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The impact of AI-generated multimedia on learning and information retention

L'impatto dei contenuti multimediali generati dall'IA sull'apprendimento e sulla ritenzione delle informazioni

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ABSTRACT Generative Artificial Intelligence (GAI) is transforming education, offering new opportunities for the creation of innovative teaching tools that facilitate access to content. This study, conducted within the framework of the AVENGERS project – *Artificial Video for Education: New Generation Empowerment Resource for Study* – involved 66 university students and aimed to evaluate the effectiveness of a GAI-generated video based on a text excerpt from the AMOS psychometric test, designed to assess comprehension, organisation, and memory skills. The objective was to compare the impact of multimedia presentation with that of traditional textual delivery. The findings suggest that educational videos generated using GAI can enhance memory retention, but are less effective in supporting the sequencing of concepts. GAI thus emerges as a promising resource for learning support, but it needs to be integrated into a broader pedagogical framework and complemented by active teaching methodologies in order to maximise its effectiveness.

KEYWORDS Higher Education Learning; Generative Artificial Intelligence (GAI); Multimedia Learning; Cognitive Performance; Learning Enhancement.

SOMMARIO L'Intelligenza Artificiale Generativa (IAG) sta trasformando l'istruzione, offrendo nuove opportunità per la creazione di strumenti didattici innovativi che facilitano l'accesso ai contenuti. Questo studio, condotto nell'ambito del progetto *AVENGERS - Artificial Video for Education: New Generation Empowerment Resource for Study*, ha coinvolto 66 studenti universitari, per valutare l'efficacia di un video generato con IAG basato su un testo tratto dal test AMOS, volto a misurare abilità di comprensione, organizzazione e memorizzazione delle informazioni. L'obiettivo era confrontare l'impatto della presentazione in formato multimediale rispetto alla tradizionale fruizione testuale. I risultati suggeriscono che i video didattici generati con IAG possono migliorare la memorizzazione, ma risultano meno efficaci nel favorire la sequenziazione dei concetti. L'IAG emerge, dunque, come una risorsa promettente per il supporto all'apprendimento, ma necessita di essere inserita in una progettazione pedagogica più ampia e affiancata da metodologie didattiche attive per massimizzarne l'efficacia.

PAROLE CHIAVE Apprendimento Universitario; Intelligenza Artificiale Generativa (IAG); Apprendimento Multimediale; Prestazione Cognitiva; Miglioramento dell'Apprendimento.

1. Introduction

The AVENGERS: Artificial Video for Education: New Generation Empowerment Resource for Study research project, presented in this paper, is set within a broader educational landscape undergoing profound transformation. This shift is characterised by the increasingly pervasive integration of advanced technologies such as Generative Artificial Intelligence (GAI). This evolution presents unprecedented opportunities to personalise learning, automate teaching support, and innovate the creation of educational content. However, the adoption of GAI in education also raises critical concerns regarding the reliability of information, data protection, and algorithmic transparency, as highlighted by Altares-López et al. (2024).

Today's students predominantly belong to Generation Z and Generation Alpha, groups that have grown up immersed in digital technologies, which have strongly influenced their learning and communication habits. Although these generations demonstrate a natural familiarity with connected devices, online platforms, and artificial intelligence tools—used both for entertainment and for accessing educational resources—numerous recent studies indicate that such exposure does not automatically translate into advanced digital competence (Creighton, 2018; Ferrari, 2012; Kassim et al., 2020; Ziatdinov & Cilliers, 2022). In other words, even if members of these generations are technologically adept, this does not necessarily imply that they possess the critical skills to select, interpret, and evaluate information effectively, nor advanced abilities in digital problem solving or in the pedagogically meaningful production of multimedia content (Blayone, 2018). This perspective moves beyond the deterministic view tied to the notion of "digital natives" (Prensky, 2009), instead emphasising the importance of intentionally and systematically developing digital competence.

This discrepancy between technological exposure and critical digital competence raises questions about how educational institutions should structure their teaching methodologies. Research in the field of pedagogy suggests that technology integration in education must be guided by targeted strategies, promoting meaningful and conscious learning rather than passive consumption of digital tools (Limone, 2020). In this context, the development of innovative

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teaching methodologies that leverage technology effectively to enhance teaching and learning processes becomes essential.

Several educational approaches have sought to address this need. The SAMR model (Substitution, Augmentation, Modification, Redefinition), proposed by Puentedura (2006), suggests that technology should not merely replace traditional methodologies (e.g., replacing textbooks with PDFs) but should also modify and redefine the learning experience, introducing new forms of interaction and collaboration between students and teachers (Zamri et al., 2024).

The TPACK framework (Technological Pedagogical Content Knowledge), on the other hand, emphasises the necessity of adequate teacher training to enable effective integration of technology into instructional design (Mishra & Koehler, 2006).

Another major challenge is the increasing use of Artificial Intelligence (AI) tools in education, which provide unprecedented learning support opportunities but also require a high level of digital literacy and critical thinking skills for responsible use (Hinojo-Lucena et al., 2019). Generative AI, for example, can be employed to customise learning pathways, provide automatic feedback, and create interactive educational materials. However, it also raises concerns regarding the reliability of generated information and the risk of excessive dependence on automated tools.

With the advent of Generative Artificial Intelligence (GAI), the concept of multimedia learning has further evolved. Platforms based on GAI, such as Pictory.ai, Synthesia, and DeepBrain, enable the creation of personalised educational content, adapting it in real time to students' needs. This approach not only enhances engagement but also supports adaptive learning, allowing students to receive explanations tailored to their level of comprehension (Luckin et al., 2016).

One of the most promising applications of GAI in education is the ability to automatically generate videos, combining speech synthesis, explanatory images, and interactive animations. According to recent studies, these tools can increase motivation and information retention, particularly among students with learning difficulties (Berg et al., 2024). However, it is crucial to ensure that the content generated is accurate and pedagogically valid, thus avoiding the risk of disseminating misleading or erroneous information (Kasneci et al., 2023).

Furthermore, it is essential to consider the ethical and pedagogical implications of integrating GAI into education. As discussed by Altares-López et al. (2024), the adoption of GAI requires careful reflection to ensure that these technologies are used responsibly and contribute effectively to enhancing educational processes.

Given these considerations, there is a pressing need to rethink teaching methodologies, ensuring that they not only exploit the potential of new technologies but also enable students to develop a critical and strategic use of digital tools. This would enhance the quality of learning and better prepare students for the demands of the modern workforce (Christine, 2017).

In this context, GAI offers the possibility of creating personalised teaching materials, such as educational videos that integrate audio narration with relevant visual elements. These tools facilitate deeper understanding and a more engaging learning experience, as highlighted by Mello et al. (2023).

This research aims to explore the impact of GAI in the design of multimedia teaching tools, assessing their effectiveness in enhancing information acquisition. By leveraging advanced GAI platforms, innovative educational content will be developed with the goal of providing students with autonomous resources that support study and enrich the learning experience.

In conclusion, GAI represents a promising frontier for educational innovation. However, its implementation must be accompanied by careful consideration of students' digital competencies and appropriate teaching methodologies to maximise benefits and mitigate potential risks.

2. Theoretical Framework

The AVENGERS research project is grounded in a robust theoretical framework based on two fundamental concepts: the Cognitive Theory of Multimedia Learning and Mobile Learning.

The Cognitive Theory of Multimedia Learning, developed by Richard E. Mayer (2001), is an essential theoretical model for understanding how the integration of words and images can positively influence learning processes. According to this theory, the simultaneous presentation of information through visual and auditory channels enhances comprehension and retention by leveraging the human cognitive system's ability to process these two input modes separately (Mayer, 2001; Mayer et al., 2008). Mayer's central hypothesis suggests that the coherent organisation of multimedia elements fosters deeper and more lasting knowledge construction while reducing the risk of cognitive overload (Sweller, 1988; 1993).

The application of multimedia learning principles in educational settings has led to the development of instructional strategies that optimise the use of audiovisual materials. Mayer identified several design principles aimed at improving learning effectiveness. Among these, the coherence principle suggests removing non-essential elements to avoid distractions, while the segmentation principle highlights the importance of breaking content into manageable units to facilitate cognitive processing (Mayer, 2005). The Modality Principle, introduced by Mayer and Moreno (2003), states that students learn more effectively when information is presented through images accompanied by audio narration rather than written text. This approach optimises cognitive processing by utilising separate channels for visual and auditory information. Presenting verbal information through audio narration prevents visual channel overload, enabling a more balanced cognitive load distribution and facilitating both comprehension and retention.

Mayer and Moreno further demonstrated that the combined use of images and audio narration enables students to construct more coherent and integrated mental representations. This occurs because audio narration frees up cognitive resources that would otherwise be occupied with reading, allowing for greater focus on image processing and its integration with verbal information. Consequently, students develop stronger connections between different representations of information, ultimately enhancing learning outcomes.

Mobile Learning (m-learning) has introduced a significant transformation in the educational landscape, leveraging the portability, connectivity, and interactivity of mobile devices to expand learning opportunities (Hockly, 2013). With the widespread adoption of smartphones and tablets, students can now access digital educational resources in real time and from any location, thereby overcoming traditional spatial and temporal constraints imposed by conventional education (Criollo et al., 2021; Goundar et al., 2022). This learning model promotes greater flexibility and personalisation, allowing adaptation to individual cognitive styles and learning paces and fostering ubiquitous learning, in which education is no longer confined to a physical classroom but extends to diverse real-world contexts (Di Fuccio et al., 2022; Limone, 2020).

The progressive integration of mobile educational platforms, interactive applications, and artificial intelligence has further enhanced the learning experience, enabling the development of adaptive and personalised learning environments.

While m-learning offers significant advantages in terms of accessibility and personalisation, several challenges must be addressed. These include the availability of digital infrastructure, the quality of educational content, and teacher training to effectively integrate these technologies into instructional programmes (Sophonhiranrak, 2021). Recent studies suggest that the success of m-learning depends not only on the technology itself but also on effective

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pedagogical design, which combines interactive strategies, collaborative learning, and continuous assessment tools to maximise educational benefits (Naveed et al., 2023).

The integration of the Cognitive Theory of Multimedia Learning with Mobile Learning presents a promising synergy for educational innovation. The segmentation of content into short, manageable modules aligns well with the needs of students using mobile devices, fostering a more dynamic and scalable learning approach (Gupta et al., 2021). Furthermore, the incorporation of interactive multimedia elements in m-learning increases student engagement, encouraging more active and immersive learning experiences (Fiorella et al., 2021; Goundar et al., 2021).

To ensure the effectiveness of these methodologies, it is crucial that the design of instructional materials is grounded in scientifically validated principles and considers the specific characteristics of mobile devices, such as smaller screen sizes and different interaction modes (Crompton et al., 2018).

The adoption of multimedia strategies and mobile technologies not only improves teaching quality but also provides students with a more flexible and personalised learning experience, making them active participants in their educational journey. In this context, research on the interaction between multimedia learning and m-learning continues to evolve, presenting new challenges and opportunities for the future of education.

2.1. Generative Artificial Intelligence in Education

Generative Artificial Intelligence (GAI) is emerging as a transformative force in the educational sector, offering unprecedented opportunities to personalise learning, automate instructional support, and innovate content creation (Mao et al., 2024). This advanced technology can autonomously generate texts, images, and sounds, opening new possibilities for teaching and learning.

GAI allows for the development of tailored educational materials that meet the specific needs of each student. By analysing learning data, it can design personalised educational pathways, offering explanations and resources aligned with learners' levels of understanding and interests (Alasadi et al., 2023). This approach aims to enhance learning effectiveness by fostering greater motivation and active participation (Altares-López et al., 2024).

The integration of GAI-powered chatbots and virtual assistants offers students immediate support, answering questions, clarifying doubts, and providing real-time feedback. These tools can reduce the workload of teachers, allowing them to focus on more strategic aspects of teaching. However, it is essential to ensure that the responses generated are accurate and pedagogically sound, to avoid the spread of misleading or incorrect information (Łodzikowski et al., 2024).

At the same time, numerous studies have highlighted the limitations and risks associated with the use of GAI in education, including concerns about the reliability of generated content, dependency on automated systems, the diminishing role of teachers, and issues related to data privacy and algorithmic transparency (Kasneci et al., 2023; Tzirides et al., 2024).

Recent Italian pedagogical literature has also begun to critically explore these issues. Limone (2020) stresses the importance of integrating digital technologies through intentional pedagogical planning rather than adopting them for their own sake. Calvani (2021) synthesises empirical evidence on the effectiveness of educational technologies, advocating for a reflective and evidence-based approach. In this context, Di Padova and Lotti (2024) propose a pedagogical model focused on inclusive education, in which GAI is used in service of accessibility and participation, grounded in sound educational principles.

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GAI also facilitates the creation of interactive multimedia content such as educational videos, simulations, and personalised quizzes. These tools can help explain complex topics in more accessible and engaging ways, fostering deeper understanding. Moreover, GAI can continuously update learning materials based on the latest findings and trends, ensuring that content remains relevant (Tzirides et al., 2023).

In summary, while GAI holds transformative potential for education, its integration must be critically and responsibly approached, taking into account not only its benefits but also its ethical, pedagogical, and cultural implications. Only through a thoughtful, evidence-informed, and context-sensitive use can GAI truly enhance teaching and learning processes.

2.1.1. GAI: Pictory.ai for Didactics

Generative Artificial Intelligence (GAI) is transforming the educational sector through advanced tools that automate and personalise the creation of multimedia content. Among the emerging platforms, Pictory.ai[1] stands out as an innovative AI-based tool designed to rapidly and efficiently convert written texts into narrative videos. This technology has the potential to revolutionise teaching by providing visual and auditory support that enhances students' learning experiences, particularly in the context of Mobile Learning (m-learning) and Multimedia Learning (Mayer, 2021).

Pictory.ai utilises artificial intelligence to analyse and interpret a text, automatically generating a visual storyboard incorporating images, video clips, and synthetic narration. The application of this tool in education aligns with several principles of Mayer's Cognitive Theory of Multimedia Learning (2001), particularly the Modality Principle, which asserts that combining images with audio narration is more effective than reading a text accompanied by static images (Mayer & Moreno, 2003). Additionally, the Segmenting Principle applies to Pictory.ai, as the platform breaks content into logical and sequential fragments, facilitating comprehension and reducing students' cognitive load (Sweller, 1988).

The integration of Pictory.ai into educational contexts can be particularly beneficial in addressing diverse learning styles and cognitive preferences. The creation of customised visual content enables more immediate access to information, increasing student engagement and motivation to learn (Tzirides et al., 2023). Furthermore, AI-generated videos enhance learning personalisation, allowing teachers to adapt instructional materials to the individual needs of students, thereby improving teaching effectiveness (Altares-López et al., 2024).

The adoption of platforms such as Pictory.ai represents a significant step towards the digitalisation of education, making instructional materials more accessible, interactive, and engaging. While Generative Artificial Intelligence provides innovative tools for educational content creation, a critical and reflective approach is essential to ensure a positive impact on student learning and future teaching methodologies.

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[1] Pictory. Pictory – Home of AI Video Editing Technology — pictory.ai. https://pictory.ai/. [Accessed 17-May-2023].

2.2. The impact of educational videos on cognitive processing and semantic memory

The introduction of technology into education has led to the development of new educational resources, including instructional videos, which facilitate learning by combining visual and auditory stimuli, significantly modulating working memory and promoting more effective semantic memory retention. Compared to text-based instruction alone, videos enable the association of new concepts with dynamic imagery, enhancing the ability to construct semantic connections within the neural network and integrate information into existing knowledge structures (Mayer, 2020; Bonaiuti, 2013).

Video-based learning is grounded in deep processing mechanisms, where semantic encoding plays a crucial role in meaning construction. The combined use of images and narration facilitates information organisation, enabling students to create coherent cognitive structures that support long-term retrieval (Santos Espino et al., 2020). Additionally, the ability to review and segment content strengthens memory consolidation, facilitating the transition of information from working memory to long-term memory (Sweller, 2011). The visual presentation of materials, particularly through animations, auditory production, and graphic representations, helps to overcome the challenges of purely verbal memory, making concepts more accessible and enduring (Mayer & Moreno, 2003).

Another fundamental aspect is the flexibility of asynchronous learning, which allows students to self-regulate their processing times, repeating complex sections while accelerating simpler ones. This process enhances semantic encoding, as it enables students to focus on essential details and actively integrate new material with prior knowledge (Noetel et al., 2021; Mitra et al., 2010). Furthermore, videos foster active engagement through practical demonstrations and simulations, which stimulate deeper cognitive processing, essential for the retention of complex concepts (Zu et al., 2017).

The use of instructional videos thus represents a powerful tool for managing cognitive load, promoting more effective information processing, and facilitating access to a more stable and enduring semantic memory. The combination of visual and verbal stimuli, along with the ability to customise the learning pace, provides students with an optimal strategy for acquiring, organising, and consolidating information, ultimately enhancing comprehension and retention of content (Carmichael et al., 2018; Kanellopoulou et al., 2019).

3. Research project

The research project AVENGERS – Artificial Video for Education: New Generation Empowerment Resource for Study explores the impact of Generative Artificial Intelligence (GAI) on the learning process of university students. Specifically, it aims to assess how the use of automatically generated multimedia educational materials may influence the ability to organise information and memorise and recall content, compared to more traditional presentation formats.

3.1. Research Hypothesis

In the present study, the research hypotheses are as follows:

- H1: the use of multimedia material generated through Generative Artificial Intelligence (GAI) influences university students' ability to identify and sequence the fundamental content of a text.

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– H2: the use of multimedia material generated through Generative Artificial Intelligence (GAI) influences university students' memorisation and recall of information contained in a text.

3.2. Sample

The research sample consists of 66 participants, including 40 females and 26 males, aged between 21 and 35 years. All participants are of Italian nationality and originate primarily from central Italy. The sample comprises university students enrolled in various academic programmes at different Italian universities, with a distribution of 60% in the humanities and 40% in the scientific field. Specifically, the disciplines represented include medical biotechnology, economics, engineering, philosophy, psychology, and sports sciences.

Recruitment was conducted on a voluntary basis through announcements disseminated via academic and social channels. Participation in the study did not involve any form of financial compensation. To ensure the suitability of participants and the validity of the collected data, specific inclusion and exclusion criteria were established.

The inclusion criteria required: (1) adequate proficiency in the Italian language, considered essential for understanding and processing the experimental materials; (2) a minimum educational qualification equivalent to a secondary school diploma; (3) enrolment in a university degree programme; (4) an age of 18 years or older. The exclusion criteria included: (1) a diagnosis of Learning Disorders (LD), which was self-reported and confirmed through a preliminary screening; (2) the presence of sensory impairments (visual or auditory) that could compromise the ability to engage with the experimental multimedia content; (3) the presence of cognitive deficits, potentially affecting comprehension and memory performance in the experimental tasks; (4) prior knowledge or familiarity with the psychometric instrument used, to avoid biases related to test familiarity.

3.3. Tools and Methods

The present study employed the AMOS battery – Abilities and Motivation for Study: Assessment and Guidance Tests for Upper Secondary School and University (De Beni et al., 2014), focusing specifically on the first subtest of the Learning Test (PA). This subtest is an integral component of the AMOS battery and was selected to assess university students' abilities in comprehension, processing, memorisation, and recall of information.

The subtest used in this research involves the study of a passage entitled *"The Protohistory of Africa"*, which is part of the standard material provided by the AMOS battery. The text is designed to simulate typical academic content and requires participants to analyse its thematic structure and memorise key information. It is important to highlight that the content is unrelated to topics usually covered in school or university curricula, thereby reducing the risk of advantages due to prior knowledge and ensuring optimal conditions for assessing cognitive performance. The passage includes descriptive information, numerical data, conceptual elements, and prompts for reflection.

The research design followed the standard procedure for administering the Learning Test from the AMOS battery, with the distinction that the passage was presented in the form of a multimedia video generated via Generative Artificial Intelligence (GAI). The video was produced using the Pictory.ai platform, which, based on an input text, generated a multimedia narrative by combining explanatory images, video clips, and synthetic narration, while also displaying the written text. Participants were therefore presented with the same material used in the psychometric assessment, but in a different format (Figure 1).

Figure 1. Screenshot of the video generated with GAI

The experiment was conducted between January and February 2025 in a controlled laboratory setting, with the constant presence of the researcher to ensure compliance with experimental conditions.

The research design adhered to the traditional protocol for administering the Learning Test from the AMOS battery. Before participating in the experiment, all participants signed an informed consent form in accordance with ethical guidelines for scientific research. Data processing was conducted in full compliance with current privacy and data protection regulations, ensuring complete anonymisation of collected information.

Participants were instructed to study the material according to their usual habits, without additional guidance, to avoid influencing spontaneous learning strategies. A 25-minute period was allocated for independent study, during which students could manage the video freely - pausing it, watching it twice in succession, or rewinding it. Following the study phase, a 30-minute break was scheduled, during which participants could engage in other activities. This pause between the study phase and the knowledge assessment was introduced based on experimental evidence suggesting that an interval of 15-30 minutes is sufficient to estimate the long-term retention of study material, with results comparable to those obtained in assessments conducted the following day (De Beni et al., 2014).

After the interval, participants proceeded with the content acquisition assessment. To this end, they completed two tasks designed to obtain objective measures of processing and recall abilities, with a maximum time limit of 8 minutes per task.

The first task, employed to test Hypothesis H1, required participants to select, from 14 titles, the seven key elements needed to construct a summary outline of the text's essential content, useful for an oral presentation. The seven unselected titles acted as distractors: although relevant to the topic, they did not represent the core conceptual elements. This task allowed for an assessment of planning abilities, specifically the ability to identify key concepts, organise them chronologically according to the text's narrative structure, and create a logical and functional sequence for subsequent oral exposition.

The second task, employed to test Hypothesis H2, consisted of a true/false questionnaire designed to assess the memorisation of specific information. To this end, 40 statements were created, of which 19 were true, corresponding to content present in the passage and only slightly paraphrased, and 21 were false, formulated in a plausible manner but not contained in the original text.

Statistical data analysis was conducted using JAMOVI software (version 2.3.28). To assess whether the scores obtained at the tests "Choice and Order of Events" ($\mu = 13.71$) and "True/False Questions" ($\mu = 24.72$) differed statistically significantly from the normative values

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established for university students in the standardised psychometric test AMOS, a two-tailed one-sample z-test was conducted for each variable.

3.4. Data analysis & results

Table 1 presents the descriptive statistics for the two tasks, "Choice and Order of Events" and "True/False Questions", designed to test whether the use of multimedia material generated through Generative Artificial Intelligence (GAI) influences university students' abilities to identify and sequence the core concepts of a narrative (H1) and to memorise and recall specific studied information (H2).

Table 1. Descriptive Statistics

	N	Missing	Mean	Median	SD	Minimum	Maximum
Choice and order of events	66	0	13.68	14.00	2.22	9	18
True/false questions	66	0	30.73	30.00	4.94	24	43

To provide a graphical representation of the data distribution, violin box plots are reported in Figure 2 and Figure 3. The score distribution for the "Choice and Order of Events" task (Figure 2) appears approximately symmetrical. The violin shape suggests a moderate concentration of data around the median, with no evident outliers. Conversely, the distribution of scores in the "True/False Questions" task (Figure 3) exhibits greater variability, with a slight asymmetry and an extended upper tail, indicating that some participants obtained significantly higher scores than the mean.

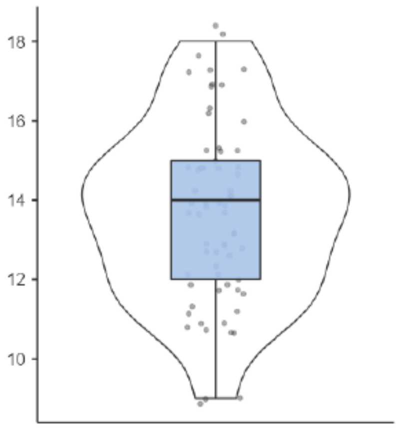

Figure 2. Box plot for Task 1 (H1)

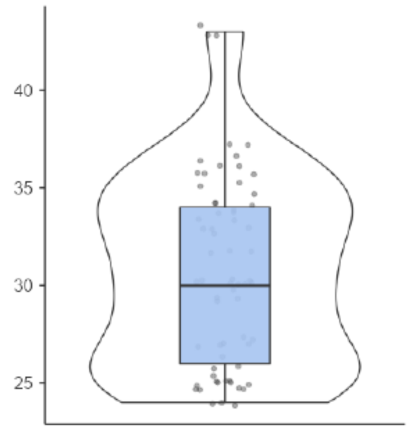

Figure 3. Box plot for Task 2 (H2)

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 $\alpha = 0.05$ was conducted to compare the sample mean ($M = 13.68$, $SD = 2.22$) with the normative population mean ($\mu = 13.71$, $\sigma = 2.98$). The results (Table 2) indicated no statistically significant difference between the sample and the population ($z = -0.08$, $p = .935$, $d = -0.01$). 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.

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Table 2. H1 one-sample z-test.

Observed z	Standard Error	p	Effect Size
-0.08	0.37	0.935	-0.01

Conversely, for the "True/False Questions" task, related to H2, a two-tailed z-test with α = 0.05 was conducted to compare the sample mean (M = 30.73, SD = 4.94) with the normative population mean (μ = 24.72, σ = 4.95). The results (Table 3) revealed a statistically significant difference between the sample and the population (z = 9.86, p < .001,), with a very large effect size, according to Cohen's d (d = 1.21). 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.

Table 3. H2 one-sample z-test.

Observed z	Standard Error	p	Effect Size
9.86	0.61	< .001	1.21

In summary, regarding the ability to identify and organise the key concepts of a text (the "Choice and Order of Events" task), the results suggest that watching the GAI-generated video did not have a significant impact on students' ability to structure information in a sequential and coherent manner, at least when compared to the standard textual format used in the AMOS test.

By contrast, the findings for the memorisation and recall of specific information (the "True/False Questions" task) indicate that the GAI-generated video enhanced information retention, likely due to the communicative redundancy provided by the simultaneous integration of text, images, and audio.

4. Discussion

In recent years, Generative Artificial Intelligence (GAI) has transformed the educational landscape, offering new opportunities for the creation of innovative and personalised instructional content (Altares-López et al., 2024; Kasneci et al., 2023). The integration of GAI into teaching is part of a broader digital transformation in education, in which modalities such as multimedia learning (Mayer, 2020) and mobile learning (Hockly, 2013) are redefining how knowledge is accessed.

According to the Cognitive Theory of Multimedia Learning, the combined use of images, audio narration, and text can enhance comprehension and information retention by activating multiple sensory channels, which reduce cognitive load and facilitate more effective processing (Mayer & Moreno, 2003; Sweller, 2011). Simultaneously, Mobile Learning (m-learning) has made learning more flexible and accessible, allowing students to engage with educational resources anytime and anywhere (Criollo et al., 2021).

Recent studies highlight that AI-generated educational videos, such as those produced by Pictory.ai, can enhance motivation and information retention, particularly among students with learning difficulties (Berg et al., 2024). However, in order to determine whether these technologies genuinely improve learning processes, it is necessary to analyse which cognitive mechanisms are activated and what pedagogical implications they entail.

Based on these considerations, the present study aimed to investigate whether the exposure to narrative multimedia content generated using Pictory.ai (which employs GAI), integrating

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explanatory images, video clips, and synthetic narration while also maintaining the written text, influenced university students' ability to identify and organise the key concepts of a text (H1) and their memory retention and delayed recall of information (H2).

The findings provide insights into the potential and limitations of GAI in university-level learning. Statistical analysis revealed that, while H1 was not confirmed, H2 found support in the data. In other words, the experimental instructional tool did not significantly improve students' ability to identify and organise key information compared to traditional teaching materials. However, it had a positive effect on their ability to memorise and recall specific details related to the studied content.

This discrepancy can be explained by considering the cognitive processes involved in the two tasks. AI-generated videos appear to facilitate semantic memory, as they present information through multiple sensory channels (visual, auditory, textual), which enhances processing and reduces cognitive load (Sweller, 2011). This effect aligns with previous research indicating that specific details are more effectively consolidated when the material is structured to minimise cognitive effort by leveraging dual coding theory (Mayer, 2020; Santos Espino et al., 2020).

However, the use of the experimental instructional support did not lead to an improvement in active information processing and conceptual organisation skills. Structuring information coherently requires deeper cognitive processing (Kasneci et al., 2023). While memory retention can benefit from stimulus redundancy and automated processing, conceptual organisation necessitates more active interaction with the content, such as constructing concept maps (Sweller, 2011).

Thus, the findings suggest that GAI, when used to create multimedia learning tools, should ideally be complemented by active learning methodologies to maximise its educational benefits.

4.1. Limitations and future directions

This study presents some limitations that should be taken into account when interpreting the results. First, the sample consisted exclusively of Italian university students, which limits the generalisability of the findings to other educational contexts. Future studies could expand the sample to include students of different age groups and cultural backgrounds.

Several studies have shown that multimedia materials may be particularly beneficial for students with learning disorders or cognitive difficulties, offering visual and auditory support that facilitates access to content (Berg et al., 2024). Further investigation in this direction could contribute to the development of innovative and inclusive educational tools tailored to the needs of a diverse student population. Additionally, future research could assess, through longitudinal studies, the long-term retention of knowledge acquired through AI-generated educational resources.

Another important limitation concerns the lack of a direct comparison between AI-generated videos and those produced by human instructors. Although this study has shown that AI-generated videos can support information retention, it has not evaluated whether these outcomes are due to specific features of AI-generated content (e.g., neutrality, uniformity, scalability) or simply to the effectiveness of the multimedia format itself. Future research could explore this aspect further, also taking into account the absence of studies in the literature using the AMOS battery in combination with videos produced by human instructors.

5. Conclusion

Generative Artificial Intelligence (GAI) is emerging as an innovative resource in the educational field, offering unprecedented opportunities to support teaching through the automatic creation of personalised multimedia content. Thanks to its capacity to integrate text, images, and audio in a synergistic way, GAI enables the development of accessible and engaging materials that facilitate access to instructional content and enrich students' learning experiences.

The findings of the present study contribute to expanding the existing literature on the actual potential and limitations of GAI in educational contexts. The data collected suggest that educational videos generated using GAI-based technologies, such as Pictory.ai, may serve as effective tools for enhancing memory retention and recall, due to communicative redundancy and the stimulation of multiple sensory channels. However, the lack of a significant impact on students' ability to conceptually organise information highlights a critical issue: although multimedia formats may effectively support mnemonic retention, they do not automatically lead to the development of higher-order cognitive skills such as logical structuring and deep understanding of content. This discrepancy underscores the importance of viewing GAI not as a stand-alone or self-sufficient solution, but rather as a tool to be integrated within an intentional instructional design that includes active learning methodologies and pedagogical strategies aimed at fostering critical thinking, metacognitive reflection, and conscious engagement with content.

Looking ahead, it is essential to promote a critical, context-sensitive, and pedagogically grounded use of GAI, one that takes into account the characteristics of the learners, the educational objectives, and the specific learning environments. Further research could more thoroughly investigate the role of GAI in relation to different learner profiles, disciplinary domains, and the interaction between AI-generated content and the active role of the teacher in the instructional process. In this regard, it will be important to distinguish the effectiveness attributable to the specific characteristics of artificial intelligence from that related, more generally, to the multimedia format employed.

In light of these considerations, the use of GAI in education should not be confined to content generation alone, but rather incorporated into a broader pedagogical framework that combines technological innovation with evidence-based teaching methodologies. Only through such an approach can the full potential of GAI be realised, ensuring more effective, critical, and meaningful learning experiences.

6. Author contributions

The contribution represents the result of a collaborative effort by the authors; specifically, Elisabetta Tombolini is the author of §§ 3, 4, 5; Luna Lembo is the author of 1, 2; Francesco Peluso Cassese is research supervisor.

7. References

Alasadi, E. A., & Baiz, C. R. (2023). Generative AI in education and research: Opportunities, concerns, and solutions. *Journal of Chemical Education*, *100*(8), 2965-2971.

Altares-López, S., Bengochea-Guevara, J. M., Ranz, C., Montes, H., & Ribeiro, A. (2024). Qualitative and quantitative analysis of student's perceptions in the use of generative AI in educational environments. *arXiv preprint arXiv:2405.13487*.

Altares-López, S., Bengochea-Guevara, J.M., Ranz, C., Montes, H., & Ribeiro, Á. (2024). Generative AI: The power of the new education. *ArXiv, abs/2405.13487*.

Berg, C., Omsén, L., Hansson, H., & Mozelius, P. (2024). Students' AI-generated Images: Impact on Motivation, Learning and, Satisfaction. In *ICAIR 2024* (Vol. 4). ACI Academic Conferences International.

Blayone, T. (2018, October). Reexamining digital-learning readiness in higher education: Positioning digital competencies as key factors and a profile application as a readiness tool. In *International Journal on E-Learning* (Vol. 17, No. 4, pp. 425-451). Association for the Advancement of Computing in Education (AACE).

Bonaiuti, G. (2013). Apprendimento significativo. In *Ambienti di apprendimento per la formazione continua. Materiali di lavoro del progetto FSE "Modelli organizzativi e didattici per il LLL"* (pp. 291-306). Guaraldi.

Carmichael, M., Reid, A., & Karpicke, J. D. (2018). Assessing the impact of educational video on student engagement, critical thinking and learning. *A SAGE white paper*, 1-21.

Christine, R. (2017). *European framework for the digital competence of educators*. Joint Research Centre.

Creighton, T. B. (2018). Digital Natives, Digital Immigrants, Digital Learners: An International Empirical Integrative Review of the Literature. *Education Leadership Review*, *19*(1), 132-140.

Criollo-C, S., Guerrero-Arias, A., Jaramillo-Alcázar, Á., & Luján-Mora, S. (2021). Mobile learning technologies for education: Benefits and pending issues. *Applied Sciences*, *11*(9), 4111.

Crompton, H., & Burke, D. (2018). The use of mobile learning in higher education: A systematic review. *Computers & Education*, *123*, 53-64.

De Beni, R., Zamperlin, C., Meneghetti, C., Cornoldi, C., Fabris, M., Tona, G. D. M., & Moè, A. (2014). *Test AMOS-Abilità e motivazione allo studio: prove di valutazione e orientamento per la scuola secondaria di secondo grado e l'università: Nuova edizione*. Edizioni Centro Studi Erickson.

Di Fuccio, R., Ferrara, F., Siano, G., & Di, A. (2022, February). ALEAS: An interactive application for ubiquitous learning in higher education in statistics. In *Stat. Edu'21-New Perspectives in Statistics Education. Proceedings of the International Conference Stat. Edu'21* (pp. 77-82). FedOA-Federico II University Press.

Di Padova, M., & Lotti, A. (2024). Progettazione didattica e Intelligenza Artificiale generativa per una scuola digitale e inclusiva. Gruppo editoriale Tab.

Ferrari, A. (2012). *Digital competence in practice: An analysis of frameworks* (Vol. 10, p. 82116). Publications Office of the European Union.

Fiorella, L., & Mayer, R. E. (2021). Principles for reducing extraneous processing in multimedia learning: Coherence, signaling, redundancy, spatial contiguity, and temporal contiguity principles. *The Cambridge Handbook of Multimedia Learning*, *3*, 185-198.

Goundar, M. S., & Kumar, B. A. (2022). The use of mobile learning applications in higher education institutes. *Education and Information Technologies*, *27*(1), 1213-1236.

Gupta, Y., Khan, F. M., & Agarwal, S. (2021). Exploring factors influencing mobile learning in higher education-A systematic review. *International Journal of Interactive Mobile Technologies*, *15*(12).

Hinojo-Lucena, F. J., Aznar-Díaz, I., Cáceres-Reche, M. P., & Romero-Rodríguez, J. M. (2019). Artificial intelligence in higher education: A bibliometric study on its impact in the scientific literature. *Education Sciences*, *9*(1), 51.

Hockly, N. (2013). Mobile learning. *ELT journal*, *67*(1), 80-84.

Kanellopoulou, C., Kermanidis, K. L., & Giannakoulopoulos, A. (2019). The dual-coding and multimedia learning theories: Film subtitles as a vocabulary teaching tool. *Education Sciences*, *9*(3), 210.

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, M., Stadler, M., & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, *103*, 102274.

Kassim, E. S., Hairuddin, H., Chowdhury, M. H. M., Al-Din, Z. H. M., & Azhar, N. S. N. (2020). Digital competencies among generation Z: comparison between. *Int J Adv Sci Technol*, 559-571.

Limone, P. (2020). Ambienti di apprendimento digitale e ubiquitous learning: prospettive applicative e di didattica nella scuola post-Covid-19. *Dirigenti Scuola*, *39*, 10-19.

Łodzikowski, K., Foltz, P. W., & Behrens, J. T. (2024). Generative AI and its educational implications. In *Trust and Inclusion in AI-Mediated Education: Where Human Learning Meets Learning Machines* (pp. 35-57). Springer Nature Switzerland.

Luckin, R., & Holmes, W. (2016). Intelligence unleashed: An argument for AI in education. UCL Knowledge Lab

Mao, J., Chen, B., & Liu, J. C. (2024). Generative artificial intelligence in education and its implications for assessment. *TechTrends*, *68*(1), 58-66.

Mayer, R. (2020). *Multimedia learning (3rd eds). Cambridge University*.

Mayer, R. E. (2002). Multimedia learning. In *Psychology of Learning and Motivation* (Vol. 41, pp. 85-139). Academic Press.

Mayer, R. E., & Johnson, C. I. (2008). Revising the redundancy principle in multimedia learning. *Journal of Educational Psychology*, *100*(2), 380.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, *38*(1), 43-52.

Mello, R. F., Freitas, E., Pereira, F. D., Cabral, L., Tedesco, P., & Ramalho, G. (2023). Education in the age of Generative AI: Context and Recent Developments. *arXiv preprint arXiv:2309.12332*.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017-1054.

Mitra, B., Lewin-Jones, J., Barrett, H., & Williamson, S. (2010). The use of video to enable deep learning. *Research in Post-Compulsory Education*, *15*(4), 405-414.

Naveed, Q. N., Choudhary, H., Ahmad, N., Alqahtani, J., & Qahmash, A. I. (2023). Mobile learning in higher education: A systematic literature review. *Sustainability*, *15*(18), 13566.

Noetel, M., Griffith, S., Delaney, O., Sanders, T., Parker, P., del Pozo Cruz, B., & Lonsdale, C. (2021). Video improves learning in higher education: A systematic review. *Review of Educational Research*, *91*(2), 204-236.

Tzirides, A-A., Saini, A., Zapata, G., Searsmith, D., Cope, B., Kalantzis, M., Castro, V., Kourkoulou, T., Jones, J., Abrantes da Silva, R. & Kastania, N. P. (2023). Generative AI: Implications and applications for education. *arXiv preprint arXiv:2305.07605*.

Prensky, M. (2009). H. sapiens digital: From digital immigrants and digital natives to digital wisdom. *Innovate: Journal of Online Education*, *5*(3).

Santos Espino, J. M., Afonso Suárez, M. D., & González-Henríquez, J. J. (2020). Video for teaching: classroom use, instructor self-production and teachers' preferences in presentation format. *Technology, Pedagogy and Education*, *29*(2), 147-162.

Sophonhiranrak, S. (2021). Features, barriers, and influencing factors of mobile learning in higher education: A systematic review. *Heliyon*, *7*(4).

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, *12*(2), 257-285.

Sweller, J. (1993). Some cognitive processes and their consequences for the organisation and presentation of information. *Australian Journal of Psychology*, *45*(1), 1-8.

Sweller, J. (2011). Cognitive load theory and E-learning. In *Artificial Intelligence in Education: 15th International Conference, AIED 2011, Auckland, New Zealand, June 28–July 2011 15* (pp. 5-6). Springer.

Tzirides, A. O., Saini, A. K., Zapata, G., Searsmith, D., Cope, B., Kalantzis, M., ... & Kastania, N. P. P. (2024). Generative AI Application in Higher Education Student Work. In *Trust and Inclusion in AI-mediated Education: Where Human Learning Meets Learning Machines* (pp. 287-301). Springer Nature Switzerland.

Zamri, M. T., & Mohamad, S. N. A. (2024). Technology Integration in Education: A Review and Analysis of SAMR Model. *International Journal of Research and Innovation in Social Science*, *8*(3s), 6195-6200.

Ziatdinov, R., & Cilliers, J. (2022). Generation Alpha: Understanding the next cohort of university students. *arXiv preprint arXiv:2202.01422*.

Zu, T., Agra, E., Hutson, J., Loschky, L. C., & Rebello, N. S. (2017). Effect of visual cues and video solutions on conceptual tasks. *arXiv preprint arXiv:1701.04497*.