

Article

Personalising Learning for Gifted and Twice-Exceptional Students: Leveraging Generative Artificial Intelligence for Strengths-Based, Neuroaffirming Education

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Abstract

Twice-exceptional students—those who are both gifted and have one or more disabilities—and gifted learners, more broadly, represent persistently underserved populations within educational systems. Gifted learners frequently encounter provision that does not adequately engage their potential, such as standardised approaches that neither recognise nor respond to their learning requirements. Traditional identification and programming approaches often rely on deficit-based approaches that pathologise neurodivergence and frequently neglect the complex, asynchronous learning profiles characteristic of twice-exceptional students. This article advances a functional alignment framework proposing that generative artificial intelligence's processing patterns may align with the cognitive characteristics of some gifted and twice-exceptional learners. The proposed functional alignment spans five dimensions: conceptual movement, knowledge integration, topic continuity, working memory, and pacing and temporal flexibility; this positions GenAI as a potentially compatible interactive platform for personalised, strengths-based learning. The functional alignment framework is explicitly theoretical, advancing propositions rather than demonstrated effects, and requires empirical validation. Positioning GenAI as a mediating platform has the potential to disrupt longstanding barriers to evidence-informed educational provision for gifted and twice-exceptional students. Through examining the intersection of gifted education, special education, and educational technology, this theoretical work outlines a trajectory for the field, characterised by flexible, personalised, strengths-based approaches that can be responsive to the student in front of the teacher, instead of the all-too-often default to one-size-fits-all approaches. Critical considerations of equity, teacher capability, and ethical implementation are addressed, theorising that GenAI's transformative potential may only be realised through deliberate, theoretically informed application grounded in deep understanding of learner neurodivergence and a proposed pivot from GenAI literacy to *GenAI fluency*. This work contributes to reconceptualising gifted education as inherently inclusive, responsive, and oriented towards actualising potential for gifted and twice-/multi-exceptional learners.

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1. Introduction

Twice-exceptional students—those who are gifted and have one or more disabilities (e.g., autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), dyslexia, dysgraphia, dyscalculia)—represent persistently underserved and frequently misunderstood populations within educational systems (Foley-Nicpon et al., 2013; Reis et al., 2014; Ronksley-Pavia, 2015). Multi-exceptional students extend this conceptualisation, demonstrating giftedness with two or more co-occurring disabilities. Although explicit distinctions exist, these populations share asynchronous, complex learning profiles central to the functional alignment framework proposed here. For the purposes of this article, the term twice-exceptional is used inclusively to encompass both twice-exceptional and multi-exceptional learners, reflecting their shared complex learning profiles and the educational challenges they often face. Where the distinction between the two populations is specifically relevant, this is noted explicitly.

Despite decades of research documenting the unique learning profiles, capabilities, and educational requirements of twice-exceptional learners (Baldwin et al., 2015; Baum et al., 2014; Foley-Nicpon et al., 2013; Ronksley-Pavia, 2016; Ronksley-Pavia & Grootenboer, 2016), educational provision remains characterised by identification barriers, inadequate programming, and pedagogical approaches that privilege standardisation over responsiveness to student learning requirements and neurodivergence (Foley-Nicpon et al., 2013; Foley-Nicpon & Assouline, 2015; Reis et al., 2021; Siegle et al., 2024). We aim to address these persistent problems by proposing a theoretical framework of functional alignment between generative artificial intelligence (GenAI) processing patterns and the broad cognitive characteristics of gifted and twice-/multi-exceptional learners. The rationale proceeds on three levels. First, gifted and twice-exceptional learners largely remain inadequately served by educational systems that default to standardised provision that does not match their complex learning profiles. Second, the proposed theoretical solution could be that GenAI's processing patterns may align functionally with the cognitive characteristics of many gifted and twice-exceptional learners in ways that position it as a potentially compatible interactive platform for personalised, strengths-based learning. Third, the contribution is a theoretical framework with practical pedagogical implications, a professional learning agenda grounded in GenAI fluency, and suggestions for empirical research required to validate and extend these propositions.

The neurodiversity paradigm recognises neurological *differences* as natural human variations instead of medical pathology (Dwyer, 2022; Hamilton & Petty, 2023; Ronksley-Pavia et al., 2025a). Neurodivergent populations include, but are not limited to, individuals with autism, ADHD, dyslexia, dyscalculia, giftedness, and twice-exceptionality (Ronksley-Pavia et al., 2025a). Twice-exceptional students display the capacity to learn and achieve at a high level, but often not in the context of formal education (Ronksley-Pavia & Clark, 2025). Traditional identification and programming frequently rely on deficit-based approaches that pathologise neurodivergence. They interpret cognitive variations as deficits or disorders only requiring *remediation* or interventions, and frequently neglect the complex, asynchronous learning profiles characteristic of twice-exceptional learners (Munro, 2002; Ronksley-Pavia, 2015; Silverman, 2017). The consequences of deficit-based educational approaches are well documented: underachievement, disengagement, social-emotional challenges, leaving school prematurely, and unrealised potential (Foley-Nicpon & Candler, 2018; Foley-Nicpon & Teriba, 2022; Ronksley-Pavia & Pendergast, 2021). An alternative approach begins with the recognition that formal educational provision makes assumptions about how students learn (Munro, 2025). The extent of alignment between these assumptions and the reality for individual students influences the likelihood of successful learning.

The emergence of GenAI technologies presents a transformative opportunity to reimagine educational provision for gifted, twice-exceptional, and multi-exceptional students. Large language models (LLMs) and other GenAI applications have demonstrated remarkable capacities for generating human-like text and images, engaging in various types of complex reasoning, synthesising information across domains, and adapting to individual communication patterns (Brown et al., 2020).

Recent research has begun to explore GenAI applications in education more broadly, focusing on personalised learning, adaptive scaffolding, and student engagement (Holmes & Porayska-Pomsta, 2023). A growing body of scholarship examines GenAI's potential to support neurodivergent learners, including students with autism, ADHD, dyslexia, and other learning challenges (Ronksley-Pavia et al., 2025a). However, systematic attention to GenAI's specific affordances for twice-exceptional learners, whose cognitive profiles combine advanced capabilities with complexities related to areas such as processing challenges and working memory issues, remains limited.

This article advances the proposition that GenAI and gifted and twice-exceptional learners may demonstrate analogous cognitive characteristics, positioning GenAI as a potentially compatible interactive platform for personalised, strengths-based learning. The theoretical and pedagogical implications of this proposition are developed across the sections that follow. The significance of this proposition extends beyond technological application to fundamental questions about the nature of learning, intelligence, and educational responsiveness. If GenAI's processing architecture aligns with certain cognitive characteristics common among many gifted and twice-exceptional learners, then interactions with GenAI may offer a technological interactive platform that engages with, instead of redirecting, the associative, systems-level reasoning that many gifted and twice-exceptional students often instinctively use. This represents a departure from deficit-oriented approaches for twice-exceptional learners in particular, which frequently position their cognitive processing approaches as problems to be *managed* or *remediated*, instead recognising these as legitimate, productive modes of engagement and cognition that can be purposefully supported through appropriately designed technological mediation.

Five key contributions are made in this article to scholarship on gifted education and twice-/multi-exceptionality, special education, and educational technology. First, we establish the theoretical framework of functional alignment between gifted and twice-exceptional learners' broad cognitive characteristics and GenAI processing patterns. Second, we articulate how GenAI may function as a mediating platform that engages with the associative, systems-level reasoning characteristic of gifted and twice-exceptional learners. This engagement has the potential to support personalised learning experiences that connect with learner capabilities, while providing responsive approaches for supporting challenges, thereby disrupting some longstanding barriers to evidence-informed provision.

Third, drawing on the intersection of gifted education, special education, and educational technology, we outline how GenAI-enabled approaches may facilitate flexible, personalised learning approaches that are responsive to the student in front of the teacher, moving decisively away from standardised, one-size-fits-all programming models that research has shown time and again systematically fail many gifted and twice-exceptional learners (Lawson et al., 2025; Rizzo et al., 2025; Ronksley-Pavia & Clark, 2025).

Fourth, we address necessary professional learning requirements for educators to be supported in effectively leveraging GenAI in support of gifted and twice-exceptional learners, including developing *GenAI fluency* (instead of the oft-used term *GenAI literacy*), deepening understanding of learner neurodivergence (particularly multi-exceptionality), and cultivating pedagogical approaches that position GenAI technology as an interactive platform.

Lastly, we critically examine conditions under which GenAI's transformative potential may be realised for gifted and twice-exceptional learners through purposeful, theoretically informed application that aims to address considerations of access, student capabilities, teacher capacity, and implementation ethics, thereby contributing to reconceptualising gifted education as inherently inclusive and decisively oriented towards actualising potential for gifted and twice-exceptional learners.

While we employed a theoretical synthesis approach, it is not purely speculative. The functional alignment framework is explicitly evidence-informed, grounded in published empirical research and the existing literature. The theorisation presented here draws on and extends that empirical base and does not proceed independently of it. The article proceeds as follows: Section 2 outlines the theoretical synthesis approach and its foundations; Section 3 articulates the functional alignment framework, theorising proposed alignment between gifted and twice-exceptional broad cognitive characteristics and GenAI processing patterns; Section 4 discusses and examines implications for practice, teacher capability, and educational futures; and Section 5 concludes with a synthesis of the framework and directions for future research.

2. Theoretical Synthesis

2.1. Conceptual Framing

The theoretical synthesis approach employed here integrates scholarship from three intersecting domains: gifted education, special education (particularly twice-/multi-exceptionality and neurodiversity), and educational technology (specifically GenAI platforms and applications). The analytical framework draws on established theories of divergent thinking (Guilford, 1968), knowledge transfer (Salomon & Perkins, 1989), and neurodiversity-affirming approaches (Chapman, 2021; Dwyer, 2022) to develop the proposition of functional alignment between gifted and twice-exceptional learners' cognitive characteristics and GenAI processing patterns. The conceptual work draws explicitly on current empirical research examining GenAI applications with twice-/multi-exceptional, neurodivergent students (James, 2024; Medlicott, 2023; Ronksley-Pavia et al., 2025b; Siegle, 2024), and is supplemented by research and reviews of GenAI for supporting neurodivergent school students (Larkey, 2023; Lemke et al., 2024; Medlicott, 2023; Moraiti & Drigas, 2023; Ronksley-Pavia et al., 2025a). This evidence-informed foundation distinguishes the theoretical synthesis presented from purely speculative argument, while the Scope and Limitations Section (Section 2.3) explicitly acknowledges the need for further empirical validation of the framework.

2.2. Analytical Process

The functional alignment framework was developed through three sequential stages. Figure 1 illustrates the sequential and iterative relationship between the three stages, each of which is described in this section. Stage 1 established the cognitive profiles of gifted and twice-exceptional learners against which GenAI processing patterns were subsequently mapped. Characterisation of cognitive processing was synthesised from the research literature on gifted and twice-exceptional learners' broad cognitive characteristics, with particular attention to non-linear thinking patterns, cross-domain pattern recognition, and associative reasoning. This synthesis also attended to behaviours that conventional pedagogical structures often pathologise, such as apparent topic discontinuity and rapid conceptual shifts. The synthesis drew on cognitive psychology, gifted education research, and neurodiversity scholarship to establish a broad profile of gifted and twice-exceptional cognitive processing characteristics.

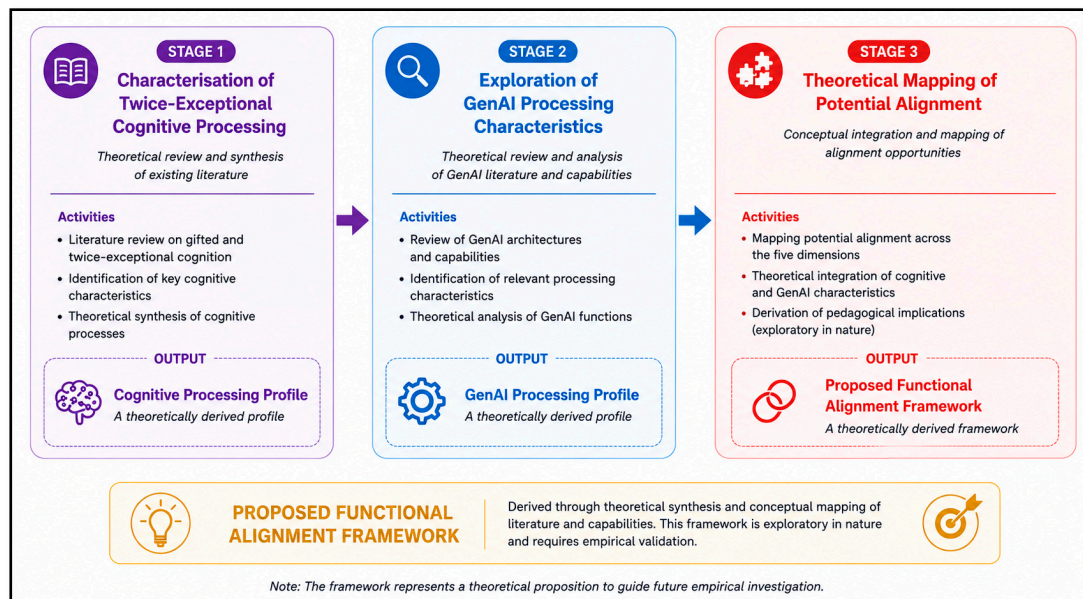


Figure 1. The sequential and iterative relationship between the three analytical stages.

Stage 2 examined GenAI’s functional patterns from an educationally accessible conceptual standpoint, not a technical one. The exploration of GenAI processing patterns and approaches identified some of the architectural and functional patterns of large language models (LLMs) and other GenAI technologies, focusing on features relevant to educational interaction: associative processing mechanisms, cross-domain knowledge integration, handling of non-linear conversational flows, and tolerance for radical topic shifts.

Stage 3 brought the preceding two stages into direct analytical dialogue to identify points of productive alignment. Mapping functional alignment involved identifying parallels between the cognitive characteristics documented in Stage 1 and the processing patterns explored in Stage 2, articulating specific points of potential alignment and their pedagogical implications. This mapping process was guided by the question: Where do gifted and twice-exceptional learners’ cognitive characteristics and GenAI’s processing patterns intersect in ways that may enable functional alignment? The theoretical foundations draw on multiple intersecting bodies of evidence.

The conceptual work builds on recent research exploring GenAI-generated pedagogical approaches for twice-/multi-exceptional learners using synthetic learner profiles (Ronksley-Pavia et al., 2025b). This research examined how GenAI platforms responded to prompts about twice-exceptional learner characteristics and the pedagogical approaches they generated. By constructing synthetic profiles grounded in empirical research on twice-exceptional cognitive processing, this methodological approach facilitated systematic exploration of GenAI’s potential role in designing strengths-based learning experiences for gifted and twice-exceptional learners without the ethical complexities and practical constraints of direct student–GenAI interaction research with vulnerable populations (James, 2024; Medicott, 2023; Ronksley-Pavia et al., 2025a). The findings revealed that pedagogical responses generated by GenAI were qualitatively different from traditional educational approaches because they engaged associative thinking approaches characteristic of many gifted and twice-exceptional learners. This research sits within a growing body of empirical work exploring educational applications of GenAI for gifted, twice-exceptional, and neurodivergent populations (James, 2024; Medicott, 2023; Ronksley-Pavia et al., 2025a; Siegle, 2024).

The functional alignment framework also draws on established theoretical scholarship across multiple disciplines. From gifted education, we synthesised research on twice-exceptionality, asynchronous development, and the interplay between potential, advanced capabilities, and learning challenges, which characterise the educational experiences of many twice-exceptional learners (Bechard, 2019; Park et al., 2018; Ronksley-Pavia, 2016; Ronksley-Pavia et al., 2019). Cognitive psychology provided foundational theories of divergent thinking and knowledge transfer (Guilford, 1968; Runco & Acar, 2019) that elucidated some thinking patterns characteristic of many gifted and twice-exceptional learners.

Special education scholarship, particularly neurodiversity-affirming approaches (e.g., Chapman, 2021; Hamilton & Petty, 2023; Rosqvist et al., 2021), informed our understanding of how deficit-based frameworks systematically disadvantage neurodivergent learners (Fatma et al., 2024; Fung, 2021; Jones & Orchard, 2024; Ronksley-Pavia, 2010). Educational technology research provided critical context for understanding how digital platforms may support or constrain differing cognitive processing approaches (Arantes, 2023; Debeer et al., 2021; Fung, 2021; Ronksley-Pavia & Neumann, 2022).

In separate yet related work, James (2024) and Siegle (2024) explored GenAI use with gifted learners, identifying potential affordances for advanced reasoning and creative problem-solving while recognising implementation challenges. Medlicott (2023) investigated GenAI applications for neurodivergent students more broadly, documenting how conversational AI interfaces reduced social-communication demands and concurrently provided adaptive scaffolding for executive function challenges.

Furthermore, multiple systematic reviews have synthesised the emerging evidence base of GenAI usage for supporting exceptional learners. A scoping literature review synthesised 47 studies examining GenAI applications across neurodivergent populations including learners with autism, ADHD, dyslexia, learning disabilities, giftedness, and twice-exceptionality (Ronksley-Pavia et al., 2025a). The review identified various consistent patterns across neurodivergent populations. GenAI's conversational interface reduced social-communication demands that many neurodivergent learners find challenging in traditional classroom settings, while its adaptive scaffolding supported personalised learning responsive to individual processing profiles. Second, GenAI's capacity to maintain conversation history provided external working memory support for learners with executive function challenges. Additionally, this review revealed significant gaps in research specifically addressing twice-exceptional learners (Ronksley-Pavia et al., 2025a).

Complementary reviews (e.g., Larkey, 2023; Lemke et al., 2024; Moraiti & Drigas, 2023) have examined GenAI for supporting neurodivergent students, identifying patterns in how GenAI provides conversational interaction, adaptive scaffolding, and external working memory support. GenAI has also been found to amplify the role of critical thinking skills and reduce reliance on prior knowledge, which is purported to promote in-depth learning (Zhao et al., 2025). However, contrary studies have suggested paradoxical impacts of GenAI, in that it reduces (and may even erode) learning skill development and critical thinking and may result in overreliance and cognitive offloading (see, for example, Gerlich, 2025; Lodge & Loble, 2026; Seung & Basham, 2026; Shukla et al., 2025).

The evolving evidence base elucidates current understandings in some GenAI educational applications for discrete diverse populations. However, it also indicates a crucial gap; despite growing scholarship separately examining GenAI usage alongside giftedness and neurodivergence, such usage with twice-exceptional learners remains under-researched. This gap is particularly concerning given that twice-exceptional learners face compounded identification and provision disparities that neither gifted education nor special education adequately address (Gilman et al., 2013; Ronksley-Pavia, 2024a; Ronksley-Pavia & Clark, 2025).

2.3. Scope and Limitations

While this article predominantly focuses on gifted and twice-exceptional learners, some principles may apply to broader neurodivergent populations. The functional alignment thesis centres on learners whose profiles include potential and/or advanced capabilities (i.e., gifted learners), and also learners who experience challenges in areas like executive function, processing speed, working memory, sensory processing, and academic skills required in formal educational provision (i.e., twice-exceptional learners). We address GenAI applications in K-12 educational contexts, with particular relevance to upper primary and secondary schooling, where student agency and independent learning become increasingly applied. Although gifted and twice-exceptional learners do not *fit* with so-called age-based developmental norms, some students may require different considerations around adult mediation and ethical safeguards for GenAI interaction; these are implications that warrant separate examination beyond the scope of this article.

However, several limitations warrant acknowledgement in framing our theorisation of the functional alignment framework for personalised learning. The framework is explicitly theoretical and exploratory in nature; it advances propositions and hypotheses that do not demonstrate causal effects and requires empirical validation through systematic research before any deterministic claims can be made. Such research could examine aspects such as user interactions, learning outcomes, longitudinal impacts, privacy and ethical implications, sustainability, safety, and differential effects across diverse learner populations. The practical applications described represent emerging practice informed by preliminary research, alongside continual, ongoing, rapid changes to GenAI platforms. These applications were not comprehensively evaluated during this current theorisation work and are outside the scope of this article.

Respective additional considerations shaped the scope of this work. The functional alignment framework draws primarily on research conducted in Western educational contexts, particularly North America and Australia. How this framework may manifest in educational systems with different cultural assumptions about giftedness, disability, twice-/multi-exceptionality, and learning remains an empirical question requiring cross-cultural research. The framework focuses specifically on LLM-based GenAI platforms. Other forms of GenAI (e.g., image generation, multimodal systems) may demonstrate different potential alignment characteristics requiring separate analysis. Furthermore, GenAI technologies are evolving rapidly, and the specific capabilities and limitations discussed reflect the current state of these technologies as of early 2026.

We also acknowledge that gifted and twice-exceptional learners experience intersecting identities involving aspects such as multiple disabilities, ethnicity, strengths, socioeconomic status variations, language variants, and other dimensions of diversity. A detailed examination of how these intersections shape GenAI interaction lies beyond the scope of this article and as such represents valuable future research opportunities.

2.4. Use of Generative AI in Article Preparation

In accordance with journal requirements for transparency regarding GenAI use, we disclose the following: During the preparation of this manuscript, the authors used Claude (Anthropic) for purposes of literature synthesis, conceptual mapping, drafting and editing assistance, and figure drafting and development. The authors critically reviewed, substantially revised, and take full responsibility for the content of this publication. GenAI was not used for data collection, analysis, or interpretation.

2.5. Ethical Considerations

The theoretical synthesis does not involve primary data collection with human participants. The empirical research informing the theorisation of the framework comprised systematic literature reviews, relevant published research, and review of other published scholarship (e.g., grey literature). No direct data were collected from human participants for this theoretical synthesis.

3. Functional Alignment: A Conceptual Framework

This section articulates the functional alignment framework across three subsections: characterising gifted and twice-exceptional cognitive characteristics; exploring relevant GenAI processing patterns; and advancing the functional alignment thesis and its proposed pedagogical implications.

3.1. Cognitive Characteristics of Gifted and Twice-Exceptional Learners

Gifted and twice-exceptional learners exhibit distinctive cognitive processing characteristics; for twice-exceptional learners, these combine advanced capabilities, or potential, with *challenges* in the context of formal educational provision (Baum & Olenchak, 2021; Maddocks, 2020; Rizzo et al., 2025; Ronksley-Pavia, 2015, 2020; Ronksley-Pavia & Ronksley-Pavia, 2023). These processing challenges arise in part because formal educational provision typically assumes that students use analytic sequential processing to convert the teaching information to knowledge in a linear, stepwise way, an assumption that does not reflect the cognitive profiles of many twice-exceptional learners (Munro, 2019). Such challenges are less likely to arise when students have the opportunity to self-direct and manage their own learning interactions with content, particularly in contexts beyond the classroom (Munro, 2019).

Six characteristic features of many gifted twice-exceptional cognition are particularly relevant to the functional alignment framework, with each frequently misunderstood in conventional educational contexts. Gifted learners characteristically use non-linear thinking processes, making rapid conceptual connections that may appear tangential or unfocused to observers expecting sequential, hierarchical reasoning (Silverman, 2005). These cognitive characteristics reflect associative thinking that simultaneously connects ideas across multiple dimensions, suggesting a sophisticated cognitive process, which, for twice-exceptional learners in particular, can be frequently misinterpreted as disorganisation or lack of focus (see Section 3.2 for an illustrative example of this in practice).

Such non-linear movement represents a strength when appropriately supported, facilitating creative problem-solving, innovative synthesis, and the recognition of patterns across disparate domains (Reis et al., 2021). The interpretations of the teaching that students form have been described as “intuitive theories of action” (Munro, 2019, p. 487), generated in part by high-level inferring and evaluation and analogical thinking (Munro, 2019, 2024). They usually contain possible ideas and relationships that were not mentioned in the teaching information. In other words, they are semantically richer than a direct interpretation of the teaching information.

They are intuitive because, at the point of forming them, the student has not had the opportunity to evaluate them. They are theories of action because the students usually know how to evaluate and validate them. They are also generally unexpected by the teacher. However, conventional pedagogical structures that privilege linear, sequential development often interpret such thinking approaches as *disorders* or *deficits* requiring *correction*. They are positioned as inattention, lack of focus, or inability to follow directions (Ronksley-Pavia, 2015). They are a consequence of a fundamental mismatch between the learner’s cognitive processing and the expectations of the instructional environment.

Many gifted and twice-exceptional learners demonstrate advanced capacities for recognising patterns across seemingly disparate knowledge domains and transferring understanding from one context to apparently dissimilar contexts, a capability that reflects what [Salomon and Perkins \(1989\)](#) term “high-road transfer” (p. 115) and [Munro \(2019\)](#) calls “fluid analogistic thinking” (p. 18); this is the abstraction of principles that can be applied flexibly across contexts, *not solely* application of learned procedures. For instance, a twice-exceptional learner might recognise structural similarities between mathematical functions, musical composition, and narrative arcs in literature, or spontaneously apply principles from biology to solve engineering problems. This cross-domain pattern recognition represents sophisticated cognitive processing, yet educational environments organised around discrete subject boundaries may not recognise or support these connections ([Runco & Acar, 2019](#)).

Related to this non-linear thinking, gifted and twice-exceptional learners often demonstrate comfort with apparent topic discontinuity, which is the ability to move between conceptual frameworks, explore tangential connections, and return to original threads without losing conceptual coherence ([Cross et al., 2014](#)). For twice-exceptional learners, this is often despite working memory issues. What may appear to observers as disconnected topic-switching or inability to maintain focus may in actuality represent the learner’s exploration of associative networks, testing connections and building understanding through lateral movement, *not just* linear progression.

These characteristics are often misinterpreted as a deficit when they co-occur with executive function challenges common for many twice-exceptional learners. For instance, a student with ADHD and ASD, along with high verbal ability, might articulate complex, multi-layered arguments that jump between concepts, making sophisticated connections that may be difficult for listeners to follow in real time ([Ronksley-Pavia, 2024b](#)).

Many gifted and twice-exceptional learners also demonstrate preferences for systems-level thinking; understanding phenomena in terms of complex, interconnected relationships, not as isolated components ([Gilger & Hynd, 2008](#)). Such cognitive orientation supports sophisticated analysis but can create challenges in educational contexts that expect a step-by-step demonstration of reasoning or explicit articulation of intermediate steps. For twice-exceptional learners, this systems-level thinking may occur at different speeds, or pacing across cognitive processes.

The asynchronous profiles characteristic of both gifted and twice-exceptional learners may mean that sophisticated conceptual insights may rapidly emerge through associative pathways, yet, for twice-exceptional learners, articulating or demonstrating these insights through sequential explanations or written work may proceed at a seemingly slower pace ([Silverman, 2017](#)). A student may arrive at conclusions or insights that seem to “come from nowhere” to observers who have not followed the same associative pathway. Teachers may interpret this as guessing, lack of understanding, or inability to show working out (e.g., in mathematics), when in actuality, it may reflect divergent thinking, pattern recognition, and a mismatch between speed of insight and speed of production.

The asynchronous cognitive profiles characteristic of many gifted and twice-exceptional learners often include significant disparities between advanced reasoning capabilities and processing constraints for twice-exceptional learners, particularly in the areas of working memory and processing speed ([Silverman, 2017](#)). Working memory limitations in regular classrooms represent a common challenge for twice-exceptional learners whose advanced reasoning abilities may be constrained by issues with simultaneously holding multiple elements of information while manipulating them ([King, 2022](#); [Ronksley-Pavia, 2024b](#); [Silverman, 2024](#)). A twice-exceptional student might grasp complex conceptual relationships and generate sophisticated insights yet struggle to maintain these ideas in working memory

long enough to coherently articulate them, organise them into written form, or integrate them with additional information.

This creates frustration when intellectual capability significantly exceeds the capacity to demonstrate that capability through conventional means that assume adequate working memory support. Variations in processing speed can create similar challenges. Many twice-exceptional learners may demonstrate rapid conceptual insights and conclusions through non-sequential, associative pathways, but require extended time for tasks involving sequential processing, written production, or detailed demonstration of their reasoning. Educational contexts that systematically privilege consistent processing speed across all tasks disadvantage those learners whose cognitive profiles reflect these variations, thus positioning slower processing as a *lack of capability* while overlooking the coexistence of advanced reasoning alongside challenges with slower production within the same learner.

3.2. Some Processing Patterns of Generative Artificial Intelligence

In exploring GenAI processing patterns, our focus was on conceptual understanding that is accessible to educational practitioners, not on technical specifications such as neural network architectures, tokenisation, or training algorithms. Key questions guiding this exploration included how GenAI can engage with topic discontinuity without redirecting learners and how it can maintain conversation history as a form of external working memory. LLMs and other GenAI technologies exhibit processing characteristics that, while mechanistically distinct from human cognition, demonstrate functional similarities relevant to educational interactions. Understanding these patterns assists in elucidating why and how GenAI may function as a compatible interactive platform for gifted and twice-exceptional learners.

GenAI systems based on transformer architectures do not use sequential processing. They process information through attention mechanisms that simultaneously create associations across the entire input context (i.e., prompts given by the user) (Brown et al., 2020). Transformer architectures represent the technical framework underlying most current LLMs, enabling them to process information associatively through what are termed *attention mechanisms* (Gupta, 2025). When responding to a prompt, these systems activate complex networks of related concepts, drawing connections across domains based on patterns learned from vast textual corpora.

The attention mechanism of associative processing means that GenAI can make connections between disparate topics, recognise patterns across contexts, and generate responses that synthesise information from countless domains. Functionally, this means that when a learner asks a GenAI system about photosynthesis, for example, and then spontaneously pivots to questions about exoplanet atmospheres, the system can engage with this conceptual transfer without requiring linear, sequential development.

The associative architecture that facilitates GenAI's flexibility means that such systems can engage productively with the associative cognitive characteristics of many gifted and twice-exceptional learners. It is important to understand that GenAI systems do not *think* in any human sense; they employ complex computational processes, which are fundamentally different from human cognition. However, when gifted and twice-exceptional learners make connections across disparate concepts, move non-linearly between topics, or explore tangential relationships, GenAI's processing architecture can follow and respond to these patterns without requiring redirection into sequential, linear formats. This capacity to engage with, and not constrain gifted learners' cognitive approaches, distinguishes GenAI from educational technologies and pedagogical structures that expect and respond to linear cognition and progression.

GenAI systems demonstrate significant capacity for integrating knowledge across traditionally separate domains, drawing on patterns learned from diverse text sources to make connections between fields. For example, when prompted to explain biological concepts using economic metaphors, or to identify parallels between historical events and contemporary situations, GenAI systems can generate coherent responses that draw on cross-domain pattern recognition.

This capacity does not necessarily require explicit instruction or prompting to make interdisciplinary connections. Instead, the system's architecture enables fluid movement between knowledge domains, recognising structural similarities and transferable principles without being constrained by conventional subject boundaries. This matches the fluid analogistic reasoning used by many gifted learners to generate their intuitive interpretations. For gifted and twice-exceptional learners whose cognition operates across traditional disciplinary silos, this represents a potential interactive platform (thinking partner) (Kiss & Quinn, 2025; Ronksley-Pavia, 2025a, 2025b) that does not constrain to single-topic boundaries or linear thought processes, but instead can connect with their cognitive orientations.

Unlike many conventional educational technologies that expect linear, structured interaction, GenAI systems can engage productively with non-linear conversational flows. A learner can shift between topics, explore tangential questions, return to earlier threads, and make lateral connections without the system interpreting these actions as problematic errors or necessitating explicit topic management.

Critically, GenAI does not pathologise topic discontinuity; there is no built-in "stay on task" directive and no interpretation of conceptual leaping as a lack of focus. The systems unassumingly respond to what the learner inputs and engages with, maintaining conversational coherence across topic transfers and supporting exploration through seemingly disparate domains. This apparent neutrality regarding linear versus non-linear interaction represents a substantial departure from many educational technologies and pedagogical approaches.

Most educational technologies are designed around linear progressions, moving sequentially through content modules, completing prerequisites before advancing, or following predetermined pathways. Similarly, traditional pedagogical approaches expect learners to stay focused on a task, follow lesson sequences, and demonstrate learning through step-by-step and age-based progression.

In contrast, GenAI's capacity to productively engage with non-linear exploration supports interaction patterns that accommodate and build on how many gifted and twice-exceptional learners process and explore information. GenAI systems rapidly generate responses and demonstrate flexibility in conceptual framing, able to move between levels of abstraction, alternative explanatory frameworks, or different modes of engagement based on a user's interaction patterns. This responsiveness accommodates the rapid conceptual insights that gifted learners may demonstrate in domains where their interests, knowledge, and advanced capabilities are strongest (i.e., areas of strength), avoiding the pacing mismatches that often occur when instruction cannot keep pace with the learner's thinking.

Beyond these processing characteristics, GenAI systems provide functional features that can address common processing constraints faced by twice-exceptional learners. As noted earlier, GenAI can serve as external working memory, maintaining conversation history and context that learners can reference without needing to simultaneously hold all information in their working memory.

When a learner engages in complex reasoning that generates multiple ideas, connections, or questions, GenAI preserves this information across the conversation, allowing the learner to revisit earlier points, build on partial ideas, or integrate emerging insights

without the working memory burden of simultaneously maintaining all elements. This external scaffolding separates a student's reasoning capability from their working memory capacity, supporting engagement of cognitive complexity without being constrained by processing limitations.

Furthermore, GenAI interaction operates without inherent time pressure, available when the learner is ready to engage and maintain conversational coherence across temporal gaps. It never gets tired or bored, although a user may encounter context window constraints and fixed-time usage constraints, especially with some of the free LLMs available. A learner can take time to formulate prompts and responses, process information at their own pace, or return to conversations after breaks without being disadvantaged for inherent characteristics such as cognitive breaks or slower processing speed. This temporal flexibility can accommodate the asynchronous pacing profiles characteristic of many gifted and twice-exceptional learners, potentially eliminating the mismatch between their capability and time constraints inherent to conventional educational contexts (e.g., timed assessments, teacher-paced instruction, and fixed lesson periods).

Moreover, how a twice-exceptional learner interacts with GenAI systems can be flexible, not solely reliant on typing or textual language skills for inputting prompts. Many GenAI platforms support voice input, permitting learners to articulate their thinking verbally without the motor demands of typing or the cognitive load of translating thoughts into written text. For twice-exceptional learners with dyslexia, dysgraphia, or other writing challenges, this multimodal interaction creates opportunities to engage their advanced reasoning capabilities without being constrained by written language production challenges. For instance, a student with dysgraphia and exceptional verbal reasoning can explore complex conceptual relationships through spoken interaction, articulating sophisticated ideas that might be difficult to express through typed text.

Likewise, learners with dyslexia can receive information aurally through text-to-speech functions, engaging with content without the processing demands of reading. Even when learners choose to type, GenAI systems demonstrate remarkable tolerance for spelling errors, processing prompts with multiple misspellings without requiring correction or perfect orthography. Twice-exceptional learners who may have dyslexia or other challenges impacting typing or spelling can focus cognitive resources on articulating complex ideas without the additional burden of ensuring accurate spelling. A twice-exceptional learner can type a misspelt prompt like "wht is the relashunship between ecosistems and climat chang" and GenAI will interpret the intended meaning and respond substantively to the conceptual question, not to the spelling errors.

Learners also retain control over when and how spelling support is provided. They can request corrections on demand (e.g., "Please check my spelling") or configure persistent instructions so that the GenAI automatically offers spelling suggestions alongside responses. This flexibility in input and output modalities means twice-exceptional learners can interact through their cognitive strengths while bypassing challenges that are often systematically privileged in conventional text-based learning environments.

3.3. The Functional Alignment Thesis

The parallels documented in the preceding sections suggest a functional alignment between GenAI processing patterns and broad cognitive characteristics of some gifted and twice-exceptional learners. While the underlying mechanisms are fundamentally different, computational processes versus human cognition, we identify this alignment across five key dimensions, presented in Table 1.

Table 1. Examples of proposed functional alignment between gifted and twice-exceptional learners and GenAI.

Cognitive Dimension	Gifted and Twice-Exceptional Learners	GenAI Processing	Pedagogical Implication
Conceptual Movement	Non-linear, associative thinking; rapid connections across ideas	Associative processing through attention mechanisms; simultaneous activation of related concepts	GenAI can engage with associative thinking patterns, responding to conceptual connections
Knowledge Integration	Cross-domain pattern recognition; transfer of principles across contexts	Integration of knowledge across domains; recognition of structural similarities	GenAI can support cross-domain thinking without disciplinary constraints
Topic Continuity	No issues with discontinuity; conceptual leaping; lateral exploration	Tolerance for non-linear conversational flow; no “stay on task” directive	GenAI engages with topic shifts as acceptable exploration
Pacing and Temporal Flexibility	Asynchronous profile: rapid insights in some areas, slower processing in others; need for self-paced engagement	Removes time pressure; available when learner is ready; maintains conversation across time	GenAI eliminates pacing mismatches between capability/potential and processing speed
Working Memory	Complex reasoning may be constrained by working memory capacity; struggle to hold multiple elements while manipulating them	Acts as external memory scaffold; maintains context and prior information	GenAI can compensate for working memory limitations without reducing cognitive complexity

Note: Table 1 presents some potential functional alignment in processing patterns, not equivalence in cognitive mechanisms. GenAI employs computational processes fundamentally different from human cognition.

The functional alignment thesis fundamentally positions GenAI differently than conventional assistive technologies or accommodations. Traditional educational accommodations for twice-exceptional learners typically aim to compensate for perceived deficits, such as by providing additional time, reducing task complexity, or offering organisational support (Assouline et al., 2006; Silverman, 2005). While such accommodations can be valuable, they can position the learner’s cognitive processing as problematic and in need of intervention.

In contrast, the functional alignment framework posits that GenAI may function as an interactive platform that engages with some of the learner’s cognitive characteristics. GenAI platforms may provide opportunities for gifted and twice-exceptional students to investigate and evaluate the intuitive theories they form and to convert them to a validated understanding of topics. Students can use their self-learning and directing capacity to steer a path through the information network that takes into account their unique understanding at any time. GenAI permits interactions with relevant teaching information that are less likely in regular teaching. When a student engages in rapid topic shifts, makes unexpected cross-domain connections, or processes information non-linearly, GenAI responds to these patterns without judgement or redirection. The learner experiences validation and engagement, not correction or just accommodation.

Perhaps most significantly, the theorised functional alignment between gifted and twice-exceptional learners and GenAI offers validation of cognitive processing characteristics that educational systems have long pathologised. When a GenAI system can engage productively with associative, non-linear thinking, apparent topic discontinuity, and rapid conceptual movement, this represents legitimate processing modes, not deficits requiring correction, thus challenging deficit-based interpretations of neurodivergent cognition. The parallel suggests that these cognitive characteristics represent legitimate modes of pro-

cessing that can be highly productive when appropriately supported. GenAI's capacity to productively engage with these characteristics demonstrates their viability as legitimate thinking approaches.

Figure 2 illustrates how the five dimensions of functional alignment can operate as an integrated framework that may reconceptualise educational approaches, potentially fundamentally transforming deficit-based approaches into strengths-based partnerships that can actualise learner potential. The pedagogical implications of this framework for how learning experiences are designed, for teacher capability, and for reconceptualising gifted education as inherently inclusive are explored in the discussion that follows.

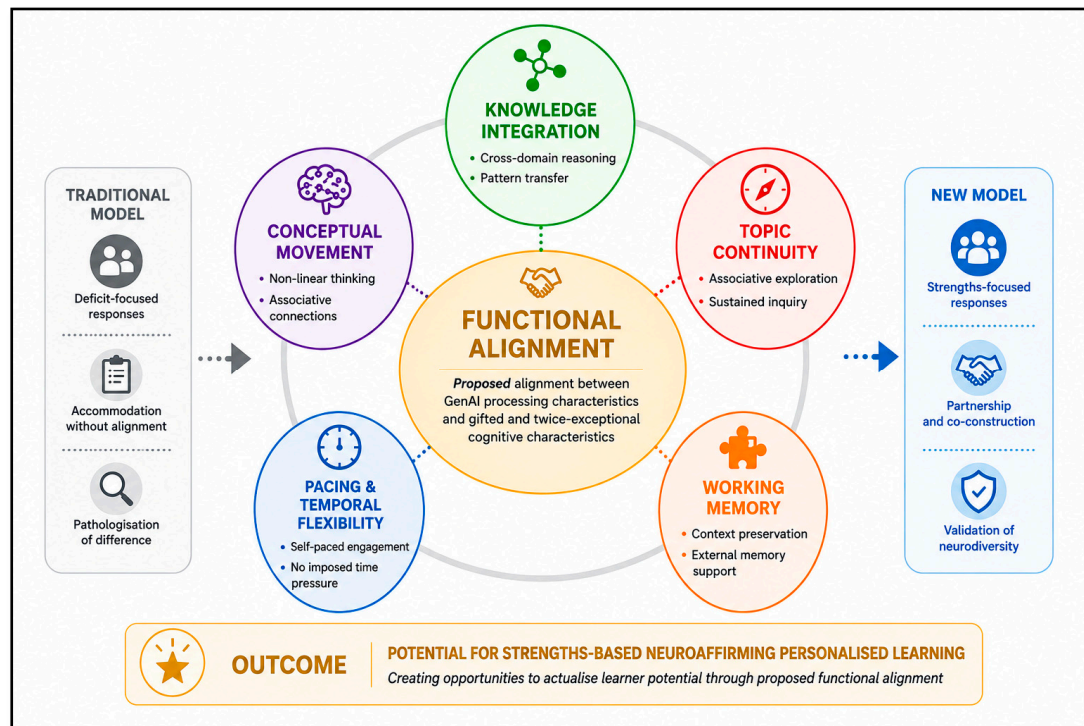


Figure 2. The functional alignment framework.

Taken together, the five dimensions of functional alignment suggest that GenAI may offer something qualitatively different from conventional educational accommodation: not compensation for apparent deficits, but engagement drawing on cognitive characteristics that formal educational provision has historically pathologised. When associative thinking leads to engagement instead of being redirected, when topic discontinuity is treated as legitimate exploration, not as a behavioural problem, and when working memory challenges are scaffolded without reducing intellectual complexity, twice-exceptional learners may experience their cognitive processing as a strength. This reframing is central to the functional alignment thesis and its implications for strengths-based, neuroaffirming educational practice, which are explored in the following discussion.

A theoretically rigorous discussion of the functional alignment framework requires explicit acknowledgement of the conditions under which the proposed alignment may not hold or may produce unintended consequences. First, GenAI systems can generate plausible but factually incorrect explanations presented with apparent confidence; this is known as *hallucination* (Özer, 2024). For example, when gifted and twice-exceptional learners are exploring advanced content, the teacher may not always be able to detect GenAI-produced errors, and students themselves may not yet have sufficient domain knowledge to evaluate the accuracy of sophisticated-sounding responses. This underscores the importance of

students developing critical thinking skills alongside their GenAI use and of teachers knowing when and where to seek specialist subject expertise (e.g., subject-specialist colleagues, faculty heads, university discipline experts, or curated curriculum resources).

Second, GenAI's tolerance for topic discontinuity and its adaptability carry the chance of overaccommodation, removing the productive struggle and cognitive effort that are pedagogically necessary for deep learning, development of critical thinking, and intellectual challenge (Seung & Basham, 2026; Shukla et al., 2025). Third, GenAI systems trained predominantly on English-language data from Western cultural contexts may produce culturally biased outputs or not reflect diverse epistemologies, potentially reproducing stereotypes and neuronormative bias (Lemke et al., 2024), which has direct implications for gifted and twice-exceptional learners from non-dominant cultural backgrounds.

Functional compatibility alone does not ensure educational benefit. The pedagogical value of GenAI interaction depends on how it is designed, implemented, and integrated within broader learning experiences. Optimal learning is more likely to occur when an individual's cognitive approaches match the opportunities for learning provided by the teaching. GenAI platforms may offer learning interactions that are largely far less readily available in typical classrooms, creating opportunities for gifted and twice-exceptional students to engage their cognitive strengths instead of being constrained by the assumptions that often pervade conventional provision.

While the functional alignment framework offers important insights, some limitations exist. GenAI systems are not human minds, and functional similarities in processing patterns should not be interpreted as equivalent cognitive mechanisms. Critically, GenAI lacks consciousness, intentionality, embodied experience, and the social-emotional dimensions of human cognition. Additionally, the framework specifically applies to certain GenAI architectures, particularly LLMs, and may not generalise to other AI technologies.

Importantly, not all gifted or twice-exceptional learners demonstrate these characteristics, and the five alignment dimensions may manifest differently across diverse gifted and twice-exceptional profiles. For instance, students whose profiles are characterised primarily by processing speed challenges may benefit from the temporal flexibility affordances of GenAI interaction, while students whose profiles involve primarily working memory challenges may gain benefit from GenAI's capacity to function as external working memory. Conversely, students without significant executive function challenges may not need the same scaffolding requirements, and for some gifted learners, the removal of pacing constraints may be less relevant than GenAI's capacity for cross-domain knowledge integration. The framework is therefore not uniformly applicable across all gifted or twice-/multi-exceptional learners, and teacher judgement remains essential regarding which dimensions of alignment may be most relevant for a particular student's profile.

4. Discussion

With the functional alignment framework established, this section explores what it may mean in practice for how learning experiences are designed, what teachers should know and be able to do, and how gifted education might be reconceptualised as inherently inclusive and responsive to neurodivergent learners.

4.1. GenAI as a Mediating Platform for Personalised Learning

GenAI's theorised functional alignment with aspects of gifted and twice-exceptional learners' cognitive profiles creates affordances for personalised learning that may extend well beyond what conventional accommodations or educational technologies can offer through leveraging GenAI platforms.

Recent research using synthetic twice-exceptional learner profiles demonstrated that appropriately prompted GenAI can generate approaches that engage advanced capabilities while providing scaffolding for challenges (Ronksley-Pavia et al., 2025b). Students who characteristically engage in complex synthesis across domains, who make unexpected connections between seemingly disparate areas of knowledge, or who explore questions that extend beyond curriculum boundaries may find that GenAI advances a conversational partner that can follow these intellectual pathways without requiring them to wait, to simplify, or to conform to predetermined linear sequences. A student exploring climate change, for instance, can fluidly move between scientific mechanisms, economic implications, political dimensions, and ethical considerations, with GenAI engaging across these domains without imposing artificial separation or sequential development. The following vignette (Box 1) illustrates how these theoretical propositions might translate into classroom practice. This vignette is provided as an illustrative example grounded in the functional alignment framework; it is theoretical and intended to make the framework's pedagogical implications concrete for practitioners.

Box 1. Vignette: Teacher-Scaffolded GenAI Engagement.

A Grade 8 student with ADHD and ASD has exceptional problem-solving skills and a passionate interest in science, yet their associative, non-linear thinking consistently moves beyond what current pedagogical approaches can accommodate.

During a biology unit on photosynthesis, the student's teacher designs a GenAI-mediated learning experience aligned with the unit, inviting the student to explore photosynthesis using their own questions as the starting point. The student opens a GenAI conversation with a question: "If photosynthesis converts light energy into chemical energy, could a similar process work under a different star's light spectrum, like a red dwarf?" Starting from curriculum knowledge but immediately extending it into astrophysics, a conceptual movement characteristic of twice-exceptional reasoning is made. GenAI directly engages with the question before the student pivots to whether plants on other planets could photosynthesise differently given different atmospheric conditions; this is topic continuity in action, with GenAI following the associative leap without redirection.

The student then asks how early Earth's atmosphere changed as photosynthesis evolved, connecting exoplanet thinking back to Earth's own evolutionary history through cross-domain pattern recognition. The student draws the whole chain together into questions about terraforming Mars, which is knowledge integration across biology, atmospheric science, planetary geology, and aerospace engineering, the kind of systems-level synthesis that conventional single-subject instruction rarely accommodates. The student is able to pursue each idea at their own pace, with GenAI maintaining the full conversation so no thinking is lost, supporting external working memory.

Reviewing the conversation log, the teacher finds a depth of conceptual understanding embedded within a systems-level exploration that written classwork would likely never have demonstrated. The teacher invites the student to share their findings with the class, positioning their work as an example of sophisticated scientific reasoning.

As Figure 3 illustrates, the vignette demonstrates simultaneous operation of all five dimensions of the functional alignment framework: associative thinking was extended, cross-domain connections were made without subject-area constraints, topic shifts were followed without correction, pace was self-directed, and working memory was scaffolded without reducing cognitive complexity.

The opportunity to engage, instead of constraining interdisciplinary thinking to disciplinary boundaries, represents strength amplification in its most fundamental sense. GenAI's apparent capacity to engage with the associative processing patterns characteristic of many gifted and twice-exceptional learners creates particular affordances for divergent exploration and creative problem-solving. Instead of prematurely converging on expected answers or conventional solution pathways, learners can explore multiple approaches, test unconventional ideas, and follow associative connections that may lead to innovative

insights. GenAI's tolerance for non-linear exploration means that thinking that appears tangential or unfocused to observers expecting sequential reasoning is instead engaged and extended. This is particularly significant for learners whose cognitive processing may have been repeatedly misinterpreted as off-task or *unfocused* when in actuality it reflects authentic intellectual engagement with complex, interconnected ideas.

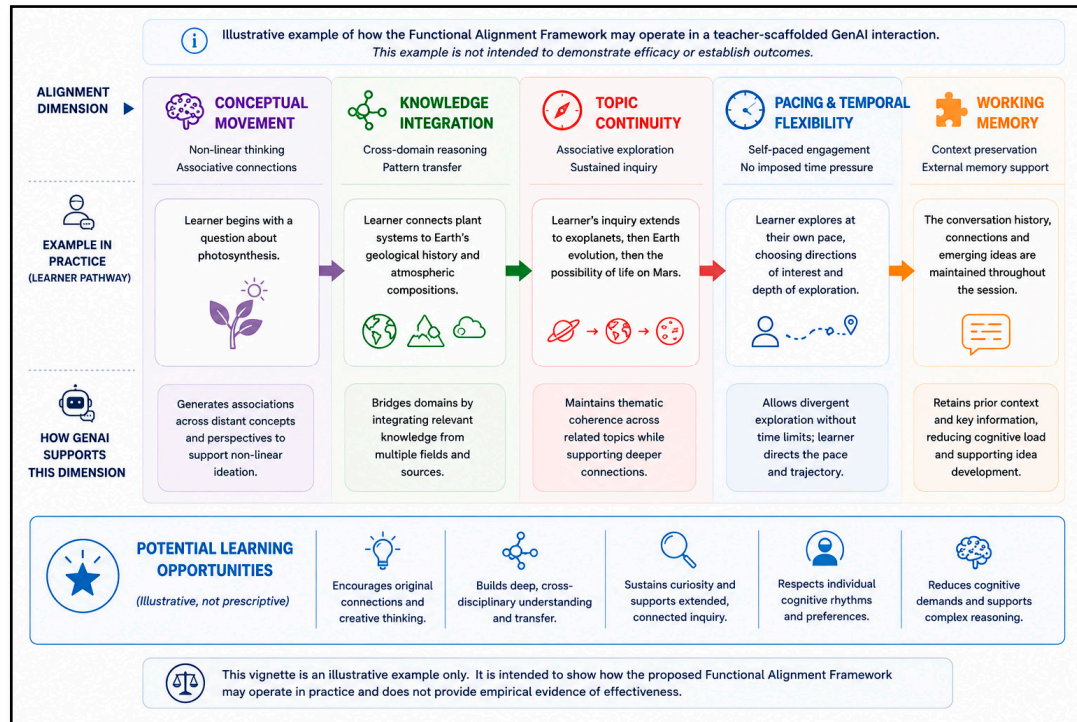


Figure 3. Application of the functional alignment framework in the vignette.

While amplifying strengths, GenAI can simultaneously provide scaffolding for some common challenges faced by twice-exceptional learners without positioning their cognitive processing as requiring only interventions. Many twice-exceptional learners experience executive function challenges. These include difficulties with organisation, task initiation, planning, and working memory, which co-occur with their potential and advanced capabilities (Assouline et al., 2006; Ronksley-Pavia, 2024b; Silverman, 2024). GenAI can provide conversational support that breaks complex tasks into manageable components, assist in organising thinking, or provides memory aids, all while engaging with the learner's cognitive sophistication. For example, a student with ADHD and advanced verbal reasoning can receive organisational scaffolding without intellectually simplifying content, which is support that occurs in the executive function domain, not in the conceptual complexity of the work itself.

Similarly, twice-exceptional learners who have strong conceptual understanding but have difficulty with written or verbal expression can use GenAI as an externalisation partner, working through ideas conversationally in ways that support articulation of sophisticated thinking that they may struggle to independently express (Ronksley-Pavia, 2024b). Such scaffolding occurs in the production and externalisation of thinking, supporting learners to articulate, structure, and communicate ideas, while the cognitive engagement remains at the learner's advanced level. GenAI assists with translating sophisticated internal reasoning into external expression without reducing the intellectual complexity of the work.

Likewise, working memory limitations that commonly occur in twice-exceptional profiles can be supported through GenAI's capacity to function as external working memory.

One reason why the restrictions arise in regular provision is because the teaching often assumes that students have automatised a range of skills, such as phonics, grammatical conventions, and implementing motor sequences. For students who have automatised such skills, they require little working memory space. However, many twice-exceptional students may not have automatised these foundational skills, and because of this, they often need to invest considerable working memory space in applying them. As a consequence, at that time, they have less space to allocate to other aspects of cognitive activity, and they may forget or lose track of some of the more complex or sophisticated ideas they were thinking about. There is also usually a time consideration here; the skills need to be rapidly accessed and implemented, which impacts the quality of the knowledge the students form, their identity as a learner, their self-efficacy, and their preparedness to engage in learning (Barber & Mueller, 2011; Townend et al., 2014).

GenAI platforms can scaffold the use of working memory in a range of ways that support twice-exceptional learners. When a twice-exceptional student generates multiple sophisticated ideas, makes complex connections, or develops layered arguments, GenAI retains this information across the conversation, supporting the learner to build on earlier thinking without the cognitive load of simultaneously holding all elements in working memory. The student can return to partially formed ideas, integrate new insights with earlier observations, or track multiple threads of reasoning without the working memory burden that often constrains demonstration of their actual reasoning capabilities. This scaffolding occurs in the memory domain while cognitive complexity remains at the learner's advanced level, separating thinking quality from working memory constraints.

The temporal flexibility of GenAI interactions addresses another common dimension of twice-exceptional asynchrony, the mismatch between rapid conceptual insights and slower processing speed for production tasks. GenAI can remove inherent time pressure, supporting learners to engage at their own pace without disadvantage for processing speed variations. A student can take time to formulate complex responses, process information deeply instead of superficially, or return to conversations after breaks because GenAI maintains conversational coherence across these temporal gaps. This eliminates the pacing mismatch that often characterise twice-exceptional learners' educational experiences (Park et al., 2018; Ronksley-Pavia, 2016), where they oscillate between frustration with instruction paced too slowly for their conceptual processing and challenges with time-pressured assessment that frequently privileges processing speed over quality of reasoning.

The functional alignment framework posits that when gifted and twice-exceptional learners interact with GenAI, they may develop a deeper, more interconnected understanding through exploring associative connections without being constrained to prescribed linear sequences (Ronksley-Pavia et al., 2025b). As discussed in Section 3.3, this engagement offers validation of cognitive approaches that educational systems have long pathologised, which is a distinction with significant implications for gifted and twice-exceptional learners' academic self-concept and engagement. These theoretical propositions advanced in the functional alignment framework capture something pedagogically significant about how GenAI may function as a mediating platform that engages with and validates gifted and twice-exceptional, neurodivergent cognition. The learner's thinking is engaged on its own terms, not being constantly redirected toward neurotypical processing patterns, creating space for authentic intellectual collaborations that, for twice-exceptional learners, are not deficit-focused accommodations.

4.2. Teacher Capability, GenAI Fluency, and Professional Learning

Realising GenAI's transformative potential for gifted and twice-exceptional learners requires substantial teacher capability development that extends well beyond basic famil-

ilarity with GenAI systems (Lemke et al., 2024; Brossi et al., 2023). Existing frameworks for teacher AI capability tend to emphasise what might be termed GenAI literacy. They include operational skills and technical knowledge such as understanding how to access platforms, formulate prompts, and interpret outputs (Lemke et al., 2024). While necessary, such operational knowledge is fundamentally insufficient for supporting gifted and twice-exceptional learners in leveraging GenAI as an interactive platform grounded in functional alignment principles.

We propose GenAI fluency as a more substantive construct that encompasses integrated understandings across four essential domains: technical knowledge of GenAI capabilities and limitations; pedagogical judgement about when and how to integrate GenAI into learning experiences; deep understanding of giftedness and learner neurodivergence; and deep knowledge of individual learners. Critically, GenAI fluency requires simultaneous recognition that twice-exceptional profiles vary significantly between individual students sharing the same disability categorisations and within individual students across different contexts, activities, and time, as do gifted learner profiles.

In practice, GenAI fluency requires competence across four minimum operational components. First, prompt design, which is the capacity to design LLM prompts that are responsive to a specific learner's cognitive profile. For example, designing open-ended prompts that invite associative exploration instead of closed questions that may constrain it, as illustrated in the vignette. Second, privacy-aware practice: understanding data privacy implications of student–GenAI interactions, including what data is stored, how it may be used, and how to explain to students and families about how GenAI is used in the classroom.

Teachers need to comprehend at a conceptual level how GenAI systems process information, not in terms of implementation details but sufficiently to understand why these systems can productively engage with non-linear thinking, cross-domain connections, and apparent topic discontinuity. Without this understanding, teachers likely cannot recognise or leverage the functional alignment that may make GenAI particularly compatible for gifted and twice-exceptional learners' cognitive characteristics. Equally important, teachers need pedagogical fluency to make informed judgments about when GenAI interaction supports learning and when it does not, how GenAI-mediated experiences complement instead of replace other pedagogical approaches, and how to design learning experiences where GenAI functions as an interactive platform, not solely as a content delivery mechanism.

Perhaps most critically, GenAI fluency requires a deep understanding of giftedness, twice-exceptionality, and neurodivergence that moves decisively beyond deficit-based conceptualisations. Teachers cannot leverage the framework without recognising neurodivergent cognition as having legitimate, productive variations, not pathologised through an intervention-only lens. This means, for example, understanding how twice-exceptional learners' cognitive profiles combine advanced capabilities with significant challenges, why behaviours that appear off-task or distracted may reflect productive cognitive engagement, how executive function challenges interact with intellectual capabilities, and the ways that conventional systemic and pedagogical structures disadvantage twice-exceptional learners (Ronksley-Pavia & Clark, 2025). Without this foundational understanding, teachers risk using GenAI in ways that reinforce instead of disrupt deficit-based approaches, perhaps employing GenAI primarily to keep students on task or to simplify content instead of engaging students' cognitive potential and respecting their associative thinking approaches.

The functional alignment framework also requires teachers to fundamentally conceptualise GenAI differently from many other educational technologies. Instead of positioning GenAI as a platform for delivering content, checking understanding, or managing behaviour, teachers should understand GenAI as a potential interactive system for learners

(and teachers themselves), one that may engage with cognitive processing characteristics that conventional approaches struggle to accommodate. This positioning moves the design focus from using GenAI for content transmission to creating learning experiences where GenAI acts as a conversational partner for exploration, synthesis, deep questioning, and deep understanding.

Instead of prescribing specific uses or constraining exploration, GenAI may centre student agency, supporting learners in developing their own productive patterns of GenAI interaction. It also clarifies the integration between GenAI-mediated learning and human teaching, recognising that teachers provide the social-emotional support, relational connections, ethical guidance, and nuanced judgement that AI fundamentally cannot replicate, meaning that GenAI functions as complementary to, not as a replacement for, human educators.

Developing this level of fluency has significant implications for both initial teacher education (ITE) and in-service professional learning. ITE programmes should integrate understanding of neurodiversity, giftedness, twice-/multi-exceptionality, and GenAI affordances in fundamentally connected, not merely additive ways, moving beyond separate programmes in special education and educational technology toward teacher preparation that fundamentally addresses responsive practice with neurodivergent learners and technological mediation as inseparable dimensions of teaching capability.

In-service professional learning should support practising teachers in developing GenAI fluency through sustained engagement instead of the often brief workshops or one-off training sessions. Communities of practice focused on GenAI implementation with gifted and twice-exceptional learners, action research examining GenAI use in specific educational contexts, collaborative development of pedagogical approaches grounded in functional alignment principles, and ongoing access to expertise in giftedness, twice-exceptionality, and educational technology. These suggestions represent more promising approaches than conventional professional development models that frequently emphasise information transmission over capability building.

4.3. Disrupting Barriers and Reconceptualising Educational Futures

Three longstanding barriers in gifted and twice-exceptional education are directly implicated by the functional alignment framework: gatekeeping identification processes, the impracticality of authentic personalised learning at scale, and the persistence of deficit-based instead of strengths-based provision. Traditional approaches to gifted education have relied heavily on formal identification processes that act as gatekeepers to programming, systematically disadvantaging twice-exceptional learners whose strengths may be masked by processing challenges or whose profiles do not fit narrow definitions of giftedness (Assouline et al., 2010; Ronksley-Pavia & Clark, 2025).

GenAI-enabled personalisation creates possibilities for responsive programming irrespective of an individual student's formal identification status. When teachers design learning experiences where GenAI serves as an interactive platform, available to all students, with the capacity to engage complexity at whatever level the learner brings, the question shifts from "which students should access advanced content?" to "how can we support each student's cognitive capabilities?" This does not eliminate the value of identification for accessing specialised services, but it reduces gatekeeping functions that currently limit educational responsiveness, for example, to twice-exceptional learners who may never receive formal identification despite having exceptional potential.

One persistent challenge in gifted and twice-exceptional education has been the difficulty of providing authentically personalised learning experiences within traditional classrooms and age-based educational structures (Reis et al., 2021; Ronksley-Pavia, 2019). Even when teachers recognise the need for personalisation, the practical constraints of

simultaneously managing diverse learning requirements often result in a default to standardised approaches that serve neither the learners' gifted potential nor their challenges (Gyarmathy & Senior, 2018; Ivcevic, 2017; Pfeiffer, 2012).

GenAI creates new possibilities for personalisation at scale; when each student can engage in personalised conversation with GenAI, exploring content and questions at their own depth and pace, following their own associative pathways, the teacher's role moves from direct content delivery to designing learning experiences and supporting individual learners in their GenAI-mediated exploration. This represents movement toward what might be termed *authentic responsiveness* to the student in front of the teacher (i.e., personalised learning), achieved not solely through individual teacher effort but through technological mediation that supports authentic personalised learning at scale in heterogeneous classroom contexts. Crucially, this responsiveness can respect gifted and twice-exceptional learners' cognitive characteristics instead of requiring conformity to neurotypical expectations. The student who thinks non-linearly, makes unexpected connections, and explores ideas that appear tangential can be supported in these cognitive approaches, instead of being constantly redirected toward sequential, linear processing that may feel unnatural or constraining. Educational responsiveness in this framing means flexibility in how learning occurs and how understanding is demonstrated, not solely on what content is covered or at what pace instruction proceeds.

Perhaps most fundamentally, the functional alignment framework may support the paradigm shift from deficit-based to strengths-based approaches in twice-exceptional education, long proposed by researchers in the field (see, for example, Baum et al., 2014; Ronksley-Pavia & Hanley, 2022). When GenAI can be used to productively engage with the cognitive characteristics that conventional approaches treat as problematic (e.g., non-linear thinking, topic discontinuity, rapid conceptual movement), it may show that these can be highly productive and student-responsive when appropriately supported. This validation could then potentially create space for authentic strengths-based practice where educational approaches leverage twice-exceptional learners' cognitive capabilities while concurrently providing responsive scaffolding for challenges, with the focus oriented towards actualising potential, not solely focused on accommodations or interventions aimed at remediating supposed deficits. The framework offers theoretical grounding for this shift, moving past deficit rhetoric to concretely demonstrate how particular cognitive patterns may be productively engaged when met with compatible supports, which GenAI has the potential to offer.

The functional alignment framework contributes to broader reconceptualisations of gifted education as inherently inclusive, responsive, and oriented toward supporting all learners in actualising their potential. Traditional gifted education approaches have largely operated through exclusionary logics, identifying a subset of students as gifted and providing them with differentiated experiences, while the majority receive standard programming (Brulles & Naglieri, 2021; Callahan et al., 2017; Gyarmathy & Senior, 2018; Nielsen, 2002). This model has been particularly problematic for twice-exceptional learners who may not meet narrow identification criteria despite exceptional potential (Foley-Nicpon & Kim, 2018; Munro, 2002; Ronksley-Pavia, 2023).

The framework suggests movement toward more inclusive conceptualisations where the goal becomes engaging each learner's capabilities and supporting talent development. The focus moves to designing learning experiences that are responsive to each student's diverse capabilities and learning profiles, converting the principles of personalised, strengths-based practice that gifted and twice-exceptional learners require into principles that benefit all learners. This does not mean eliminating attention to students with giftedness and high potential or denying the reality of giftedness and the particular requirements of gifted learn-

ers. Instead, it suggests that such approaches to authentically responsive education respect neurological variations while supporting each learner in actualising potential. Inclusive gifted education in this framing means making responsive, personalised, strengths-based approaches universally accessible, which our conceptualisation of the functional alignment framework aims to facilitate.

4.4. Critical Considerations: Equity, Ethics, and Implementation

While the functional alignment framework offers promise for reimagining educational provision for gifted and twice-exceptional learners, realising this potential requires careful attention to equity, ethics, and implementation realities. Such considerations are not peripheral concerns to be addressed after developing technological approaches, but rather central questions that determine whether GenAI's transformative potential can be realised for gifted and twice-exceptional learners or whether it becomes another dimension of educational inequality.

The question of equitable access is immediate and pressing; GenAI's potential to support gifted and twice-exceptional learners can only be realised if access is equitably distributed, not concentrated among already advantaged populations. Current realities suggest significant concern; digital divides in device access and internet connectivity (Gallardo & Whitacre, 2024), resource disparities between well-funded and under-resourced schools, and inequitable home environments all threaten to make GenAI access another dimension of educational inequality (Suárez & García-Mariño, 2025). Gifted and twice-exceptional learners from marginalised communities—those experiencing intersections of disability, giftedness, and systemic marginalisation based on ethnicity, socioeconomic status, language, or other factors—are those who may be most in need of the responsive, personalised support that GenAI could enable, yet are least likely to have access in the absence of deliberate policy intervention (Suárez & García-Mariño, 2025). Without such intervention, GenAI risks exacerbating, not ameliorating, existing inequities in gifted education provision, creating yet another mechanism through which educational (dis)advantage accrues (Ronksley-Pavia & Clark, 2025).

Beyond access to GenAI technology itself, equity requires sustained attention to cultural responsiveness and algorithmic appropriateness (Holmes & Porayska-Pomsta, 2023; Lemke et al., 2024). GenAI systems trained primarily on English-language textual data from dominant cultural contexts may not support learners from diverse linguistic and cultural backgrounds equally well (Brossi et al., 2023). The functional alignment framework may manifest differently across cultural contexts where educational expectations, communication patterns, and conceptualisations of giftedness and disability (Piske et al., 2022) vary from those assumed in the predominantly Western research literature. Ensuring that GenAI implementation supports and does not disadvantage marginalised, gifted, and twice-exceptional learners requires ongoing attention to dimensions of equity, including research examining differential effects across diverse populations and deliberate design of implementation approaches that centre and do not marginalise the requirements of students experiencing multiple forms of educational disadvantage.

Ethical questions surrounding GenAI implementation in education become particularly acute when working with school-aged students. Privacy and data protection concerns arise whenever student interactions with digital systems generate data that could be used for surveillance, behavioural prediction, or commercial purposes (Laird et al., 2023; Dawson et al., 2019; Holmes & Porayska-Pomsta, 2023). Protecting student privacy requires robust policies and practices, with attention to students with disabilities whose educational records are already subject to extensive documentation. Parents and students need transparent

information about how GenAI systems operate, what data is collected, and how it is used, with meaningful capacity to provide informed consent or to decline participation.

A further implementation risk warranting explicit attention is the potential for overreliance on GenAI, with consequent cognitive offloading that may inadvertently diminish the development of independent reasoning skills (Gerlich, 2025). While GenAI's capacity to scaffold complex thinking is a central affordance of the functional alignment framework, this same capacity carries the risk of reducing the productive struggle that is essential to deep learning for gifted and twice-exceptional learners (Gerlich, 2025; Lodge & Loble, 2026; Seung & Basham, 2026). When GenAI resolves cognitive challenges too readily, learners may be deprived of the effortful processing through which durable understanding usually develops. This is a particular concern for gifted and twice-/multi-exceptional learners, for whom intellectual challenge is pedagogically necessary. Educators should therefore deliberately calibrate GenAI use, confirming it functions as a thinking partner that extends and deepens reasoning, not replacing it, while also monitoring for signs that students are cognitively offloading instead of actively engaging.

Appropriate implementation of safe practices is equally crucial. While the functional alignment framework positions GenAI as an interactive platform, this does not mean that GenAI should replace human interaction or that all educational functions should be mediated by AI. Human teachers provide teaching and subject expertise, social-emotional support, relational connection, ethical guidance, and nuanced judgement that AI fundamentally cannot replicate. GenAI should complement not substitute for essential human dimensions of education, with clear boundaries around what GenAI can, should, and should not do in educational contexts.

Implementation realities present substantial challenges even when equity and ethics are carefully addressed. Teachers already manage overwhelming workloads, schools operate within constrained budgets, and systemic inertia often favours familiar approaches over innovation. Expecting individual teachers to transform practice without systemic support is both unrealistic and unfair. Realising this transformative potential requires system-level changes: policy support for GenAI implementation, funding for professional learning and technological infrastructure, adjustment of curriculum and assessment expectations to accommodate personalised pathways, and cultural changes toward valuing responsiveness over standardisation.

These changes are substantial and will likely encounter resistance from multiple sources, including those concerned about technological disruption of traditional teaching, those worried about job security and sustainability, and those questioning whether resources should be directed toward technological implementation when schools face numerous other pressing needs. This reality suggests the necessity of phased, deliberate implementation that progressively builds capacity, not expectations of rapid transformation. Pilot programmes that explore GenAI implementation in specific contexts, action research that generates evidence about what approaches work for which learners under what conditions, and communities of practice that support teachers in developing and sharing expertise represent more promising pathways than top-down mandates or rapid system-wide adoption. System-level policy can create enabling conditions while supporting variation in local implementation that responds to particular community contexts, resources, and requirements. Throughout this process, ongoing research examining outcomes, equity, and impacts across diverse populations should inform continued development and refinement of approaches.

4.5. Future Research Directions

The functional alignment framework requires empirical validation and extension through research that, for example, could examine learning outcomes, implementation processes, and long-term impacts for gifted students. Several research priorities emerge as particularly salient.

First, does GenAI interaction grounded in functional alignment principles actually improve learning outcomes for gifted and twice-exceptional students? Comparative studies examining academic achievement, engagement, self-efficacy, metacognitive development, and other outcomes are needed to establish whether the theoretical promise of functional alignment translates to measurable educational benefit.

Second, what are the longitudinal impacts of sustained GenAI interaction on gifted and twice-exceptional learners' academic trajectories, self-understanding, identity development, and educational outcomes? Research following learners over extended time periods is warranted to understand the benefits and potential risks of GenAI integration into personalised learning experiences.

Third, the functional alignment framework may be more or less salient for different twice-exceptional profiles, and research exploring how alignment may operate across diverse combinations of potential, capabilities, and challenges is needed to understand the boundaries and variations of the framework. Fourth, how can teachers develop GenAI fluency, what professional learning approaches are most effective, and how does GenAI integration actually occur in classroom practice for diverse gifted learners?

Implementation research that investigates the processes of teacher learning and pedagogical change is necessary for translating our theoretical framework into practical educational improvement. Finally, and arguably most important, who actually benefits from GenAI-enabled approaches, and are there differential effects based on ethnicity, socioeconomic status, language, disability categories, or other dimensions of human variation? Equity-focused research should be prioritised to assist in ensuring that GenAI implementation reduces and does not reproduce or exacerbate educational inequities.

5. Conclusions

The functional alignment framework advances the proposition that GenAI may engage productively with the broad cognitive characteristics of gifted and twice-exceptional learners, such as non-linear thinking, cross-domain connections, topic discontinuity, and pacing. This represents a theoretical proposition requiring empirical validation.

When a student rapidly pivots between topics, makes unexpected connections, or arrives at insights through associative pathways, GenAI may engage with these patterns without the judgement, redirection, or pathologisation that can characterise many educational responses. The learner may experience validation and engagement that respects their cognitive processing. The framework challenges longstanding deficit-based approaches by proposing that such cognitive patterns can be productively engaged when met with compatible, not constraining, supports. Realising this potential requires substantial development of GenAI fluency: integrated understanding that encompasses technical knowledge of GenAI capabilities, pedagogical judgement about implementation, deep understanding of giftedness and twice-exceptionality, and deep understanding of individual gifted and twice-exceptional learners.

Teachers should be supported to move beyond deficit-based conceptualisations to recognise neurodivergent cognition as legitimate variations, understanding why behaviours that may appear off-task actually reflect productive cognitive engagement for some students. The framework contributes to broader reconceptualisations of gifted education as inherently inclusive and responsive, moving focus toward engaging each learner's potential and capabilities.

However, realising the transformative potential of GenAI requires careful attention to equity, ethics, and implementation. Gifted and twice-exceptional learners from marginalised communities are those who most likely require the responsive, personalised support that GenAI could enable, yet are least likely to have access without deliberate policy intervention. Ethical implementation requires robust privacy protections, appropriate approaches that position GenAI as complementary to human teaching, and system-level changes in policy, funding, and professional learning.

Future research is warranted to explore if functional alignment principles actually improve outcomes, how alignment may operate across diverse profiles, and fundamentally, who may benefit, so that GenAI might ameliorate existing inequities. Despite these necessary caveats and the substantial work required, the functional alignment framework offers potential for reimagining educational provision for gifted and twice-exceptional learners. GenAI's potential to engage with neurodivergent cognitive patterns without judgement challenges deficit interpretations and creates contexts for authentic strengths-based, personalised learning practice. This represents GenAI's transformative potential as an interactive platform that can validate what learners bring, engage with how they think, and support them to develop capabilities while simultaneously retaining their authentic cognitive selves. In pursuing this potential with careful attention to equity, ethics, and sustainability, it may be possible to move toward educational futures where the experiences of marginalisation and misunderstanding of gifted and twice-exceptional learners are replaced with recognition, responsiveness, and authentic opportunities to actualise their potential.

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Abbreviations

The following abbreviations are used in this manuscript:

GenAI	Generative Artificial Intelligence
ITE	Initial Teacher Education
LLM	Large Language Model
LLMs	Large Language Models
PD	Professional development

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