

Who Tells the Better Math Story? Exploring Gen AI in a Digital Algebra Game

Kubra Kaymakci-Ustuner, Effie Lai-Chong Law and Frederick WB Li

Department of Computer Science, Durham University, UK

jvpm77@durham.ac.uk

wsnv42@durham.ac.uk

dcs01w@durham.ac.uk

Abstract: Learning algebra can be challenging for children due to its abstract nature. Story-based game design can support learning by contextualising mathematical structures. Recent advances in generative artificial intelligence (genAI) offer new opportunities for reflection and meaning-making. This paper presents a genAI-supported, story-based digital algebra game designed for students aged 9–11 encountering algebra for the first time. The game consists of three levels, progressing from recognition to production.. An embedded LLM system (Algy) generates an alternative story using the same student inputs - character, place, and equation - for creating their own stories. Students compare both stories, select one, and justify their choice. The study involved 136 students and four teachers. Data from written justifications and interviews were analysed thematically. Results showed that students choosing AI-generated stories valued clarity, detail, correctness, and perceived intelligence. In contrast, those preferring their own stories emphasised ownership, creativity, and emotional engagement. Teachers reported that integrating genAI within a structured game made it more controllable and trustworthy. Findings suggest that structured integration of genAI can support reflection while preserving student ownership.

Keywords: Digital game-based learning, Algebra, Digital storytelling, Participatory design

1. Introduction

The rapid advancement of generative artificial intelligence (AI) has begun to reshape educational practices across disciplines (Kasneci et al. 2023; Dwivedi et al. 2023). Tools based on large language models (LLMs) are increasingly accessible to students, enabling them to generate text, explanations, and creative content with minimal effort. While such systems offer new opportunities for learning, they also raise pedagogical concerns regarding over-reliance, reduced ownership, and uncritical acceptance of AI-generated outputs (Zhai 2023; Baidoo-Anu & Owusu Ansah 2023). Particularly in primary education, questions remain about how generative AI can be meaningfully and safely integrated into structured learning environments rather than used as an open-ended answer provider.

At the same time, digital game-based learning (DGBL) continues to demonstrate its potential to enhance engagement, motivation, and conceptual understanding (Plass et al. 2015; Hamari et al. 2016). In mathematics education, digital games have been shown to support reasoning, problem-solving, and the contextualisation of abstract concepts. Algebra, in particular, presents challenges for young learners due to the abstract nature of symbolic representations. Story-based approaches and digital storytelling (DST) can help bridge this gap by connecting equations to meaningful real-life narratives (Robin, 2008). Despite growing interest in both DGBL and generative AI (genAI), limited research has examined how AI can be embedded within structured mathematics games in ways that promote reflection rather than replace student thinking. The present study addresses this gap by introducing a genAI-embedded Digital Algebra Game (DAG) designed for students aged 9–11. In this design, AI functions not as an authority but as a bounded co-creator, prompting students to compare, evaluate, and justify mathematical stories.

This paper reports the classroom implementation of the AI-embedded DAG with 136 students and four teachers. The study addressed two research questions.

RQ1: *How do primary students justify their preference between self-generated and AI-generated mathematical stories in the game?*

RQ2: *How do students and perceive the integration of genAI within the digital algebra game?*

This study makes three main contributions. First, it provides empirical evidence on how primary students justify their preferences between human- and AI-generated mathematical narratives within a structured game environment. Second, it offers insights into how students and teachers perceive the role of genAI when embedded as a co-creative element in mathematics learning. Third, it presents a design approach in which genAI is integrated as a bounded partner rather than an open-ended answer provider, contributing to ongoing discussions on responsible AI use in primary education.

2. Background

2.1 Conceptual Frameworks

With the increasing integration of digital technologies into education, DGBL and DST have emerged as effective approaches to support student learning (Prensky, 2001, Frasca, 2001). Research shows that educational digital games can enhance students' motivation, engagement, and academic achievement by fostering curiosity, challenge, and immediate feedback (Yeh et.al. 2020, Kapp, 2012). In mathematics education, DGBL has been found to support problem-solving, critical thinking, and understanding of abstract concepts, particularly in topics that require conceptualisation and strategic reasoning (Cetin, Mirasyedioglu, 2019; Majid, Ridwan, 2019). Studies also indicate that allowing students to take active roles, such as designing or creating within games, can further enhance their learning and motivation (Bulut et.al., 2022; Kalmpourtzis, 2019).

Similarly, DST provides meaningful contexts that help students connect mathematical concepts to real-life situations (Morgan, 2006; Albano, et.al., 2020). By combining narrative elements with multimedia, DST makes abstract ideas more concrete and supports students' conceptual understanding, problem-solving, and engagement (Dincer & Yilmaz, 2019). Empirical studies show that DST increases student participation and encourages collaboration (Albano, et.al., 2020; Niemi, et.al., 2018). However, research specifically focusing on the use of DST in algebra remains limited (Unuvar & Barut, 2020).

These approaches are grounded in established learning theories. Experiential Learning Theory emphasises learning through concrete experiences and reflection, supporting the transformation of abstract concepts into tangible understanding (Kolb, 1984; Smith, et.al., 2015). Constructivist perspectives highlight the active role of learners in constructing knowledge through meaningful, student-centred activities (Bereiter, 1994; Pelech, 2021). In addition, motivation theories, particularly SDT, underline the importance of autonomy, competence, and relatedness in enhancing engagement (Rokaya, 2021; Xia, et.al., 2022). Together, these perspectives provide a theoretical foundation for integrating game-based and story-based approaches in mathematics learning.

2.2 Generative AI in Education

Recent advances in genAI, particularly LLMs, have created new opportunities for teaching and learning. These systems enable natural language interaction, generate context-sensitive responses, and provide on-demand support, making them increasingly relevant in educational settings (Bauer, et.al., 2025). GenAI tools such as ChatGPT can facilitate student engagement by supporting questioning, reflection, and interactive learning processes, allowing learners to actively construct knowledge through dialogue (Elim, 2024).

A growing body of research highlights the potential of genAI to support reflective learning, which plays a central role in developing critical thinking and deeper understanding. Reflective learning involves evaluating ideas and reconsidering alternative perspectives. LLMs can support this process through immediate, adaptive feedback (Yuan & Hu, 2025). By prompting students to reconsider their responses and compare alternative perspectives, genAI can act as a scaffold for reflective and metacognitive thinking.

In addition, recent research on AI literacy emphasises that education should go beyond technical understanding and support students' ability to critically reflect on the social and ethical implications of intelligent technologies. (Malinverni et.al., 2025). This perspective, often referred to as *reflective AI literacy*, highlights the importance of developing students' capacity to question assumptions, evaluate AI systems, and consider their broader societal impact. Such approaches position reflection not only as an individual cognitive process but also as a means of understanding the wider implications of technology use.

However, the effectiveness of genAI depends on how it is pedagogically integrated. AI does not inherently improve learning outcomes, and excessive reliance on AI may reduce cognitive engagement and lead to superficial learning processes (Bauer et.al. 2025). Moreover, generative AI systems may produce inaccurate or biased outputs, highlighting the importance of developing students' ability to critically evaluate AI-generated content.

Despite the growing interest in genAI, there is still limited research exploring how genAI can be meaningfully integrated into structured, game-based learning environments to support reflective thinking in mathematics education. Building on this gap, this study integrates genAI within a story-based digital algebra game to support reflective learning. Rather than using AI as an answer provider, the system positions AI as a co-creator that generates alternative solutions based on the same inputs. By comparing their own stories with AI-generated ones and justifying their choices, students are encouraged to engage in reflection, evaluate mathematical

correctness, and develop critical awareness of AI outputs. In this way, the game design leverages the strengths of genAI while promoting active learning and reflective thinking.

3. Methodology

This classroom-based study examined the implementation of our genAI-embedded DAG in two primary schools.. The study aimed to explore how students responded to AI-generated mathematical stories, how they justified their preferences, and how teachers evaluated the pedagogical reliability of embedding genAI within a controlled game environment.

3.1 Development of the GenAI DAG

The genAI DAG is an interactive story-based learning environment designed to support students' early encounters with algebra. The core design principle is to transform abstract symbolic expressions into meaningful, real-life narratives. Students construct stories grounded in everyday contexts while embedding given algebraic equations into these narratives. The development of DAG was informed by the learning theories outlined in Section 2.1.

The game consists of three progressive levels.

Level 1 focuses on recognition. Students are presented with an equation and multiple story options. Then they are asked to identify the mathematically correct story. This stage supports the connection between symbolic representation and contextual meaning.

Level 2 introduces guided construction. Students complete partially structured stories by filling in key mathematical components aligned with a chosen equation, character, and place. This scaffolding reduces cognitive load while helping students better connect equations with meaningful stories.

Level 3 moves to independent production. Students select a character, a place, and an equation to generate their own mathematical story.



Figure 1: Screenshot from the game interface showing the character selection screen

The distinctive innovation in this version of DAG lies in the structured integration of genAI within Level 3. After students submit their story, an embedded LLM, specifically GPT-4 (via ChatGPT), represented in the game as a robot character named *Algy*, generates an alternative story using the same inputs.

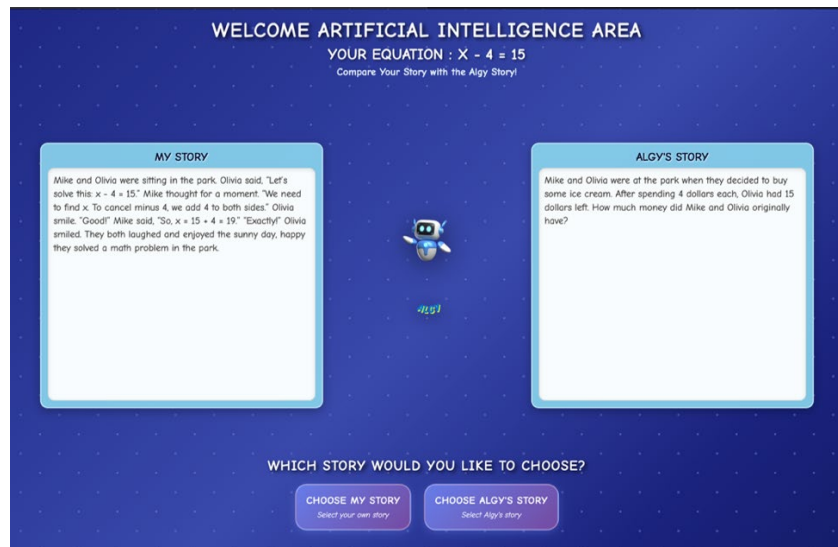


Figure 2: The in-game representation of *Algy*, the AI partner embedded in Level 3. It is a prototype interface with scribbles (no real text)

Algy was intentionally designed as a friendly and approachable robot to encourage students to perceive AI not as a competitor or authority, but as a collaborative partner. Both the student-generated story and Algy's story are displayed side by side, and students are required to select one and justify their choice in writing.

The genAI component was implemented using the GPT-4 via the OpenAI API. The system follows a client–server architecture, where user inputs (character, place, and equation) are sent to a backend service and embedded into a structured prompt template. Prompt engineering was used to guide the model to produce mathematically consistent and contextually meaningful stories, aligned with the given equation and appropriate for the target age group.

The generated story is displayed alongside the student's story in real time. A word limit constraint was included to ensure concise and comparable outputs, and the prompt explicitly required the correct use of the given equation within the story. This structured comparison task promotes reflective learning, evaluation of mathematical correctness while preserving student ownership and agency in the learning process.

3.2 Participants

Ethical approval was obtained from ANONYMOUS. Informed consent was secured from schools, teachers, parents, and students prior to data collection. Participation was voluntary and no compensation was provided. The study was conducted in two primary schools and involved 136 students aged 9–11 and four teachers. The first and second school involved 98 and 40 students, respectively. The first author ran the GenAI DAG directly in classroom settings. To ensure anonymity, students were assigned codes in the format [S1/S2–serial number, where S1=School 1; S2=School 2].

3.3 Data Collection

Data were collected during the classroom implementation of the GenAI DAG. Students completed all three levels individually, with each student using a separate computer throughout the activity. In Level 3, after creating their own mathematical story, they were presented with an AI-generated alternative story based on the same character, place, and equation. Students were instructed to read both stories carefully, compare them, select the one they preferred, and provide a written justification for their choice within the game interface. No predefined evaluation criteria were provided; instead, students were encouraged to use their own judgement (e.g., considering mathematical correctness, clarity, completeness, or any other aspects they considered important) when making their decision. The written justifications from all 136 students constituted the primary data source of this study. Following gameplay, semi-structured interviews were conducted with volunteering students to further explore their reasoning and perceptions of the AI-generated stories. All interviews were audio-recorded and transcribed for analysis.

4. Results

This section presents the findings of the study in relation to the research questions. First, students' story preferences and justifications are reported. Then, we presented the interview findings based on a thematic analysis (see Table 1-2-3). Inter-rater reliability (IRR) between the two researchers was high, with a Cohen's Kappa value of 0.72. Any discrepancies in coding were discussed until consensus was reached.

4.1 Students' Story Preferences

Across both schools (N = 138), 58 students selected the AI-generated story, while 64 preferred their own story. A small number of responses (n = 16) were unclear or missing.

4.1.1 Reasons for preferring AI-generated stories

This subsection presents the reasons why some students preferred AI-generated stories during the activity.

Table 1: Themes related to students' preference for AI-generated stories (in descending order)

Theme	Sub-theme	Example Student Statements	Freq.
Perceived Competence	Intelligence	"He is a computer and he knows more." / "Robots know better than me." / "It sounded smarter."	14
	Correctness	"It looked more correct." / "It had fewer mistakes." / "I trusted the math." / "Correct one."	11
Structural Quality	Clarity and Understandability	"The AI story was clearer to understand." / "It makes more sense." / "It was easier to read."	18
	Detail and Completeness	"It was longer." / "It had more details." / "More complete." / "Added more key information."	12
Reliability	Trust and Confidence	"I trusted the AI story more." / "I believed it more." / "I felt more confident choosing it."	13
	Low-Risk Choice	"The AI story felt safer to choose." / "AI is a safer option." / "I wasn't sure about my answer."	12

In general, students' evaluations of AI-generated stories were shaped by three main factors: perceived competence (n=25), structural quality (n=30), and reliability (n=25). Students tended to perceive AI as more intelligent and accurate, while also appreciating the clarity and completeness of its outputs. In addition, many students expressed greater trust in AI and considered it a safer option when they were uncertain about their own responses.

4.1.2 Reasons for preferring self-generated stories

This subsection explains the reasons why some students preferred the stories they created themselves.

Table 2: Themes related to students' preference for Self-generated stories (in descending order)

Theme	Sub-theme	Example Student Statements	Freq.
Ownership	Personal Feeling	"I chose my own story because I wrote it." / "My words, my story." / "It felt like mine."	12
	Pride and Effort	"We put lots of time and work into it." / "It's mine, I'm proud of it."	5
Emotional Engagement	Emotional Connection	"My story made me happy." / "My story is fun." / "I feel better."	7
	Personal Ideas	"It was my idea." / "It was creative."	5
	Personal Interest	"It has a cookie in it and I like cookies." / "Waffles and pancakes are good." / "It was exciting."	5

Theme	Sub-theme	Example Student Statements	Freq.
Critical Evaluation	Robotic Style	<i>"The AI story felt too robotic."</i>	3
	Cultural Mismatch	<i>"AI used dollars but we use pounds." / "It should be pounds." / "Wrong money."</i>	9
Cognitive Ease	Simplicity	<i>"Mine was simpler." / "It wasn't complicated." / "Not too complex." / "Less confusing."</i>	6
	Clarity and Conciseness	<i>"Shorter and clear." / "Easier to understand." / "It makes sense." / "Quick to read."</i>	6

Students' preferences for their own stories were influenced by four main factors: ownership (n=17), emotional engagement (n=14), critical evaluation of AI (n=11), and cognitive ease (n=5). Students often valued their own work due to a sense of personal connection and effort, while also expressing emotional attachment to their stories. In addition, some students critically evaluated AI-generated stories, and others preferred their own stories because they were simpler and easier to process.

4.2 Students' Perceptions of DAG

This section presents students' perceptions of the DAG activity based on interview data collected from 46 participants.

Table 3: Themes related to students' perceptions of the DAG

Theme	Sub-theme	Example Student Statements	Freq.
Game Experience	Creativity	<i>"Making your own story." / "You can create your own story."</i>	20
	Personalization	<i>"I liked choosing my character." / "You can write your own name."</i>	18
	Enjoyment	<i>"It feels like a game, not a test." / "It teaches me algebra." "It was fun and entertaining." / "The game made maths less boring."</i>	26
	Challenges in the Game	<i>"The maths was a little bit hard." / "Some questions were confusing."</i>	16
Perceptions of AI in the Game	Pedagogical support	<i>"It helps people learn." / "The AI explained things." / "Robot teacher." / "Helper." / "I learn something"</i>	22
	Cognitive perception	<i>"Get more IQ" / "Make me smart"</i>	10
	Emotional Perception	<i>"The AI made the game more interesting." "Friend." / "Buddy." / "Real person."</i>	14
	Critical perceptions	<i>"Sometimes the AI was confusing." / "AI can sometimes tell lies." "Talking robot." / "Students may rely too much on AI."</i>	12

Students' responses revealed two main dimensions: game experience and perceptions of AI in the game. While students highlighted creativity, enjoyment, and personalisation as key aspects of their game experience, they also expressed mixed perceptions of AI, recognising both its supportive role in learning and its potential limitations.

5. Discussion

5.1 Revisiting the Research Questions

5.1.1 RQ1

The findings reveal a clear distinction between two competing dimensions shaping students' preferences: perceived competence and personal ownership. Students who preferred AI-generated stories consistently associated AI with higher levels of intelligence, correctness, and reliability. The AI-generated outputs were often described as clearer, more detailed, and more complete, suggesting that students evaluated these stories primarily through cognitive and structural criteria. At the same time, the preference of many students to perceive AI as a "safer" or more reliable option raises important pedagogical considerations. Choosing AI-generated stories in situations of uncertainty suggests that students may be relying on AI as an epistemic authority rather than critically evaluating its output. This behaviour can be interpreted as an early manifestation of automation bias, where users rely on system-generated responses due to perceived competence (Parasuraman & Riley, 1997). Such findings support existing concerns in the literature about over-reliance on generative AI and the potential reduction of cognitive engagement if learners uncritically accept AI outputs (Bauer, 2025).

At the same time, students who preferred their own stories emphasised ownership, creativity, and emotional engagement, highlighting the importance of personal investment in learning. Their responses resonate with the constructivist perspectives, which emphasise that learning involves active meaning-making rather than passive reception of correct answers (Smith, et.al., 2015) and that learning is not only about arriving at correct answers but also about actively constructing meaning through personal engagement (Xia, et.al., 2022). From this perspective, students' preference for self-generated stories reflects not a rejection of correctness, but a prioritisation of agency, identity, and personal relevance in the learning process. This finding also aligns with SDT, which highlights autonomy as a key driver of motivation and engagement (Deci & Ryan, 2008). The value students placed on "my story" and "my idea" suggests that opportunities for ownership can play a critical role in sustaining meaningful engagement, even in cognitively demanding tasks such as early algebra. While AI-generated stories were perceived as epistemically stronger, self-generated stories were valued for their personal meaning and creative expression. .

However, the findings also provide encouraging evidence that students are capable of critically engaging with AI. Some participants explicitly identified limitations in AI-generated stories, such as a "robotic" tone or cultural inconsistencies (e.g., the use of unfamiliar currency). These observations indicate emerging forms of critical AI literacy, where students begin to question and evaluate AI-generated content rather than passively accepting it. (Long & Magerko, 2020). This suggests that even at a young age, learners can develop an awareness of both the strengths and limitations of AI, particularly when they are positioned as evaluators rather than passive users. However, the observed tendency to rely on AI as a low-risk choice raises important concerns about over-reliance and reduced critical engagement. Previous research on generative AI in education has warned that learners may accept AI-generated outputs uncritically, leading to surface-level learning processes and diminished cognitive effort (Kasneci et al. 2023; Zhai 2023; Dwivedi et al. 2023; Baidoo-Anu & Ansah 2023; Selwyn 2019). The present findings provide empirical support for these concerns, particularly in cases where students relied on AI due to uncertainty rather than evaluation.

5.1.2 RQ2

Students' perceptions of the AI-integrated game reveal a complex and multi-dimensional understanding of AI's role in learning. On one hand, AI was widely perceived as a supportive and engaging element of the game. Students described it as a "helper," "buddy," or even a "teacher," indicating that the integration of AI contributed positively to their learning experience and motivation. On the other hand, students also expressed critical awareness, acknowledging that AI could be confusing, make mistakes, or potentially lead to over-reliance. This dual perception suggests that students did not view AI as authoritative, but rather as a useful yet limited tool. Importantly, these findings highlight the role of structured design in shaping how AI is perceived and used. By embedding AI within a bounded, game-based environment and requiring students to compare and justify their choices, the system positioned AI as a co-creator rather than an authoritative answer provider. (Yuan & Hu, 2025).

The design encouraged students to compare alternative representations and articulate their reasoning. This design choice aligns with research on *reflective learning*, which emphasises the importance of comparison,

evaluation, and justification in developing deeper understanding . By requiring students to make a choice and justify their reasoning, the game shifted the role of AI from an authority to a stimulus for reflection. In doing so, it supported reflective thinking processes, encouraging students to think not only about *what* is correct, but *why* it is correct.

From a theoretical perspective, the findings support the integration of the constructivist and experiential learning principles in AI-supported environments (Section 2.1). Furthermore, the strong emphasis on ownership and creativity also aligns with the SDT. The presence of AI did not reduce these elements; instead, when carefully structured, it appeared to complement them by introducing alternative perspectives that prompted deeper thinking.

Overall, the findings suggest that generative AI can play a productive role in primary mathematics education when it is carefully integrated within pedagogically grounded designs. Rather than replacing student thinking, AI can be used to extend it by creating opportunities for comparison, evaluation, and reflection. However, the balance between supporting learning and maintaining student agency remains critical. Ensuring that students do not over-rely on AI, while still benefiting from its strengths, is a key challenge for future research and design.

5.2 Limitations and Future Work

This study has some limitations. The sample was limited to students from two primary schools, which may affect generalisability. The focus on introductory algebra also restricts transferability to other mathematical domains. In addition, the study relied on self-reported data rather than direct measures of learning outcomes. Furthermore, the AI system was implemented in a structured manner, which may not reflect more open-ended AI use. Future research should involve larger and more diverse samples, extend to different mathematical topics, and explore how varying levels of AI autonomy influence students' learning and critical engagement.

6. Conclusion

This study explored how primary school students engage with generative AI digital algebra game. The findings reveal a tension between students' preference for AI-generated stories, driven by perceived correctness and reliability, and their preference for self-generated stories, grounded in ownership, creativity, and emotional engagement. Importantly, the results show that when generative AI is positioned as a co-creator rather than an answer provider, it can support reflection, comparison, and critical evaluation. Students were not only able to benefit from AI-generated alternatives but also demonstrated emerging awareness of its limitations.

Overall, the findings suggest that pedagogically structured generative AI can promote reflection, comparison, and critical evaluation while preserving student agency.

Acknowledgements

We extend our gratitude to Ministry of National Education of Türkiye for their generous support and funding, which made this research possible. Appreciation is also given to the school's head teacher and students for providing us the precious opportunity and a friendly environment to conduct this study.

References

- Albano, G., Coppola, C., Iacono, U. D., Fiorentino, G., Pierri, A., & Polo, M. (2020). Technology to enable new paradigms of teaching. *Journal of E-learning and Knowledge Society*, 16(1), 65–71
- Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Journal of AI*, 7(1), 52-62.
- Bauer, E., Greiff, S., Graesser, A. C., Scheiter, K., & Sailer, M. (2025). Looking beyond the hype: Understanding the effects of AI on learning. *Educational Psychology Review*, 37(2), 45.
- Bereiter, C. (1994). Constructivism, socioculturalism, and Popper's world 3. *Educational researcher*, 23(7), 21-23.
- Bulut, D., Samur, Y., & Cömert, Z. (2022). The effect of educational game design process on students' creativity. *Smart Learning Environments*, 9(1), 8.
- Çetin, Y., & Mirasyedioğlu, Ş. (2019). The effect of technology-supported problem-based teaching practices on mathematics achievement. *Journal of Computer and Education Research*, 7(13), 13-34.
- Deci, E. L., & Ryan, R. M. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian psychology/Psychologie canadienne*, 49(3), 182.
- Deleş, B., Özenoğlu, Y. E., & Aydoğdu, F. (2025). The Effect of Digital Games on The Mathematical Reasoning Skills of Preschool Children. *International Journal of Human– Computer Interaction*, 1-10.
- Dennehy, D., Griva, A., Pouloudi, N., Dwivedi, Y. K., Mäntymäki, M., & Pappas, I. O. (2023). Artificial intelligence (AI) and information systems: perspectives to responsible AI. *Information Systems Frontiers*, 25(1), 1-7

- Dinçer, B., & Yılmaz, S. (2019). An Experimental Study on the Effect of Digital Storytelling in Mathematics Lessons on Teaching the Concept of Clarity. *International Journal of New Trends in Arts, Sports & Science Education (IJTASE)*, 8(2), 49-57.
- Dwivedi, Y. K. (2025). Generative Artificial Intelligence (GenAI) in entrepreneurial education and practice: emerging insights, the GAIN Framework, and research agenda. *International Entrepreneurship and Management Journal*, 21(1), 82.
- Elim, EHSY. (2026) Promoting cognitive skills in AI-supported learning environments: the integration of bloom's taxonomy, *Education* 3-13, 54:3, 612-622,
- Frasca, G. (2001), Rethinking agency and immersion: video games as a means of consciousness-raising, *Digital Creativity*, 12(3), 167-174.
- Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in human behavior*, 54, 170-179.
- Kalpourtzis, G. (2019). Developing kindergarten students' game design skills by teaching game design through organized game design interventions. *Multimedia Tools and Applications*, 78(14), 20485–20510.
- Kapp, K. M. (2012). *The gamification of learning and instruction: Game-based methods and strategies for training and education*. San Francisco: Pfeiffer.
- Kasneci, E., Sebler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and individual differences*, 103, 102274.
- Kasneci, E., Sebler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., ... & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and individual differences*, 103, 102274.
- Kolb, B. (1984). Functions of the frontal cortex of the rat: a comparative review. *Brain Research Reviews*, 8(1), 65-98.
- Rokaya, B. B. (2021). Constructive learning approach in mathematics education: challenges
- Long, D., & Magerko, B. (2020, April). What is AI literacy? Competencies and design considerations. In *Proceedings of the 2020 CHI conference on human factors in computing systems*(pp. 1-16).
- Majid, N. W. A., & Ridwan, T. (2019). Development of the traditional digital games for strengthening childhood's verbal skill. *Jurnal Pendidikan Vokasi*, 9(1), 75–82.
- Malinverni, L., Schaper, M. M., Rubegni, E., & Tamashiro, M. A. (2025). Scaffolding children's critical reflection on intelligent technologies: opportunities from speculative fiction. *International Journal of Child-Computer Interaction*, 43, 100727.
- Morgan, S. (2006). Foreword: What a Writer Does Best. *The Missouri Review*, 29(2), 5-7.
- Niemi, H., Niu, S., Vivitsou, M., & Li, B. (2018). Digital storytelling for twenty-first-century competencies with math literacy and student engagement in China and Finland. *Contemporary Educational Technology*, 9(4), 331–353
- Parasuraman, R., & Riley, V. (1997). Humans and automation: Use, misuse, disuse, abuse. *Human factors*, 39(2), 230-253.
- Pelech, J. (2021). Student-centered research: Blending constructivism with action research. IAP.
- Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational psychologist*, 50(4), 258-283.
- Prensky, M. (2001). Fun, play and games: What makes games engaging. *Digital game-based learning*, 5(1), 5-31.
- Robin, B. R. (2008). Digital storytelling: A powerful technology tool for the 21st century classroom. *Theory into practice*, 47(3), 220-228.
- Selwyn, N. (2019). *Should robots replace teachers?: AI and the future of education*. John Wiley & Sons.
- Smith, L., Martin, W. G., Wan, A., Duenas, G., Shumack, K., & Beziat, T. L. (2015). Using Reform Pedagogy To Improve Students' application Skills In College Remedial Mathematics Courses. *Mathematics And Computer Education*, 49(2), 124.
- Tokac, U., Novak, E., & Thompson, C. G. (2019). Effects of game-based learning on students' mathematics achievement: A meta-analysis. *Journal of Computer Assisted Learning*, 35(3), 407-420.
- Ünüvar, E., & Barut, S. (2020). The effect of using educational mathematics stories enriched with cartoons in teaching integers on children's academic achievement. *Academy Journal of Educational Sciences*, 4(1),
- Xia, Q., Chiu, T. K., Lee, M., Sanusi, I. T., Dai, Y., & Chai, C. S. (2022). A self-determination theory (SDT) design approach for inclusive and diverse artificial intelligence (AI) education. *Computers & Education*, 189, 104582.
- Yeh, Y. C., Sai, N. P., & Chuang, C. H. (2020). Differentiating between the "Need" for and the "Experience" of self-determination regarding their influence on pupils' learning of creativity. *International Journal of Human-Computer Interaction*, 36(14), 1368-1378.
- Yuan, B., & Hu, J. (2025, December). Generative AI as a tool for enhancing reflective learning in students. In *2025 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)* (pp. 1-6). IEEE.
- Zhai, X. (2023). ChatGPT for next generation science learning. *XRDS: Crossroads, The ACM Magazine for Students*, 29(3), 42-46.