameters. Without this, autonomy may actually hinder pupil progress and engagement.

Competence

Pupils' perceptions of GenAI were most positive when it delivered clear, personalised feedback with 'next steps'. This was concisely noted by one pupil during Int-9 who concluded that the GenAI 'gave us very good feedback and next steps.' Another pupil concurred, stating also for Int-9, that 'It made me more determined to do a good answer for the feedback, which was clear and very helpful.' These quotes demonstrate positive pupil responses to the feedback utility feature, highlighting how pupils utilise feedback to develop their sense of competence and improve the standard of their work. This response was not restricted to Int-9 alone; for Int-5, one pupil confirmed that the GenAI 'helped explain what I needed to do'. This aligns with SDT, where competence refers to a felt sense of effectiveness and mastery (Ryan and Deci, 2000). In the classroom context, the GenAI interventions served as quick feedback tools that pupils could act upon immediately. This aligns with agentic participation and competence development through responsive guidance (Reeve, 2012; Wang and Xue, 2024). When considered alongside the MES data, this study suggests that the positive perception of GenAI's ability to help pupils improve also had an impact on the MES adaptive dimension of 'self-belief', which increased (+0.47), indicating that pupils felt more capable (Martin, 2003).

The GenAI was able to encourage this competence gain within a geographic context, rather than in a purely generic fashion, helping to improve explanations, apply evidence to support arguments, and correct any misunderstandings of geographic processes. However, competence benefits are more likely to be seen when teachers mediate how pupils interpret and act upon guidance provided by the GenAI. In summary, pupils perceived GenAI to be a helpful tool in providing ‘next steps’ and boosting confidence; nonetheless, the durability of this perception and engagement depends undoubtedly on the design quality and teacher mediation.

4.2.2.1.2 Links to Affective and Behavioural Engagement

Affective Engagement

Pupils perceived high levels of affective engagement, with 25% of all codes relating to this theme. From a multidimensional perspective of engagement, affective (emotional) engagement refers to interest, enjoyment and a sense of belonging (Fredricks et al., 2004). This is supported by the two most frequently used words by pupils in their post-intervention surveys being ‘fun’ (94 mentions) and ‘interesting’ (45 mentions). This indicates that GenAI-mediated pedagogy was able to foster emotional buy-in among pupils. This is important because a genuine interest and enjoyment of the subject are key catalysts for developing and sustaining behavioural and cognitive investment.

However, there should be a distinction between true affective engagement and novelty. This was observed in Int-3, where pupils were required to create their own images of volcanic eruptions. PIPS showed nine comments coded as relating to affective engagement, and 19 out of 20 pupils answered that the GenAI made the lesson more interesting. Conversely, when triangulated against the TRLs, this affective engagement appears to be based more on novelty, with the teacher noting ‘some descriptions lacked sufficient detail, which led to generic or incomplete images’ (TRL, Int-3). GenAI, therefore, must be carefully used and designed; otherwise, affective engagement may not lead to sustainable intrinsic engagement. From a critical realist perspective, this divergence indicates a novelty-inspired enthusiasm without corresponding gains at the mechanism level. With the Int-3 example, this could be countered by pupils engaging with the novelty of GenAI image creation, but being supported with follow-up analysis questions. These could challenge pupils to explain the processes shown in the generated image or to participate in a decision-making exercise. Teacher mediation would then connect the GenAI affective 'hook' to powerful geographical knowledge, like evidence-based reasoning, rather than to just generic 'fun' (Maude, 2016). Consequently, the design of GenAI-mediated tasks is crucial, with promptcraft, success criteria, and teacher questioning playing a key role in transforming 'fun' into thinking, thereby reducing the risk of user passivity (Downs and Campbell, 2024).

Behavioural Engagement

Pupils perceived that GenAI supported on-task participation. For example, in Int-2 one pupil felt it 'more engaging whilst still learning the same material', while for Int-4 another reported it 'made it more creative and engaging'. This links to a multidimensional approach, specifically behavioural engagement. This concerns effort, persistence and on-task conduct (Fredricks et al., 2004). These quotes demonstrate the pupils' perception that they were staying on task due to the creative pedagogy represented by the GenAI. Regarding the behavioural dimension of engagement, this would suggest that the novelty 'hook' GenAI can provide directly helps to support and develop it.

Pupils also attributed their staying on task to the way GenAI provided immediate, personalised responses. They always knew what they had to do next and how it linked specifically to their own development. For Int-9, one pupil reflected this: 'It gave me feedback on my exam answer and a next step task.' Whilst improving behavioural engagement, it also helps support pupils' sense of competence and persistence.

This positive perception was also reflected in the MES data. 'Task management' as a dimension increased by +0.38. This suggests GenAI can have a positive impact on behavioural engagement within geography education. As with affective engagement, the novelty 'hook' presents an opportunity for geography teachers, but it needs to be linked to deeper learning if it is to be truly durable. It was noted in the TRLs that, although pupils may have been on task, their responses and interactions were brief or vague (Int-3, 6, and 9). In other words, whilst pupils are 'on-task', the learning derived from it could be superficial. This places an emphasis on the responsibility of teachers to ensure pupil engagement is not merely compliant. Rather, they must develop other dimensions of engagement, such as affective and cognitive engagement (Fredricks et al., 2004).

4.3 Research Question 3: Does GenAI shape particular aspects of engagement, focusing on motivation and participation?

This section will focus on the influence of GenAI-mediated interventions on two core elements of pupil engagement in Year 9 geography lessons: motivation and participation. In this study, 'motivation' refers to the psychological processes that move a pupil to act in learning (Ryan and Deci, 2000). ‘Participation’ refers to observable effort, persistence and on-task conduct in classroom activities and is linked to behavioural engagement. Guided by Fredricks et al.’s multidimensional view and Martin’s adaptive/maladaptive profile, the findings and discussion for this research question will consider the changes across relevant MES subscales, both adaptive (self-belief, task management, valuing) and maladaptive (anxiety, uncertain control, self-sabotage). Consistent with a critical realist approach, this data will be triangulated with post-intervention pupil surveys, teacher interviews, and the TRLs to connect observable behaviours to underlying mechanisms; for example, competence building through quick feedback. Analytically, this study distinguishes between effects likely driven by novelty and those consistent with sustained motivational and participatory gains in geography tasks.

4.3.1 Findings

4.3.1.1 MES Survey Data

Motivation was measured using the MES (Martin, 1999–2024). This subsection reports the changes from pre- to post-intervention for both adaptive and maladaptive subscales. These changes are found in Figure 2. A more detailed description of the subscale changes can be found in *4.1.1.1*.

Adaptive motivation: beliefs and value

Figure 2 shows adaptive changes in blue. ‘Self-belief’ increased (+0.47), whereas ‘valuing’ (-0.19), learning focus (-0.12) and persistence (-0.39) showed decreases.

Adaptive self-regulation: planning and task management

Self-regulatory subscales showed mixed change. 'Task management' increased (+0.38), while 'planning' decreased (-0.43).

Maladaptive dimensions

The five maladaptive subscales found within MES experienced rises (Figure 2). 'Anxiety' (+0.54), 'failure avoidance' (+0.25), 'uncertain control' (+0.54), 'self-sabotage' (+0.56) and 'disengagement' (+0.40) all increased.

Link to the qualitative data and discussion section

These MES patterns, particularly the rise in 'self-belief' and 'task management' alongside increased 'anxiety' and 'uncertain control', are elaborated on in PIPS, teacher interviews, and a TRL (4.3.1.2), and are interpreted within the theoretical framework (4.3.2).

4.3.1.2 Qualitative Themes

This subsection presents qualitative evidence on motivation and participation, drawn from open-ended responses in PIPS, TRLs, and teacher interviews. Data were coded using the framework outlined in Section 3.5. Of the twelve thematic codes, a focus will be placed on eight primary themes most relevant to Research Question 3 (RQ3). The themes are: behavioural, competence, autonomy, affective, feedback use, cognitive, relatedness, and anxiety. Table 10 represents a thematic overview and frequency count for these eight themes. For a full summary, see Appendix 4.

Thematic Overview and Frequency Counts

Theme	Definition	Referenc es & %s	Source (Pupil	Illustrative quote

			survey/ Log/ Interview)	
1.Behavioural	Observable participation (effort, persistence, attention, and on task conduct in class activities).	62 (11.7%)	22/33/7	“AI can heighten attentiveness because responses are immediate and scaffold thinking, complementing rather than replacing peer dialogue.” (Teacher Z interview)
2.Cognitive	Evidence of deeper thinking (questioning, explanation, strategy use and reflection beyond recall).	39 (7.4%)	13/13/13	“I like to use AI in blended/ flipped learning, getting pupils to research and internalise content rather than copy-paste.” (Teacher X interview)
3.Affective	Emotions and attitudes towards learning (interest, enjoyment and sense of belonging that can lead to sustained learning).	94 (17.8%)	62/15/17	“Instant feedback can be used for retrieval practice and role-play; a simulation of political interviews made concepts come alive and be enjoyable.” (Teacher Y interview)
4.Autonomy	Pupil ownership of learning.	32 (6.1 %)	9/19/4	"The opportunity to conduct a simulated interview with a “tsunami survivor” was highly motivating. Framing the activity as an authentic enquiry—where pupils could pose their own questions and receive lifelike responses—sparked curiosity and made the learning experience feel personal and immersive.” (TRL – Int 8)
5.Competence	Felt effectiveness and capability in meeting task demands.	36 (6.8%)	16/13/7	“Instant feedback is incredibly powerful, especially when it intellectually stretches pupils rather than spoon-feeding answers.” (Teacher Z interview)
6.Relatedness	Perceived connection and support from teachers and other pupils (collaborative work and responsive	68 (12.9%)	31/28/9	“Using screens can isolate pupils, they go into their own world and miss shared learning experiences.” (Teacher X interview)

	guidance).			
7.Feedback use	Pupils noticing, understanding and acting on actionable feedback (e.g. WIN) to revise work and improve performance.	45 (8.5%)	20/18/7	"It made me more determined to do a good answer for the feedback, which was clear and very helpful." (PIPS – Int 9)
8.Anxiety	Negative effect (worry, uncertainty, fear of error) which can be linked to avoidance and self-sabotage maladaptive dimensions.	29 (5.5%)	5/8/16	"Some pupils may find the sheer volume of information AI can provide to be overwhelming." (Teacher Z interview)

Table 10 – Summary of themes and frequency of codes of engagement and motivation identified by PIPS, teacher interviews and TRLs.

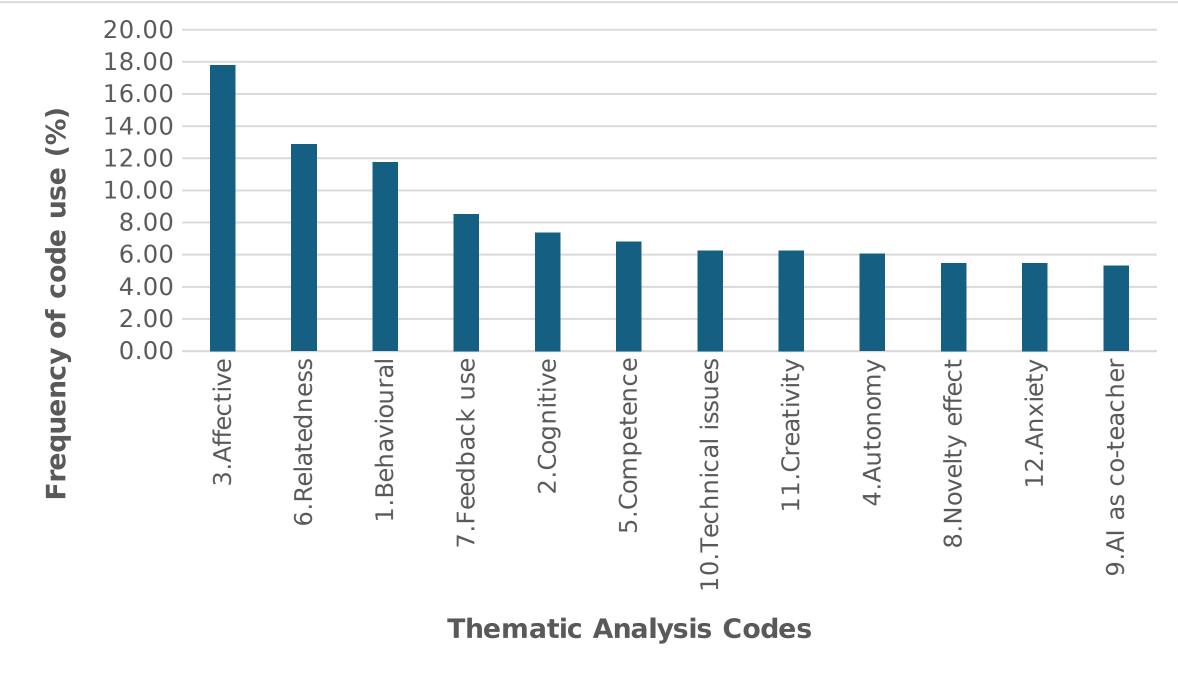

Figure 7 – Graph showing the frequency of the codes used in PIPS, teacher interviews and TRLs.

Behavioural engagement

This was referenced 62 times (11.7%: PIPS 22, TRL 33, Interviews 7). Pupils reported "It made it more creative and made it more engaging to use." (PIPS, Int-4); TRL noted "every pupil received the right level of challenge. This ensured sustained engagement by preventing both frustration and boredom" (TRL, Int-5). Further, "AI can heighten attentiveness because responses are immediate and scaffold thinking, complementing rather than replacing peer dialogue" (Teacher Z interview), capturing how immediate prompts sustained focus during activities. References to behavioural engagement appeared across all three sources.

Competence

Defined as pupils' felt effectiveness and knowing what a good standard of work looked like. Referenced 36 times (6.8%: PIPS 16, TRL 13, Interviews 7). Pupils and teachers highlighted the value of precise guidance, for example, "instant feedback is incredibly powerful, especially when it intellectually stretches pupils rather than spoon-feeding answers" (Teacher Z interview), with one pupil also noting "it helped us feel like we did well" (PIPS, Int-9). References to this theme were made in a variety of different interventions, ranging from feedback-heavy lessons, such as the Exam Coach GPT (Int-9), to video creation using Canva (Int-4).

Autonomy

This was referenced 32 times (6.1%: PIPS 9, TRL 19, Interviews 4). Referencing the simulated enquiry task, the TRL noted that: "The opportunity to conduct a simulated interview with a 'tsunami survivor' was highly motivating… pupils could pose their own questions and receive lifelike responses" (TRL, Int-8). Additionally, one pupil reported "it gave me feedback on my exam answer and a next step task" (PIPS, Int-9). Mentions concentrated in enquiry style activities, Int-7 and Int-8.

Affective engagement

This was referenced 94 times (17.8%: PIPS 62, TRL 15, Interviews 17). One pupil reported that the GenAI made ‘cool specific pictures’ (PIPS, Int-4). However, there were concerns pupils may lose interest if not given the correct guidance by the teacher leading the activity, with it being noted that “without sufficient prompt guidance, these pupils defaulted to superficial responses and subsequently lost interest when the resulting images failed to meet their expectations” (TRL, Int-3). This theme was coded primarily for image-based and high-feedback activities, such as Int-3 and Int-9.

Feedback use

This was referenced 45 times (8.5%: PIPS 20, TRL 18, Interviews 7). One pupil reported “it taught us how to improve our answers” (PIPS, Int-9), aligning with teacher reflections that “the instant formative feedback was the standout feature” (TRL, Int-9). There was, however, apprehension that pupils were using GenAI to just complete the task rather than to engage with it to deepen cognitive development, with Teacher Y stating, “AI delivers answers too quickly” (Teacher Y interview).

Cognitive engagement

This was referenced 39 times (7.4%: PIPS 13, TRL 13, Interviews 13). The TRL noted that GenAI allowed “pupils to design creative, context-specific protection plans for their own school, which sparked ownership and genuine interest” (TRL, Int-6). It can therefore be considered an effective platform for developing problem-solving.

Relatedness

This was referenced 68 times (12.9%: PIPS 31, TRL 28, Interviews 9). Pupils reported, “It was really fun to work in groups” (PIPS, Int-6). However, it was noted in the TRL that the level of relatedness codes may not be reflective of GenAI use but of the pedagogical choice: “While the technology added novelty, the collaborative planning format itself is inherently engaging, so pupil involvement remained consistent whether or not AI was used” (TRL, Int-6).

Anxiety

This was referenced 29 times (5.5%: PIPS 5, TRL 8, Interviews 16). As one interviewee cautioned, “some pupils may find the sheer volume of information AI can provide to be overwhelming” (Teacher Z interview). One pupil found GenAI hard to interact with and stated that they “didn’t understand what to do” (PIPS, Int-3).

4.3.2 Discussion

4.3.2.1 Theoretical implications

The evidence suggests that GenAI did impact specific aspects of engagement, but not uniformly. It tended to increase motivation through improvements in competence, with MES showing a +0.47 rise in ‘self-belief’ and improved ‘task management’, which increased by +0.38. Maladaptive attributes, however, also increased (‘anxiety’ +0.54, ‘uncertain control’ +0.54, ‘self-sabotage’ +0.56), while some adaptive attributes experienced decreases (valuing -0.19, persistence -0.39). Pupils’ and teachers’ accounts identify immediacy and actionable ‘next steps’ as drivers of competence linked to motivation, and to differentiated challenges in class activities, helping to sustain on-task behaviour. When considered from multidimensional engagement and SDT perspectives, these patterns indicate gains when feedback is usable and choice is supported, but costs when guidance feels impersonal or overwhelming.

Competence and motivational lift

Pupils most often recognised GenAI's impact on motivation when it gave clear, personalised feedback with next steps. They responded positively to this as it provided them with an attainable pathway to improvement: "It taught us how to improve our answers" (PIPS, Int-9). Teachers echoed this, noting that "the instant formative feedback was the standout feature" and that it was "incredibly powerful, especially when it intellectually stretches pupils rather than spoon feeding answers" (Teacher Z interview). This aligns with SDT by emphasising how task-focused and timely feedback can support competence, leading to more durable motivation, and was reflected in the +0.47 rise in 'self-belief' in the MES data. In geography, competence gains were most prominent when the next steps involved attempting to challenge pupil understanding and use of knowledge. This is where a link to powerful geographic knowledge plays a role in enriching pupil understanding (Maude, 2016).

Participation sustained by immediacy

Pupils attributed the ability to stay on task to the way GenAI structured the activity and responded immediately, reducing idle time by providing them with clear 'next steps'. Teacher evidence corroborated this: "Every pupil received the right level of challenge… preventing frustration and boredom" (TRL, Int-5), and "AI can heighten attentiveness because responses are immediate and scaffold thinking, complementing, rather than replacing, peer dialogue" (Teacher Z interview). The impact of this GenAI use can be seen in the increase in 'task management' in the MES data, which rose by +0.38.

Participation was most robust when geography tasks were carefully designed with checkpoints provided against success criteria. This helped pupils, no matter what their ability, to engage with the task and receive guidance about their progress.

Autonomy

GenAI-supported autonomy occurred when pupils exercised choice within clear bounds, for example, in the simulated enquiry where pupils asked questions and received realistic responses from GenAI acting as a tsunami survivor (Int-7). Teachers valued this innovation but cautioned that unsupported freedom can backfire. Pupils may choose to take shortcuts, using GenAI to just find out the answer rather than engaging in cognitive reasoning. This would restrict the potential for deeper learning. The teachers interviewed shared this fear, with one succinctly saying, “GenAI delivers answers too quickly” (Teacher Y interview).

In SDT, autonomy refers to pupils taking responsibility and ownership of their learning, not just having choices (Ryan and Deci, 2000). If pupils are given a wide choice of options without an understanding of the learning objectives and how these options fit into their learning pathway, they may find it overwhelming. This is consistent with the rises in ‘uncertain control’ and ‘anxiety’ (each +0.54). Choices should, therefore, be supported with exemplars and adapted teaching pedagogy, so they remain intelligible and success feels attainable. In geography, this requires having clear boundaries of study, within which choices are made. GenAI can then serve as a supportive tool, granting pupils autonomy while maintaining parameters to prevent excessive freedom.

Affective ‘hook’ versus durable value

Pupils reported that each of the GenAI-mediated lessons had made the activities ‘fun’ and ‘interesting’, indicating strong affective engagement. Triangulation of the data showed this did not have a corresponding impact upon ‘valuing’ or ‘persistence’. Teachers highlighted novelty-driven drift: “without sufficient prompt guidance, pupils defaulted to superficial responses and lost interest when the resulting images failed to meet expectations” (TRL, Int-3); likewise, “the wealth of creative options was counterproductive… pupils drifted away from the core task” (TRL, Int-4).

SDT links positive affect to intrinsic motivation, but expectancy-value theorists, such as Wigfield and Eccles (2000), highlight that interest needs utility to sustain effort. This study suggests that novelty-fuelled affective engagement may not lead to sustained engagement, as pupils would start to have a lower opinion of the value of what they are learning. This was reflected in the MES data, which showed decreases for ‘valuing’ (-0.19) and persistence (-0.39).

The implication for geography education is that there must be a pairing of the affective ‘hook’ with disciplinary follow-ups to ensure pupils can see the value of the tasks they are engaging with. This approach will also develop pupils’ cognitive engagement with the content, while simultaneously channelling their enthusiasm.

Increasing maladaptive attributes

The same immediacy that builds competence could lead to pupils panicking about making mistakes and having these errors highlighted in front of their peers. This could explain the increase in ‘anxiety’ (+0.54) in the MES data. One consequence of this could be that pupils start to actively undermine their own efforts to disguise their anxiety, and could explain the increase in ‘self-sabotage’ (+0.56). Teachers described two stressors: firstly, the “sheer volume of information” that can be overwhelming (Teacher Z interview), and secondly, technical issues can confuse pupils, for example, poorly formed or inaccurate images in Int-1. In Martin’s model, these are maladaptive facets, whereas from an SDT perspective, they signal thwarted competence and autonomy.

The implication of this for geography education is once again the need for carefully designed pedagogy, including safeguards to counter this trend. These safeguards could involve clarifying tasks, telling pupils exactly what is expected of them, highlighting suggested pacing, and considering load management. To reduce ‘self-sabotage’, geography teachers should ensure that pupils have a safe learning environment. There is also an opportunity to use powerful knowledge in geography, which would allow pupils to draw upon their own experiences and prior knowledge.

Relatedness

Teacher testimony reveals that motivation and participation were strongest when GenAI was integrated into collaborative learning activities. This is consistent with SDT, where, through peer connection and teacher involvement, participation can be sustained. This emphasis on peer and teacher interaction raises questions about whether GenAI can meet pupils’ relatedness needs. In geography education, GenAI could play a significant role as a learning tool; nevertheless, teachers will still be essential to validate contributions, correct misconceptions, and link ideas to powerful geographical knowledge. Without this, there would be a danger that pupils would not engage cognitively and would experience only superficial learning.

5. Conclusion

5.1 Summary of findings

Research Question 1:

GenAI most reliably enhanced behavioural participation and perceived capability when activities were built around immediate, specific feedback. Quantitatively, ‘self-belief’ rose (+0.47) and ‘task management’ improved (+0.38), while ‘valuing’ (-0.19), ‘learning focus’ (-0.12) and ‘persistence’ (-0.39) declined, and all five maladaptive dimensions increased, notably ‘anxiety’ and ‘uncertain control’ both +0.54. PIPS indicated that most interventions were perceived as more interesting, with the highest approvals for tasks that closed the feedback loop within the lesson, such as Int-3 and Int-9. TRLs also recorded noticeably higher participation in several GenAI lessons and a particularly focused work ethic during Int-9, where pupils responded to the feedback provided by the GenAI. Depth of thinking, however, depended on design; for example, Int-9 prompted metacognitive reflection, whereas some open-ended creative tasks, such as Int-2 and Int-4, elicited superficial description. Overall, GenAI primarily shaped engagement through the immediacy and clarity of feedback within well-defined tasks, where aims and success criteria were more clear, and gains were more uniform and substantial.

Research Question 2:

Pupils' perceptions were broadly positive but conditional on task design. Affective engagement responses were strong, with "fun" and "interesting" being the most frequent descriptors. Many pupils valued the usefulness of personalised guidance and the sense of ownership that came with being able to pose their own questions, for example, in Int-8. At the same time, it was notable that there was nervousness about instant marking, uncertainty when pupils were presented with too many options, and examples of technical issues, all of which dampened confidence. Both teacher interviews and TRL suggested pupils continued to seek teacher validation, indicating that while GenAI could act as a supportive 'co-teacher', human interaction remained important for making sense of feedback and judging accuracy. In summary, pupils liked GenAI most when it was responsive, set within a clear framework and specifically connected to geography learning goals. They were wary when speed, choice overload or reliability concerns became more prominent.

Research Question 3:

Findings showed a complex picture. On the one hand, motivation shifted towards greater confidence and organisation (‘self-belief’ +0.47; ‘task management’ +0.38) and qualitative evidence documented sustained on-task participation, frequent use of feedback and moments of deeper cognitive engagement for decision-making tasks. On the other hand, maladaptive indicators increased (‘anxiety’ +0.54; ‘uncertain control’ +0.54; with additional rises in ‘failure avoidance’, ‘self-sabotage’ and ‘disengagement’) alongside dips in ‘planning’ (-0.43) and ‘persistence’ (-0.39). The pattern suggests a plausible cause for this. When the intervention emphasised instant feedback, set within a clear framework of standards, it helped to provide pupils with a pathway to improvement, which bolstered competence beliefs and levels of participation. Where tasks emphasised novelty or offered too wide a choice, pupils’ motivation was more fragile and anxiety more salient.

5.2 Implications for practice

The evidence from this study suggests that GenAI can be a productive catalyst for engagement in Year 9 geography when it is carefully and deliberately embedded within clear pedagogical routines. Gains in ‘self-belief' and 'task management' alongside teachers' reports of sustained participation indicate that pupils respond well to immediate, specific guidance. At the same time, the rises in 'anxiety' and 'uncertain control' signal design risks that must be actively mitigated. The implications and suggestions below are practical steps that reflect the findings of this research.

Turning "fun" into cognitive engagement

Where pupils found GenAI tasks "fun" or "interesting", I would require them to explain and justify their choices to secure cognitive engagement. For example, when using GenAI to create images based on description, pupils should be challenged to explain geographic processes and/or link to case study examples. This would shift the focus of learning beyond description and elicit more in-depth reasoning.

Provide autonomy within a framework to avoid overload

Pupils appreciated being given a choice, but they reported uncertainty when the options were too open. This means that in future practice, I will provide pupils with suggested pathways of varying difficulty that can help establish a framework for pupil autonomy. This would preserve volition while addressing the increase in uncertain control that was reported in this research.

Humanise feedback

Although pupils valued GenAI guidance, they continued to seek validation from their teachers. After each feedback cycle, I will conduct a brief whole-class or small-group debrief (depending on the activity) to highlight common misconceptions and explicitly link corrections to relevant disciplinary ideas. This should help pupils develop their sense of competence and support relatedness without slowing progress.

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Appendix

Appendix 1: Motivation and Engagement Scale Survey and Subscales

MES Survey

1. If I can't understand my schoolwork at first, I keep going over it until I do. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

2. I feel very pleased with myself when I really understand what I'm taught at school. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

3. When I study, I usually study in places where I can concentrate. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

4. I'm able to use some of the things I learn at school in other parts of my life. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

5. Sometimes I don't try hard at assignments so I have an excuse if I don't do so well. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

6. When I don't do so well at school I'm often unsure how to avoid that happening again. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

7. I feel very pleased with myself when I do well at school by working hard. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

8. Each week I'm trying less and less. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

9. If my homework is difficult, I keep working at it trying to figure it out. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

10. When exams and assignments are coming up, I worry a lot. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

11. Often the main reason I work at school is because I don't want people to think that I'm dumb. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

12. When I get a good mark I'm often not sure how I'm going to get that mark again. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

13. If I try hard, I believe I can do my schoolwork well. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

14. Learning at school is important. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

15. I don't really care about school anymore. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

16. When I get a bad mark I'm often unsure how I'm going to avoid getting that mark again. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

17. When I study, I usually organize my study area to help me study best. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

18. I'm often unsure how I can avoid doing poorly at school. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

19. I worry about failing exams and assignments. *

	Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
	○	○	○	○	○	○	○

20. Often the main reason I work at school is because I don’t want people to think bad things about me. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

21. I get it clear in my head what I’m going to do when I sit down to study. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

22. I’ve pretty much given up being involved in things at school. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

23. If I don’t give up, I believe I can do difficult schoolwork. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

24. I sometimes don’t study very hard before exams so I have an excuse if I don’t do so well. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

25. I feel very pleased with myself when what I learn at school gives me a better idea of how something works. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

26. I feel very pleased with myself when I learn new things at school. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

27. Before I start an assignment, I plan out how I am going to do it. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

28. When I'm taught something that doesn't make sense, I spend time to try to understand it. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

29. I've pretty much given up being interested in school. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

30. I try to plan things out before I start working on my homework or assignments. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

31. Often the main reason I work at school is because I don't want to disappoint my parents. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

32. When I study, I usually try to find a place where I can study well. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

33. If I have enough time, I believe I can do well in my schoolwork. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

34. What I learn at school will be useful in the future. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

35. I sometimes do things other than study the night before an exam so I have an excuse if I don't do so well. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

36. I'll keep working at difficult schoolwork until I think I've figured it out. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

37. When I do tests or exams I don't feel very good. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

38. Often the main reason I work at school is because I don't want my teacher to think less of me. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

39. I usually stick to a study timetable or study plan. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

40. If I work hard enough, I believe I can get on top of my schoolwork. *

Strongly disagree	Disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

41. It's important to understand what I'm taught at school. *

Strongly disagree	disagree	Disagree somewhat	neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

42. I sometimes put assignments and study off until the last moment so I have an excuse if I don't do so well. *

Strongly disagree	disagree	Disagree somewhat	neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

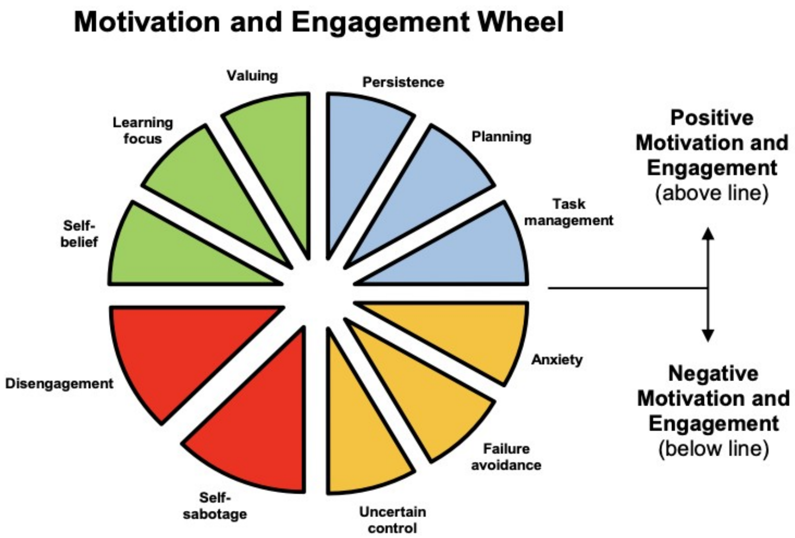
43. In terms of my schoolwork, I'd call myself a worrier. *

Strongly disagree	disagree	Disagree somewhat	neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

44. When I study, I usually study at times when I can concentrate best. *

Strongly disagree	disagree	Disagree somewhat	neither agree nor disagree	Agree somewhat	Agree	Strongly agree
○	○	○	○	○	○	○

MES Subscales with average change between pre- and post-intervention MES surveys



Motivation and Engagement Wheel (Martin, 1999–2024)

Dimension: Self belief		
Question		Change
13	If I try hard, I believe I can do my schoolwork well.	0.1
23	If I don't give up, I believe I can do difficult schoolwork.	-0.05
33	If I have enough time, I believe I can do well in my schoolwork.	-0.05
40	If I work hard enough, I believe I can get on top of my schoolwork.	2.05

TABLE 2a – Showing average change between pre- and post-intervention MES surveys for 'Self-belief'

Dimension: Valuing		
Question		Change
4	I'm able to use some of the things I learn at school in other parts of my life.	-0.05
14	Learning at school is important.	-0.25
34	What I learn at school will be useful in the future.	-0.2
41	It's important to understand what I'm taught at school.	-0.15

TABLE 3a – Showing average change between pre- and post-intervention MES surveys for 'Valuing'

Dimension: Learning focus		
Question		Change
2	I feel very pleased with myself when I really understand what I'm taught at school.	0.15
7	I feel very pleased with myself when I do well at school by working hard.	-0.2
25	I feel very pleased with myself when what I learn at school gives me a better idea of how something works.	-0.15
26	I feel very pleased with myself when I learn new things at school.	-0.25

TABLE 4a – Showing average change between pre- and post-intervention MES surveys for 'Learning focus'

Dimension: Persistence		
Question		Change
1	If I can't understand my schoolwork at first, I keep going over it until I do.	-0.15
9	If my homework is difficult, I keep working at it trying to figure it out.	-0.25
28	When I'm taught something that doesn't make sense, I spend time to try to understand it.	-0.45
36	I'll keep working at difficult schoolwork until I think I've figured it out.	-0.2

TABLE 5a – Showing average change between pre- and post-intervention MES surveys for 'Persistence'

Dimension: Task management		
Question		Change
3	When I study, I usually study in places where I can concentrate.	0.1
17	When I study, I usually organize my study area to help me study best.	0.4
32	When I study, I usually try to find a place where I can study well.	0.5
44	When I study, I usually study at times when I can concentrate best.	0.25
Dimension: Planning		
Question		Change
21	I get it clear in my head what I'm going to do when I sit down to study.	-0.6
27	Before I start an assignment, I plan out how I am going to do it.	-0.2
30	I try to plan things out before I start working on my homework or assignments.	0.35
39	I usually stick to a study timetable or study plan.	0.2

TABLE 6a – Showing average change between pre- and post-intervention MES surveys for 'task management' and 'planning'

Dimension: Anxiety		
Question		Change
10	When exams and assignments are coming up, I worry a lot.	0.5

19	I worry about failing exams and assignments.	0.15
37	When I do tests or exams, I don't feel very good.	0.6
43	In terms of my schoolwork, I'd call myself a worrier.	0.45
Dimension: Failure avoidance		
Question		Change
11	Often the main reason I work at school is because I don't want people to think that I'm dumb.	0.45
20	Often the main reason I work at school is because I don't want people to think bad things about me.	0.15
31	Often the main reason I work at school is because I don't want to disappoint my parents.	0.35
38	Often the main reason I work at school is because I don't want my teacher to think less of me.	-0.1
Dimension: Uncertain control		
Question		Change
6	When I don't do so well at school I'm often unsure how to avoid that happening again.	0.95
12	When I get a good mark I'm often not sure how I'm going to get that mark again.	0.7
16	When I get a bad mark I'm often unsure how I'm going to avoid getting that mark again.	0.15
18	I'm often unsure how I can avoid doing poorly at school.	0.5
Dimension: Self-sabotage		
Question		Change
5	Sometimes I don't try hard at assignments so I have an excuse if I don't do so well.	0.75
24	I sometimes don't study very hard before exams so I have an excuse if I don't do so well.	0.65
35	I sometimes do things other than study the night before an exam so I have an excuse if I don't do so well.	0.5
42	I sometimes put assignments and study off until the last moment so I have an excuse if I don't do so well.	0.5
Dimension: Disengagement		
Question		Change
8	Each week I'm trying less and less.	0.35
15	I don't really care about school anymore.	0.55
22	I've pretty much given up being involved in things at school.	0.1
29	I've pretty much given up being interested in school.	0.55

TABLE 7a – Showing average change between pre- and post-intervention MES surveys for negative motivation and engagement dimensions

Appendix 2: Post-Intervention Pupil Surveys (PIPS)

1. Did GenAI make the lesson more interesting? If yes, why? *

◯ Yes

◯ No

2. If yes to Question 1 please explain below:

Enter your answer

3. How much did GenAI help you stay focused? (1 – Not at all, 5 – Very much) *

Not at all	A little	Somewhat	Quite a bit	Very much
◯	◯	◯	◯	◯

4. What was the most helpful thing about GenAI today? *

Enter your answer

5. Did anything about GenAI make it harder to participate? If yes, can you give details of the issue? *

◯ Yes

◯ No

6. If you answered 'yes' to Question 5, please can you provide explanation below.

Enter your answer

7. Would you want to use GenAI again in lessons? Can you explain your answer? *

Enter your answer

Appendix 3: Teacher Interview Questions

Section 1 – General Context

1. How would you describe the level of pupil engagement in your geography lessons currently?
2. What strategies do you typically use to encourage motivation, attention, and participation in your lessons?
3. What challenges do you face in keeping pupils engaged with geography, particularly with complex topics like earthquakes and volcanoes?

Section 2 – Potential impact of AI

4. What are your initial thoughts on the idea of using GenAI tools, like ChatGPT, in geography lessons?
5. How do you think GenAI might shape how pupils engage with tasks such as analysing geographic processes or solving problems?
6. In what ways do you think GenAI could affect pupils' motivation to participate in lessons?
7. Do you anticipate any differences in how pupils pay attention or interact with activities when using GenAI compared to traditional methods?
8. Are there specific features of GenAI, such as instant feedback or interactive questioning, that you think might enhance engagement? Why?

Section 3 – Professional Reflections

9. Do you have any concerns about how GenAI might influence teaching and learning in your classroom?
10. What practical challenges do you think could arise when integrating GenAI tools into lessons?
11. What support or resources would you need to make the use of GenAI tools effective and manageable?

Section 4 – Conclusion

12. Is there anything else you'd like to add about your expectations for this intervention?
13. Do you have any advice on how to monitor or evaluate the impact of GenAI on pupil engagement?

Appendix 4: Thematic Coding for PIPS

Table 8a – Themes of engagement and motivation identified by pupils' post-intervention surveys.

Themes		Examples from PIPS
1	Behavioural engagement (e.g. on task participation, visible involvement)	'The lesson felt more engaging whilst still learning the same material.' (Int-2) 'It made it more creative and made it more engaging to use.' (Int-4)
2	Cognitive engagement (e.g. problem-solving, deep thinking, curiosity)	'We were able to see how AI thinks compared to our brain.' (Int-1)
3	Affective engagement (e.g. enjoyment, interest, emotional connection)	'Very interesting and a lot of info.' (Int-1) 'ChatGPT made the lesson more interesting because it can add photos which helps me remember key terms and is better than a lot of just writing since that can be boring to just read and doesn't stay in my head.' (Int-2) 'The AI generated good questions which helped me interested in the lesson.' (Int-8)
4	Autonomy (references to choice, independence)	'I liked being able to ask my own questions to the survivor and have a conversation.' (Int-7)
5	Competence (confidence, success, perceived difficulty)	'The task wasn't too hard and the images were quite interesting.' (Int-1)
6	Relatedness and peer support (peer interaction, collaboration, GenAI and teacher support)	'Helped explain what I needed to do and how to do it' (Int-5) 'It was really fun to work in groups.' (Int-6)
7	Feedback use (GenAI or teacher)	'It gave personalized feedback and it was something different.' (Int-6) 'Gave us very good feedback and next steps.' (Int-9)
8	Novelty effect (excitement, curiosity about GenAI as new technology)	'It added a new feel to learning.' (Int-1) 'It helps us explore new possibilities around geography.' (Int-6)
9	GenAI as co-teacher	'The AI generated good questions which helped me interested in the lesson.' (Int-8)
10	Technical/access issues (glitches, access issues)	'It kept stopping and not working.' (Int-4) 'It was not interactive and just gave us info/ feedback.' (Int-7)
11	Creativity (moments where AI tasks created imaginative or	'It was interesting because it was engaging and fun to play with.' (Int-2)

	playful responses)	'We could make videos and be creative' (Int-4)
12	Anxiety (expressions of stress or worry)	'I found it difficult to understand.' (Int-4) 'I was nervous putting my answers into the AI and getting marked immediately.' (Int-9)
13	Teacher reservations (concerns over GenAI's pedagogical value)	Not applicable for the thematic analysis of pupil surveys.

Appendix 5: Thematic Coding Summary for PIPS, Teacher Interviews and TRLs

Theme	Definition	References & %s	Source (Pupil survey/ Log/ Interview)	Illustrative quote
1.Behavioural	Observable participation (effort, persistence, attention, and on task conduct in class activities).	62 (11.7%)	22/33/7	"AI can heighten attentiveness because responses are immediate and scaffold thinking, complementing rather than replacing peer dialogue." (Teacher Z interview)
2.Cognitive	Evidence of deeper thinking (questioning, explanation, strategy use and reflection beyond recall).	39 (7.4%)	13/13/13	"I like to use AI in blended/ flipped learning, getting pupils to research and internalise content rather than copy-paste." (Teacher X interview)
3.Affective	Emotions and attitudes towards learning (interest, enjoyment and sense of belonging that can lead to sustained learning).	94 (17.8%)	62/15/17	"Instant feedback can be used for retrieval practice and role-play; a simulation of political interviews made concepts come alive and be enjoyable." (Teacher Y interview)
4.Autonomy	Pupil ownership of learning.	32 (6.1 %)	9/19/4	"The opportunity to conduct a simulated interview with a "tsunami survivor" was highly motivating. Framing the activity as an authentic enquiry—where pupils could pose their own questions and receive lifelike responses—sparked curiosity and made the learning

				experience feel personal and immersive.” (Teacher Log – Int 8)
5.Competence	Felt effectiveness and capability in meeting task demands.	36 (6.8%)	16/13/7	“Instant feedback is incredibly powerful, especially when it intellectually stretches pupils rather than spoon-feeding answers.” (Teacher Z interview)
6.Relatedness	Perceived connection and support from teachers and other pupils (collaborative work and responsive guidance).	68 (12.9%)	31/28/9	“Using screens can isolate pupils, they go into their own world and miss shared learning experiences.” (Teacher X interview)
7.Feedback use	Pupils noticing, understanding and acting on actionable feedback (e.g. WIN) to revise work and improve performance.	45 (8.5%)	20/18/7	“It made me more determined to do a good answer for the feedback, which was clear and very helpful.” (Pupil Survey – Int 9)
8.Novelty effect	Short-lived interest attributable to the ‘newness’ of GenAI rather than disciplinary value, risking surface engagement unless designs channel it into thinking.	29 (5.5%)	17/10/2	“A minority of pupils found the wealth of creative options counterproductive. With seemingly endless templates, transitions, and media assets at their fingertips, these learners spent disproportionate time exploring aesthetics rather than crafting their narrative, causing them to drift away from the core task.” (Teacher Log – Int 4)
9.AI as co-teacher	Perception of GenAI as a supportive assistant, providing prompts, exemplars and scaffolds. Teachers mediate accuracy, context and social connection.	28 (5.3%)	16/5/7	“The AI generated good questions which helped me.” (Pupil Survey – Int 8)
10.Technical issues	Barriers that interrupt	33 (6.3%)	17/12/4	“Some pupils find the images created to be too

	engagement or flow (access issues, prompt misunderstandings) reducing task focus or confidence.			similar to each other, with ChatGPT not creating clearly defined images. ChatGPT also included words in some of the images but these were spelt incorrectly and did confuse pupils.” (Teacher Log – Int 1)
11.Creativity	Opportunities to generate, test and create ideas or products.	33 (6.3%)	18/13/2	“The opportunity to see their own words transformed into vivid imagery proved highly motivating.” (Teacher Log – Int 3)
12.Anxiety	Negative effect (worry, uncertainty, fear of error) which can be linked to avoidance and self-sabotage maladaptive dimensions.	29 (5.5%)	5/8/16	“Some pupils may find the sheer volume of information AI can provide to be overwhelming.” (Teacher Z interview)