Elisabetta Tombolini
Università Telematica Niccolò Cusano | elisabetta.tombolini@unicusano.it

Luna Lembo
Università Telematica Niccolò Cusano | luna.lembo@unicusano.it

Francesco Peluso Cassese
Università Digitale Pegaso | francesco.pelusocassese@unipegaso.it

AVENGERS: L'impatto dei video generati con Intelligenza Artificiale sull'apprendimento e la memoria nella scuola secondaria di secondo grado per un'educazione inclusiva

AVENGERS: The impact of AI-generated videos on learning and memory in upper secondary school for inclusive education

Call

Generative Artificial Intelligence (GAI) is playing an increasingly significant role in the field of education, offering new opportunities for the creation of accessible and personalised learning resources. This study, conducted as part of the AVENGERS – *Artificial Video for Education: New Generation Empowerment Resource for Study* project, explores the effectiveness of GAI-generated videos in school settings, with particular attention to their application in special pedagogy. The sample, composed of upper secondary school students, included a significant proportion of learners with Individualised Education Plans (IEPs). The educational intervention was based on a GAI-generated video built from a passage taken from the AMOS psychometric battery, aimed at assessing comprehension, organisation, and memory. The results suggest that GAI can serve as an effective tool for inclusive education, even in the presence of specific learning needs, provided its use is embedded within a structured teaching framework that combines technology with active methodologies, progressive support strategies, and attention to diverse cognitive profiles.

Keywords: Innovative educational technologies; Generative Artificial Intelligence (GAI); Multimedia Learning; Learning Enhancement; Upper secondary school.

L'intelligenza artificiale generativa (GAI) sta assumendo un ruolo sempre più rilevante in ambito educativo, offrendo nuove opportunità per la creazione di risorse didattiche accessibili e personalizzate. Questo studio, condotto all'interno del progetto AVENGERS – Artificial Video for Education: New Generation Empowerment Resource for Study, esplora l'efficacia dei video generati con GAI nel contesto scolastico, con particolare attenzione alla pedagogia speciale. Il campione, composto da studenti della scuola secondaria di secondo grado, includeva una percentuale significativa di alunni con PDP (Piano Didattico Personalizzato). L'intervento didattico si è basato su un video GAI costruito a partire da un brano della batteria AMOS, mirato a valutare comprensione, organizzazione e memoria. I risultati emersi indicano che la GAI può rappresentare un efficace strumento di inclusione scolastica, anche in presenza di bisogni educativi specifici, a condizione che il suo impiego sia integrato all'interno di un progetto didattico strutturato, che combini l'utilizzo della tecnologia con metodologie attive, strategie di supporto progressivo e attenzione alla diversità dei profili cognitivi.

Parole chiave: Tecnologie educative innovative; Intelligenza Artificiale Generativa (IAG); Apprendimento multimediale; Potenziamento dell'apprendimento; Scuola secondaria di secondo grado.

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Corresponding Author: Elisabetta Tombolini | elisabetta.tombolini@unicusano.it.

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1. Introduction

Generative Artificial Intelligence (GAI) is gradually transforming the educational landscape, offering new opportunities for the creation of personalised, accessible, and engaging learning content. In particular, platforms such as *Synthesia*, *DeepBrain*, and *Pictory.ai* enable the automatic production of multimodal educational videos, integrating synthetic narration, dynamic visualisations, and real-time adaptation to students' learning levels (Luckin et al., 2016). These tools have proven especially beneficial in addressing special educational needs, enhancing students' motivation, comprehension, and information retention (Berg et al., 2024). However, to ensure the truly effective and inclusive integration of GAI into teaching practices, it is essential to design intentional learning environments that combine technology with active and personalised instructional strategies. Such strategies should support diverse cognitive profiles and foster transversal skills such as critical thinking and learner autonomy (Christine, 2017; Mello et al., 2023). Within this framework, the AVENGERS project – *Artificial Video for Education: New Generation Empowerment Resource for Study* was developed to explore the impact of GAI-generated multimedia content on learning and memory retention. The study was carried out in an upper secondary school setting and involved a sample that included students with Individualised Education Plans (IEPs), to assess the potential of these tools from an inclusive education perspective.

2. Theoretical Framework

The AVENGERS The AVENGERS project is based on the integration of two complementary theoretical approaches: the Cognitive Theory of Multimedia Learning (Mayer, 2001; 2013) and Mobile Learning (m-learning). According to Mayer, learning improves when information is presented in a coordinated manner through both visual and auditory channels, optimizing mental processing and reducing cognitive overload. Principles such as segmentation, coherence, and modality (Mayer & Moreno, 2003) have been widely validated by research in promoting deep and lasting understanding, avoiding situations in which students must simultaneously manage too many sources of information (Sweller, 1988; 1993; van Merriënboer & Sweller, 2010). Recent meta-analyses (Makransky et al., 2022) highlight how the consistent application of these principles can significantly enhance the effectiveness of digital education, especially in complex or information-dense contexts. Meanwhile, Mobile Learning has revolutionized the ways in which educational content is accessed and consumed, making learning more flexible, contextual, and personalized, thanks to the portability of mobile devices and their increasing computing power (Hockly, 2013; Traxler, 2018). Recent studies confirm that well-designed m-learning enhances motivation, autonomy, and continuity of learning, even in informal or blended settings (Criollo-C et al., 2021; Crompton et al., 2022). In particular, the combination of mobile devices, artificial intelligence, and interactive content is giving rise to new adaptive, inclusive, and responsive learning environments (Fitria et al., 2023; Chen et al., 2022). However, the effectiveness of these technologies depends on the presence of informed pedagogical strategies that can integrate elements such as collaborative work, metacognitive reflection, and formative assessment (Naveed et al., 2023; Viberg et al., 2021). The synergy between multimedia learning and mobile learning thus represents a highly promising perspective for educational innovation. Digital content segmented and designed according to multimedia principles helps reduce cognitive load, while mobile and interactive functionalities enhance students' active engagement, even on small-screen devices and in informal settings (Gupta et al., 2021; Anuyahong et al., 2023). Moreover, the possibility of learning «on the move» promotes continuous and contextualized education, which is also valuable in professional, technical, and informal environments. In this context, the advent of Generative Artificial Intelligence opens up new scenarios for personalized learning. Advanced algorithms are now capable of generating tailored explanations, dynamic visualizations, adaptive exercises, and automated feedback, fostering highly individualized learning experiences (Kamalov et al., 2023; Lai et al., 2023). Generative AI can also support inclusive education by adapting content to students with special educational needs, language difficulties, or different cognitive styles (Bond et al., 2024). With the AVENGERS project, established learning theories and emerging technologies are integrated into an educational ecosystem oriented toward quality, inclusion, and sustainability. The convergence of evidence-based approaches and advanced digital solutions represents one of the main drivers for building learning environments capable of effectively addressing the challenges of contemporary education.

2.1 The Generative Artificial Intelligence in education

Generative Artificial Intelligence (GAI) is emerging as a powerful driver of innovation in education, offering new opportunities to personalise learning, automate instructional support, and create dynamic, multimodal content (Mao et al., 2024). Through the autonomous generation of text, images, and audio, GAI supports the development of customised educational materials, adapted to students' individual needs and learning profiles (Alasadi et al., 2023). By analysing learning data, GAI can design personalised learning pathways, promoting greater motivation and active engagement (Altares-López et al., 2024). Additionally, the integration of chatbots and virtual assistants powered by GAI provides learners with immediate support—answering questions, clarifying content, and offering real-time feedback. These tools can also alleviate part of the teacher's workload, though their effectiveness depends on the accuracy and pedagogical reliability of the generated responses (Łodzikowski et al., 2024). GAI also enhances the production of interactive multimedia resources, such as videos, simulations, and adaptive quizzes, helping to explain complex topics in more engaging and accessible ways. Its ability to update content continuously based on the latest research ensures that educational materials remain current and relevant (Olga et al., 2023). However, the integration of GAI into education must be approached with caution. While it presents great promise for improving access and personalisation, it also raises important ethical and pedagogical concerns, including those related to misinformation, student over-reliance, and algorithmic opacity (Tzirides et al., 2024). To fully harness its potential, GAI should be used within a well-designed educational framework, ensuring responsible, inclusive, and pedagogically sound implementation.

2.1.1. GAI: Pictory.ai for didactics

Generative Artificial Intelligence (GAI) is reshaping the educational landscape by enabling the automated and personalised production of multimedia content. Amongst the most promising tools in this domain, *Pictory.ai* has emerged as an innovative AI-powered platform capable of transforming written texts into narrative videos with remarkable speed and efficiency. This technology offers valuable potential for enhancing the learning experience, particularly within the frameworks of Mobile Learning (m-learning) and Multimedia Learning (Mayer, 2021). *Pictory.ai* uses artificial intelligence to process and interpret written input, generating a storyboard that integrates images, video clips, and synthetic voice narration. Its pedagogical relevance aligns closely with key principles from Mayer's Cognitive Theory of Multimedia Learning (2001). Notably, the Modality Principle suggests that students learn more effectively when images are combined with spoken narration rather than on-screen text (Mayer & Moreno, 2003). Moreover, the Segmenting Principle, which involves breaking content into manageable units, is reflected in *Pictory.ai*'s capacity to deliver logically structured, sequential information that reduces cognitive load and supports comprehension (Sweller, 1988). The integration of *Pictory.ai* into educational practice is particularly beneficial for addressing diverse learning styles and cognitive profiles. By generating tailored visual content, the platform facilitates quicker access to information, promoting greater learner engagement and motivation (Tzirides et al., 2023). Additionally, the adaptability of AI-generated videos supports the personalisation of learning, empowering educators to design resources that respond to the specific needs and levels of individual students, thereby enhancing instructional effectiveness (Altares-López et al., 2024). Adopting platforms like *Pictory.ai* represents a meaningful advancement in the digital transformation of education, offering interactive, inclusive, and accessible materials. However, while GAI provides innovative opportunities for content creation, its use must be accompanied by a critical and pedagogically informed approach, ensuring that its integration contributes positively to student learning and to the future evolution of teaching methodologies.

3. Research project

The AVENGERS project – *Artificial Video for Education: New Generation Empowerment Resource for Study* – explores the impact of Generative Artificial Intelligence (GAI) on students' learning processes, with a focus on individuals attending upper secondary school. The research investigates whether automatically generated multimedia educational materials, produced through GAI, can affect students' ability to organise, retain, and recall information when compared to traditional text-based formats.

3.1 Research hypothesis

This study is guided by the following hypotheses:

- H1: the use of GAI-generated multimedia content influences students' ability—particularly those in upper secondary school—to identify and sequence the key ideas within a text.
- H2: the use of GAI-generated multimedia content impacts students' ability to accurately memorise and recall information presented in a text.

3.2 Sample

The study involved a total of 36 students enrolled at the "Bianciardi" Art School, a public upper secondary institution located in the Tuscany region of Italy, specifically in the city of Grosseto. The participants were randomly divided into two groups of equal size: an experimental group (n = 18) and a control group (n = 18). The sample was drawn from four classes within the Architecture and Fine Arts programmes, comprising two third-year cohorts (n = 16) and two fourth-year cohorts (n = 20).

In terms of gender distribution, the sample consisted of 14 male students (38.9%) and 22 female students (61.1%), as shown in Figure 1. Participants were aged between 16 and 19 years (Figure 2).

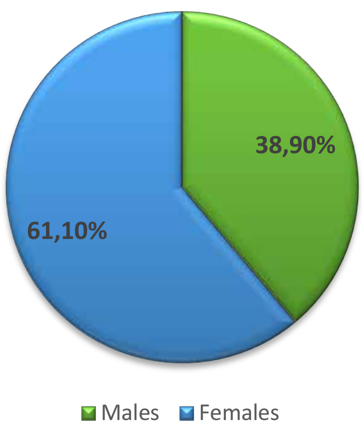

Figure 1. Gender distribution of the sample

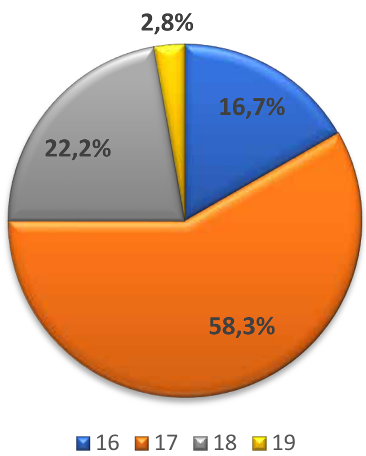

Figure 2. Age distribution of the sample

The group reflected a certain level of cultural and ethnic diversity: six students had mixed or non-Italian backgrounds, including Italo-Chilean, Italo-Polish, Italo-Romanian, Peruvian, Ukrainian, and Italo-Venezuelan origins. The rest of the sample was composed of students of Italian nationality.

A total of 25% of participants had an active Individual Education Plan (IEP), while none were identified as having a certified disability as defined by Italian Law no. 104/1992.

Participation in the research was entirely voluntary and without any form of compensation. Prior to the start of the experimental activities, written informed consent was obtained from all participants and, when necessary, from their parents or legal guardians. The study was conducted in accordance with recognised ethical standards for research involving human subjects, and all data were processed in full compliance with current privacy legislation, ensuring complete anonymisation.

3.3 Tools and methods

This study made use of the AMOS battery - *Abilities and Motivation for Study: Assessment and Guidance Tests for Upper Secondary School and University* (De Beni et al., 2014) specifically selecting the Learning Test (PA) to investigate participants' comprehension, memory, and recall skills. Although the Learning Test comprises two subtests, only the first was utilised in this research. This subtest involves studying a passage titled *The Prehistory of Africa*, structured to resemble academic educational content. Participants are required to analyse its thematic structure and memorise essential information. The text was chosen for its limited relevance to typical school or university curricula, thus minimising the likelihood of pre-existing knowledge influencing performance. This ensured optimal conditions for learning, allowing for a more accurate assessment of cognitive functioning. The passage contains descriptive elements, numerical data, conceptual information, and reflective prompts.

The study adhered to the standard protocol for administering the AMOS Learning Test, with one notable variation: the text was not presented in its original written format, but rather as a multimedia video generated through Generative Artificial Intelligence (GAI). Using the *Pictory.ai* platform, the written passage was transformed into a video that combined visual elements (such as explanatory images and short clips), synthetic voice narration, and on-screen text (Figure 3). In this way, participants engaged with the same psychometric material used in the AMOS test, but through an alternative and multimodal delivery method.

Figure 3. Screenshot from the GAI-generated video.

The experimental phase took place between January and March 2025, under the constant supervision of the research team to ensure full compliance with the established experimental protocol. The procedure unfolded through four sequential phases, described below to enhance clarity and replicability:

- *Informed consent and ethical compliance:* Before taking part in the study, all participants signed an informed consent form, and, where appropriate, so did their legal guardians, in accordance with ethical guidelines for scientific research involving human subjects. All data were processed in compliance with data protection legislation and anonymised to preserve confidentiality.
- *Study session:* All participants were exposed to the same educational content in the form of an AI-generated video, created using the Pictory.ai platform. Students were asked to study the material independently, using their preferred strategies and without receiving specific instructions. Each participant was given 25 minutes to complete the session. They were allowed to pause, rewatch, or navigate the video freely. This approach was intended to simulate a naturalistic study experience while minimising external interference in individual learning processes.
- *Retention interval:* After the study session, all participants observed a 30-minute break during which they were permitted to rest or engage in unrelated activities. This interval was introduced in accordance with prior research (De Beni et al., 2014), which suggests that a 15–30 minute delay is sufficient to assess long-term memory performance and produces results comparable to next-day testing.
- *Assessment phase:* At the end of the break, participants completed two post-test tasks derived from the relevant AMOS subtest, designed to provide objective, standardised measures of comprehension and memory. Each task had a maximum completion time of eight minutes and was administered under controlled classroom conditions.
  The first task, aimed at testing Hypothesis H1, reproduced the AMOS activity "Choice and Order of Events." It required students to select the seven most important titles from a list of 14, building a conceptual outline for a hypothetical oral presentation. The seven unselected titles acted as distractors: although thematically related to the general topic, they did not reflect the core ideas of the passage. This task measured participants' ability to identify key concepts, organise them according to the original narrative flow, and build a coherent and functional sequence suitable for summarisation and oral reproduction.
  The second task, associated with Hypothesis H2, corresponded to the AMOS "True/False Questions" activity, aimed at measuring the retention of specific factual information. It included 40 statements, of which 19 were factually correct and directly drawn from the original passage (with only minimal rephrasing), while the remaining 21 were plausible but absent from the original content.
  Both tasks followed the scoring criteria and cognitive targets outlined in the original AMOS protocol.

The dataset was analysed using JAMOVI statistical software (version 2.6.26). The analysis followed a two-step approach: first, descriptive statistics (mean, standard deviation, and distribution patterns) were calculated for each task to summarise overall performance. Second, inferential analyses were carried out to test the two research hypotheses. Given the availability of normative data from the AMOS standardisation sample, one-sample two-tailed z-tests were selected as the most appropriate statistical method to assess whether participants' scores significantly differed from expected population values. The threshold for statistical significance was set at $\alpha = .05$. In addition to p-values, Cohen's d was computed to estimate the effect size and assess the practical relevance of the results. Specifically, the tests compared the observed mean scores from the "Choice and Order of Events" task and the "True/False Questions" task against the respective AMOS normative values ($\mu = 13.11$, $\sigma = 3.87$ for the former; $\mu = 23.05$, $\sigma = 7.10$ for the latter), as established for upper secondary school students in the standardised psychometric battery.

3.4 Data analysis and results

The descriptive statistics for the two assessment tasks - "Choice and Order of Events" and "True/False Questions" - are presented in Table 1. These tasks were designed to examine whether the use of multimedia content generated through Generative Artificial Intelligence (GAI) influences students' ability to identify and sequence the main concepts of a narrative (H1), and to memorise and recall specific information previously studied (H2).

	N	Missing	Mean	Median	SD	Minimum	Maximum
Choise and order of events	36	0	12.9	13.0	1.93	10	16
True/false questions	36	0	30.0	30.0	5.12	23	42

Table 1. Descriptive Statistics

To provide a graphical representation of score distributions, violin box plots are reported in Figure 4 and Figure 5. The “Choice and Order of Events” task (Figure 4) presents a slightly more peaked distribution, with a higher density of scores just above the median. The interquartile range is narrower, indicating lower variability among participants. The symmetrical shape and compact tails suggest consistent performance across the sample, with scores concentrated in the upper-middle part of the scale and no major deviations from the central trend. Conversely, the distribution for the “True/False Questions” task (Figure 5) appears relatively symmetrical, with the median centred within the interquartile range. The data points are moderately spread, and the overall shape suggests a balanced distribution, with no extreme outliers and a fair concentration of scores around the mean

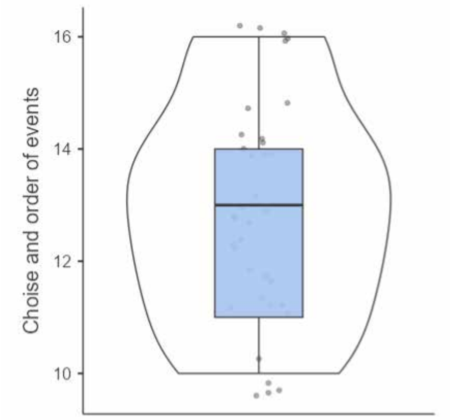

Figure 4. Box plot for Task 1 (H1)

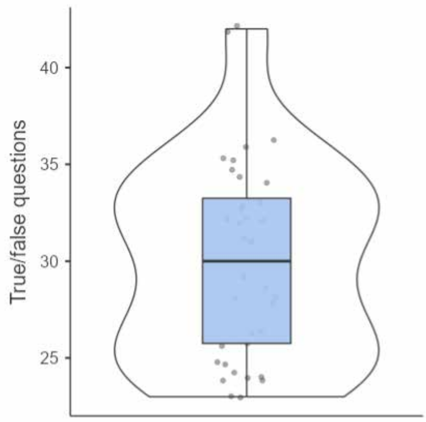

Figure 5. Box plot for Task 2 (H2)

To determine whether the sample means significantly differed from the normative values of the reference population, two-tailed one-sample z-tests were conducted for each research hypothesis.

For the «Choice and Order of Events» task, related to H1, a two-tailed one-sample z-test with α = 0.05 was conducted to compare the sample mean (M = 12.09, SD = 1.93) with the normative population mean (μ = 13.11). The results (Table 2) indicated no statistically significant difference between the sample and the population (z = -0.326, p = .745, d = -0.05). Consequently, H1 cannot be confirmed, and the null hypothesis was retained: the experimental intervention did not influence the ability to identify and sequence the core concepts of a narrative within the sample.

Observed *z*	Standard Error	*p*	Effect Size
−0.326	0.64	0.745	-0.05

Table 2. H1 one-sample z-test

Conversely, for the «True/False Questions» task, related to H2, a two-tailed z-test with $\alpha = 0.05$ was conducted to compare the sample mean ($M = 30$, $SD = 5.12$) with the normative population mean ($\mu = 23.05$). The results (Table 3) revealed a statistically significant difference between the sample and the population ($z = 5.36$, $p < .001$, $d = 0.98$), with a very large effect size, as per Cohen's d guidelines. Therefore, H2 is confirmed, and the null hypothesis was rejected: the experimental intervention had a significant impact on the ability to memorise and recall specific studied information within the sample.

Observed *z*	Standard Error	*p*	Effect Size
5.36	1.30	< .001	0.98

Table 3. H2 one-sample z-test

4. Discussion

In recent times, Generative Artificial Intelligence (GAI) has played an increasingly prominent role in reshaping educational practices, opening up novel pathways for the design of tailored and creative instructional materials (Altares-López et al., 2024; Kasneci et al., 2023). The incorporation of GAI into learning environments aligns with the broader trajectory of digital transformation in education, where modalities such as multimedia learning (Mayer, 2020) and mobile learning (Hockly, 2013) are redefining how learners engage with knowledge.

Drawing on the principles of the Cognitive Theory of Multimedia Learning, the integration of images, spoken narration, and text supports deeper understanding and memory retention by engaging multiple sensory channels, thereby lightening cognitive load and promoting more efficient processing (Mayer & Moreno, 2003; Sweller, 2011). Parallel to this, the growing diffusion of Mobile Learning (m-learning) has made educational content more readily available, offering students the possibility to access materials at their own pace and from any location (Criollo et al., 2021).

Within this framework, the current study set out to evaluate the effects of exposing upper secondary students to a narrative-based multimedia resource produced through *Pictory.ai*—an AI-powered platform that combines illustrative visuals, short video clips, synthetic voice narration, and written text. The research focused on two specific hypotheses: whether this instructional approach influenced students' capacity to extract and structure the core ideas of a text (H1), and whether it enhanced their ability to memorise and retrieve information after a delay (H2).

The results shed light on both the strengths and limits of GAI in the context of higher education. Statistical findings revealed that while H1 did not reach significance, H2 was supported by the data. In practical terms, the multimedia material did not lead to improvements in students' ability to identify and organise key concepts. However, it did positively impact their recall of specific factual content.

This divergence may be attributed to the differing cognitive demands of the two tasks. Videos generated through AI seem to support semantic memory, thanks to their multimodal delivery format (visual, auditory, textual), which fosters more efficient encoding and reduces cognitive load (Sweller, 2011). This outcome aligns with previous studies suggesting that specific content is more effectively retained when presented in formats that reduce processing strain and activate dual coding pathways (Mayer, 2020; Santos Espino et al., 2020).

On the other hand, the same format appeared less effective in supporting deeper elaboration processes such as conceptual organisation. Structuring knowledge into coherent frameworks requires higher-order thinking skills and active engagement with the material (Kasneci et al., 2023). Whilst memory for details may benefit from redundancy and passive processing, the ability to synthesise and organise information necessitates deliberate cognitive effort—often fostered by strategies like concept mapping or collaborative elaboration (Sweller, 2011).

These findings suggest that while GAI-generated multimedia tools offer promising support for memory-related outcomes, their full potential in fostering meaningful learning may only be realised when integrated with active pedagogical strategies.

5. Conclusion

Generative Artificial Intelligence (GAI) is emerging as a valuable tool in education, enabling the creation of multimedia materials that enhance access to content and enrich the learning experience. GAI-generated educational videos, in particular, can support information retention by engaging multiple sensory channels, and offer significant benefits for students who require differentiated and accessible resources—such as those with Individualised Education Plans (IEPs). The results of this study contribute to the growing body of research on the educational use of GAI, confirming its potential for knowledge consolidation, while also pointing out important pedagogical challenges. Notably, the absence of significant effects on students' ability to organise information suggests that these tools should not be used in isolation, but rather integrated within broader active learning strategies. To be truly effective and inclusive, the use of GAI must be grounded in evidence-based teaching practices that combine technological innovation with collaborative and reflective methodologies. When thoughtfully embedded into instructional design, GAI can enhance personalisation, foster student engagement, and provide meaningful support for diverse learners, particularly those with special educational needs.

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