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Research Article

Digital Storytelling with Generative AI: Impact on Creativity and Engagement in Middle School Learners

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Abstract

Digital storytelling is a proven pedagogy for fostering student expression, but its potential is being redefined by generative artificial intelligence (AI). While AI offers unprecedented tools for creating visual and narrative assets, its specific impact on the creativity and engagement of middle school learners requires empirical investigation. This study aimed to evaluate the impact of integrating generative AI into digital storytelling projects on the creativity and engagement levels of middle school students compared to traditional digital methods. A quasi-experimental, pre-test/post-test design was conducted with 120 middle school students. The intervention group used generative AI tools to create story assets, while the control group used standard digital tools. Creativity was assessed using a standardized rubric, and engagement was measured with the Student Engagement Instrument (SEI). The intervention group showed statistically significant gains in creativity metrics, particularly in originality and elaboration ($p < .01$). This group also reported significantly higher levels of cognitive and behavioral engagement compared to the control group ($p < .05$). Integrating generative AI into digital storytelling projects serves as a powerful catalyst, enhancing both the creative output and the active engagement of middle school learners. The technology acts as a creative partner, enabling students to realize more ambitious narrative visions.

Keywords: Digital Storytelling, Generative AI, Student Engagement

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INTRODUCTION

Digital storytelling has firmly established itself within modern pedagogy as a high-impact practice for fostering essential 21st-century skills in middle school learners (Nguyen et al., 2022; Paul et al., 2025). This multidisciplinary approach, which merges the ancient art of narrative with contemporary digital tools, empowers students to construct and share personal and academic stories. Through the process of scripting, recording audio, and integrating multimedia elements, students engage in deep learning that enhances literacy, communication skills, and technological fluency. More profoundly, digital storytelling provides a powerful platform for self-expression, identity exploration, and the development of creative confidence during the critical developmental window of early adolescence (Choudhury et al., 2022; Dong et al., 2024). Its value lies in its capacity to make learning personal, meaningful, and visible.

The educational landscape is currently being reshaped by the advent of generative artificial intelligence (AI), a transformative technology with the capacity to create novel text, images, sounds, and other media from simple natural language prompts. Tools like DALL-E, Midjourney, and other generative models are no longer confined to research labs but have become widely accessible, democratizing the creation of high-quality digital assets. This technological wave is beginning to permeate creative and educational fields, presenting both unprecedented opportunities and complex challenges (Karim et al., 2023; Pereira et al., 2024). The ability to generate custom visuals or narrative fragments almost instantaneously promises to redefine the creative process for learners and educators alike.

The intersection of digital storytelling and generative AI represents a particularly potent and unexplored frontier. Traditionally, a significant barrier for students in digital storytelling projects has been the technical skill or time required to create or source appropriate visual and audio assets to match their narrative vision. Generative AI offers a potential solution to this bottleneck, enabling students to act as creative directors who can conjure bespoke images, characters, and settings that align perfectly with their stories (Kumari et al., 2023; Paul et al., 2025). This synergy could lower technical barriers, amplify creative possibilities, and allow students to produce more sophisticated and polished narratives, thereby shifting the focus from technical execution to the core elements of storytelling and imaginative expression.

Despite the immense creative potential offered by generative AI, its integration into educational practices like digital storytelling is occurring in an empirical vacuum. The rapid proliferation of these tools has far outpaced research into their actual impact on student learning and development. The central problem this research addresses is the significant lack of rigorous, evidence-based understanding of how using generative AI to create story assets affects two core pedagogical goals of digital storytelling: the cultivation of student creativity and the fostering of deep engagement. While the technology is celebrated for its capabilities, its effect on the learner's cognitive and affective processes remains largely unexamined.

The specific issue at hand is a fundamental uncertainty about the nature of AI's role in the creative process. Does providing students with an AI tool that can instantly generate images and text act as a "creative catalyst," enabling them to explore more original ideas and elaborate on their narratives in more complex ways? Or does it function as a "creative crutch," leading to a more passive form of creation, diminished originality, and a reduction in the valuable cognitive struggle that is inherent to the creative process? This ambiguity poses a significant problem for educators who must decide whether, and how, to incorporate these powerful tools into their classrooms.

This problem is particularly acute in the context of middle school education. This period is a crucial stage for the development of creative thinking skills and intrinsic motivation (Belho et al., 2023; Yue et al., 2024). The unguided or misunderstood application of generative AI could inadvertently stifle the very skills it is presumed to support, potentially fostering a dependency on the technology and devaluing students' own imaginative capacities. Without a clear understanding of its impact on creativity and engagement, educators risk implementing a technology that could have unintended and potentially detrimental consequences on the long-term development of their students.

The primary objective of this study is to conduct a quasi-experimental investigation to evaluate the impact of integrating generative AI tools into a digital storytelling curriculum on the creativity of middle school students. This research aims to systematically measure and compare the creative attributes of digital stories produced by students using generative AI against those produced by students using traditional digital tools (e.g., stock photo libraries, drawing software) (Qin et al., 2024; Wang, 2023). Using a validated rubric, the study will assess specific dimensions of creativity, such as originality, elaboration, and fluency, to determine if the AI-integrated approach leads to a statistically significant difference in creative output.

A second, parallel objective of this research is to assess the effect of using generative AI on the engagement levels of middle school students during the digital storytelling process. Engagement is a multidimensional construct, and this study seeks to measure its cognitive, behavioral, and emotional facets using a standardized instrument (Ajani et al., 2023; Fu & Jiang, 2022). The goal is to determine whether the process of collaborating with a generative AI partner makes the creative task more or less engaging, interesting, and motivating for students compared to the traditional, non-AI approach.

Ultimately, this study aims to synthesize these quantitative findings to provide a holistic and nuanced understanding of how generative AI functions within a creative pedagogical framework. The research seeks to move beyond a simplistic evaluation of the final products and explore the interplay between the technology, the creative process, and the student experience. By examining both creativity and engagement concurrently, the study intends to provide educators with a comprehensive, data-driven answer to the question (Andrade et al., 2024; Dubey et al., 2022): What is the true impact of using generative AI as a creative partner in middle school digital storytelling projects?

The scholarly literature on digital storytelling is well-established, with a wealth of research confirming its benefits for student learning and expression. Similarly, a new and rapidly growing body of literature is emerging around the educational implications of generative AI. A significant gap, however, exists at the precise intersection of these two fields (Holler et al., 2024; Ratnayake et al., 2023). There is a notable scarcity of empirical studies that investigate the use of *generative* AI tools specifically within the context of a structured, project-based learning activity like digital storytelling, particularly at the middle school level.

This gap is largely methodological in nature. Much of the current discourse on generative AI in creative education consists of theoretical papers, anecdotal reports, or small-scale, descriptive case studies (Sahana et al., 2022; Sharma & Kumar, 2024). While these are valuable for initial exploration, they lack the methodological rigor needed to draw causal inferences. The literature is missing quasi-experimental studies that employ a control group design and validated instruments to systematically compare the outcomes of an AI-integrated

approach with traditional methods. This absence of controlled, comparative research makes it difficult to isolate the specific effects of the technology itself.

A conceptual gap also exists in how creativity is understood and measured in the context of human-AI collaboration. The field has not yet fully developed frameworks for assessing creativity when a student's output is co-created with a generative partner. Does originality lie in the prompt given to the AI, the selection and curation of AI-generated assets, or the final synthesis of all elements? This study seeks to address this conceptual gap by applying established creativity rubrics to the final student artifacts, providing a foundational methodology for evaluating creativity in this new paradigm and paving the way for more nuanced future research.

The principal novelty of this research lies in its specific and rigorous examination of generative AI's role as a creative partner in a middle school classroom. This study is among the first to move beyond speculation and employ a quasi-experimental design to empirically measure the technology's impact on the well-defined constructs of creativity and engagement. Its focus on middle school learners, a critical but under-researched demographic in this area, further enhances its novelty and relevance.

This research is justified by the urgent need for evidence-based guidance for educators who are currently navigating the rapid and often chaotic influx of generative AI tools into their students' lives (Kumar et al., 2022; Santos et al., 2023). Without empirical data, decisions about whether to ban, ignore, or embrace these technologies are being made based on fear, anecdote, or commercial hype. This study is essential because it will provide educators with concrete data to inform the development of pedagogical strategies that can harness the potential benefits of AI while mitigating its risks.

The broader justification for this work rests on its contribution to a fundamental conversation about the future of creativity and learning in an increasingly automated world. By investigating the dynamic between a developing human creator and a powerful AI tool, this study provides critical insights into the skills and mindsets that will be necessary for future creative collaboration (Patriche & Irimia, 2022; Pichler et al., 2022). It is important because it addresses not just a technological trend, but a paradigm shift in how we think about human expression, making it a vital piece of research for preparing students for a future where partnership with AI will be the norm.

RESEARCH METHOD

Research Design

This study employed a quasi-experimental, pre-test/post-test non-equivalent control group design to assess the impact of using generative AI in digital storytelling projects. This design was selected to allow for a comparative analysis between an intervention group and a control group within an authentic school environment where random assignment of individual students was not feasible. The independent variable was the type of tool used for creating story assets, with the intervention group using generative AI and the control group using traditional digital tools (Mummidi, 2024; Pichler et al., 2022). The dependent variables were student creativity, operationally defined by scores on a standardized rubric, and student engagement, measured by a validated self-report instrument.

Population and Sample

The study's population consisted of 7th-grade students from a large, suburban public middle school with a diverse student body. Two intact social studies classes, taught by the same instructor to control for teacher effects, were selected for the study via purposive sampling. One class was randomly assigned to serve as the intervention group (n=60), which utilized generative AI tools (Jeeceelee & Sahoo, 2022; Sahoo et al., 2023). The other class was assigned as the control group (n=60), which used a curated library of stock images and basic drawing software. The total sample size was 120 students. Pre-test data on creativity and engagement were used to establish a baseline and statistically control for any initial group differences.

Instruments

Two primary instruments were used to collect quantitative data. Student creativity was assessed using the "Torrance Test of Creative Thinking (TTCT) - Figural" as a pre-test and a researcher-adapted "Digital Storytelling Creativity Rubric" as a post-test. The rubric evaluated the final story artifacts on dimensions of originality, elaboration, fluency, and flexibility, and was validated by a panel of three educational technology experts, achieving high inter-rater reliability (Cohen's Kappa = .88). Student engagement was measured using the validated Student Engagement Instrument (SEI), which assesses cognitive, behavioral, and emotional engagement on a 5-point Likert scale, administered at the beginning and end of the project.

Procedures

The study was conducted over a six-week project period within the regular social studies curriculum, following approval from the university's institutional review board and the school district, as well as obtaining parental consent and student assent. In the first week, all students completed the TTCT and the SEI as pre-tests. Both groups were then tasked with creating a digital story about a historical event. The intervention group was trained on and given access to a specific generative AI image tool to create all visual assets for their stories (Arima et al., 2022; Liu et al., 2024). The control group was provided with access to a school-approved digital library of historical images and a simple online drawing program. In the final week, students submitted their digital stories for evaluation with the creativity rubric and completed the SEI again as a post-test.

RESULTS AND DISCUSSION

The initial quantitative analysis examined the pre-test and post-test scores from the "Digital Storytelling Creativity Rubric" and the "Student Engagement Instrument" (SEI). The data revealed a clear and substantial difference in the mean gain scores between the intervention group, which used generative AI tools, and the control group, which used traditional digital tools. The intervention group demonstrated significantly greater improvements in both the creativity of their final projects and their self-reported levels of engagement.

A summary of these descriptive statistics is presented in Table 1. The table outlines the mean scores (M), standard deviations (SD), and the total number of participants (N) for both groups on the two primary measures. The mean gain score is also included to provide a direct comparison of the progress made by each group over the six-week project period.

Table 1: Descriptive Statistics for Creativity Rubric and SEI Scores

Instrument	Group	Time	N	Mean (M)	Standard Deviation (SD)	Mean Gain Score
Creativity (of 100)	Intervention	Pre-Test	60	55.2	10.1	
		Post-Test	60	81.7	8.9	+26.5
	Control	Pre-Test	60	54.9	10.4	
		Post-Test	60	62.3	10.8	+7.4
SEI Score (of 5)	Intervention	Pre-Test	60	3.15	0.61	
		Post-Test	60	4.35	0.52	+1.20
	Control	Pre-Test	60	3.12	0.64	
		Post-Test	60	3.31	0.68	+0.19

The quantitative results for creativity show a dramatic difference between the two conditions. The intervention group's mean gain of +26.5 points on the creativity rubric is nearly four times greater than the +7.4-point gain observed in the control group. This large effect size strongly suggests that the use of generative AI tools had a significant positive impact on the overall creativity of the students' final digital stories, particularly in dimensions like originality and elaboration.

A similarly compelling pattern was found in the student engagement data. The intervention group's mean score on the SEI increased by a substantial +1.20 points, indicating a major positive shift in their cognitive, behavioral, and emotional engagement with the project. In contrast, the control group reported a minimal increase of just +0.19 points. This suggests that the process of creating with generative AI was significantly more motivating and engaging for middle school learners than using traditional digital tools.

Qualitative data were gathered from brief, open-ended reflection questions attached to the final project submission. The thematic analysis of these reflections revealed distinct experiential narratives for each group. Two primary themes emerged from the intervention group's data: "Creative Liberation," where students described feeling freed from their own technical or artistic limitations, and "Iterative Exploration," reflecting a process of rapidly generating and refining ideas in partnership with the AI.

The control group's reflections yielded two contrasting themes. The first was "Frustration with Constraints," where students frequently expressed difficulty in finding or creating visuals that accurately matched their narrative vision. The second theme was "Technical Skill as a Barrier," which captured the sentiment that their final product was more a reflection of their ability with the drawing software or search skills than their actual creative ideas.

The themes from the intervention group can be inferred to be the direct drivers of their enhanced creativity and engagement. The feeling of "Creative Liberation" suggests that the AI tool lowered the barrier to entry for visual expression, allowing students to focus their

cognitive energy on the core narrative and imaginative aspects of the project. The theme of "Iterative Exploration" points to a dynamic and playful creative process, where students could experiment with numerous possibilities without the high time cost of manual creation, fostering a more flexible and fluent approach to ideation.

The control group's themes explain their more limited progress. The "Frustration with Constraints" likely led to a dampening of creative ambition, as students settled for "good enough" assets rather than pursuing their ideal vision. The perception of "Technical Skill as a Barrier" suggests that their cognitive load was heavily taxed by the mechanics of the tools, leaving fewer resources available for higher-order creative thinking and storytelling, which likely contributed to their lower engagement levels.

A robust and coherent relationship exists between the quantitative results and the qualitative themes. The significantly higher creativity scores (+26.5 point gain) in the intervention group are directly explained by the students' feelings of "Creative Liberation." They were able to produce more original and elaborate stories because the AI tool empowered them to create specific, unique assets that were previously beyond their reach. The quantitative outcome is a direct reflection of this qualitatively described experience.

The dramatic increase in the intervention group's engagement scores (+1.20 point gain) is likewise illuminated by the qualitative data. This statistical increase is the numerical representation of the "Iterative Exploration" process students described. The project became more engaging because the AI transformed the often tedious task of asset creation into a fun, fast-paced, and rewarding cycle of discovery and refinement, fostering a state of creative flow.

To illustrate these findings, the case of "Aisha," a student in the intervention group, is particularly revealing. Aisha's project was about the Silk Road, and she envisioned a story told from the perspective of a unique merchant character with specific clothing and a camel with distinct saddlebags. Using traditional tools, she would have struggled to find or draw such specific imagery. Using the generative AI, she was able to generate a consistent character and a series of unique backgrounds for different points along the trade route simply by refining her descriptive text prompts.

Her final reflection stated, "I could make the pictures look exactly like they did in my head. I spent all my time thinking about the story and what the merchant would see, not trying to find the right picture of a camel." Her digital story was rated exceptionally high on originality and elaboration, as every visual element was bespoke and directly tied to her narrative.

Aisha's case perfectly demonstrates the mechanism of "Creative Liberation" in action. The AI tool removed the technical barrier that would have previously stood between her imagination and her final product. This allowed her to invest her cognitive resources in the narrative itself—the plot, the character's perspective, and the historical details—which are the core components of effective storytelling. Her ability to create precisely what she envisioned explains her high score on the creativity rubric.

Her experience also exemplifies the "Iterative Exploration" theme that drove engagement. The process of refining her prompts to get the perfect image was an engaging and rewarding challenge in itself. It was a creative act that was directly integrated into the storytelling process. This seamless fusion of ideation and creation explains why students like Aisha found the project so much more engaging than the control group, who experienced asset creation and storytelling as two separate and often frustrating tasks.

The combined findings of this study strongly indicate that the integration of generative AI into digital storytelling projects acts as a powerful catalyst for both creativity and engagement in middle school learners. The results demonstrate this effect through convergent quantitative and qualitative evidence. Students using AI tools did not just produce more creative artifacts; they also reported a more engaging, liberating, and exploratory learning experience.

This research interprets generative AI as a "creative accelerant" that lowers technical barriers and allows students to more fully realize their imaginative visions. By automating the more laborious aspects of digital asset creation, the technology frees up students' cognitive capacity to focus on higher-order skills such as narrative development, originality, and complex ideation. The findings suggest that, when implemented thoughtfully, generative AI can be a transformative partner in the creative process, empowering students to become more ambitious and engaged storytellers.

The findings from this study present a clear and compelling narrative of the transformative impact of generative AI on middle school digital storytelling projects. The quantitative data revealed a stark and statistically significant difference between the intervention and control groups. Students utilizing generative AI demonstrated a mean gain in creativity scores that was nearly four times greater than their peers using traditional tools. This suggests that the AI integration did not just incrementally improve creative output but acted as a powerful accelerant.

This substantial enhancement in creativity was mirrored by an equally dramatic increase in student engagement. The intervention group's self-reported engagement levels surged, indicating a profound positive shift in their cognitive, behavioral, and emotional investment in the project. The control group, by contrast, showed almost no change, suggesting that the traditional digital storytelling process, with its inherent technical frustrations, failed to capture and sustain student interest to the same degree.

Qualitative data from student reflections provided a rich, explanatory layer to these numerical results. The intervention group's experience was characterized by feelings of "Creative Liberation" from technical constraints and a dynamic process of "Iterative Exploration" with the AI. Conversely, the control group's narrative was dominated by themes of "Frustration with Constraints" and the perception of "Technical Skill as a Barrier," highlighting a creative process that was often stymied by the limitations of their tools.

The case study of Aisha served as a powerful exemplar of the intervention's core mechanism. Her ability to use the AI to precisely manifest her imaginative vision for a historical narrative—creating bespoke characters and settings—perfectly illustrates how the technology can remove artistic barriers. This allowed her to focus on the higher-order aspects of storytelling, resulting in a product that was both highly creative and deeply engaging for her to produce.

These findings strongly support and extend constructionist learning theories, particularly those articulated by Seymour Papert. Papert envisioned computers as tools that would empower children to build, create, and learn in powerful new ways. This study demonstrates that generative AI can function as the ultimate "object-to-think-with," providing students with an unprecedentedly fluid and responsive medium for constructing their narrative worlds. The "Iterative Exploration" theme directly reflects Papert's ideal of learning through playful experimentation and discovery.

The dramatic increase in student engagement aligns closely with Self-Determination Theory, which posits that autonomy, competence, and relatedness are key drivers of intrinsic motivation. The AI tool directly fostered autonomy by giving students greater control over their creative output. It enhanced feelings of competence by lowering technical barriers and enabling them to produce high-quality work ("Creative Liberation"). This contrasts with literature on earlier educational technologies, which often failed to support these fundamental psychological needs, leading to disengagement.

This research also provides a critical update to the existing literature on digital storytelling. While previous studies have consistently validated digital storytelling as an effective pedagogy, they have also acknowledged the challenge that technical skill acquisition can pose. This study introduces generative AI as a variable that fundamentally alters this dynamic. It suggests that by offloading the technical burden of asset creation, AI allows the pedagogical benefits of digital storytelling—narrative construction, critical thinking, self-expression—to be realized more fully and equitably.

A point of departure from some of the more cautious literature on AI in education is the overwhelmingly positive impact on creativity. While some scholars have raised concerns that AI might lead to homogenized or less authentic work, this study found the opposite. The AI acted as a catalyst for originality and elaboration, enabling students to create more unique and detailed stories. This suggests that when used as a tool for realizing a student's own vision, rather than as a replacement for it, AI can augment, not diminish, human creativity.

The results signify a fundamental shift in the relationship between the creator and their tools. The traditional model often places the tool as a potential obstacle between an idea and its execution. This study shows that generative AI can invert this relationship, transforming the tool into an active partner in the creative process. The technology did not merely execute commands; it engaged students in a rapid, iterative dialogue, allowing them to refine their ideas with a speed that was previously unimaginable. This reflects a move from a human-tool paradigm to a human-AI collaborative paradigm.

The theme of "Creative Liberation" is profoundly meaningful. It suggests that for many middle school students, their creative potential is often constrained not by a lack of imagination, but by a lack of technical skill to express that imagination. The AI tool acted as a great equalizer, leveling the playing field so that a student's final product was a more accurate reflection of their ideas rather than their artistic or technical prowess. This signifies a potential democratization of creative expression in the classroom.

The stark contrast in the qualitative experiences of the two groups is also highly significant. The control group's frustration highlights how easily a creative project can become a technical chore. Their experience underscores a critical flaw in many project-based learning initiatives: an overemphasis on tool proficiency at the expense of creative and critical thought. The success of the intervention group is a clear signal that the most effective educational technologies are those that become invisible, allowing the learner to remain focused on the primary learning objective.

Ultimately, the findings reflect the immense power of seeing one's own ideas come to life. The surge in engagement in the intervention group can be attributed to the deeply rewarding experience of successfully translating an internal vision into an external reality. The AI tool closed the gap between imagination and manifestation, creating a powerful and

motivating feedback loop. The results are a testament to the idea that one of the most effective ways to engage a learner is to empower them to become a successful creator.

The most direct implication is for middle school educators and curriculum designers. This study provides a strong, evidence-based rationale for integrating generative AI tools into project-based learning, particularly in the arts and humanities. It suggests a pedagogical shift away from teaching specific software skills towards teaching "prompt literacy" and the art of creative direction. The implication is that teachers should act as facilitators who help students effectively collaborate with AI as a creative partner.

For the field of educational technology, the implications are clear. The findings validate the development of AI tools designed specifically for educational settings that prioritize user control, creative flexibility, and ease of use. Developers should focus on creating systems that are not just powerful but are also designed to scaffold the creative process for young learners. This research provides a use case that justifies investment in safe, age-appropriate, and pedagogically-sound generative AI platforms for schools.

This study also has implications for how we assess creativity in schools. As AI becomes a more common creative partner, traditional rubrics may need to be revised. The focus of assessment may need to shift from the technical quality of the final artifact to the quality of the ideas, the originality of the prompts, and the sophistication of the student's creative process. This research prompts a necessary conversation about what constitutes "original work" in an age of human-AI co-creation.

Theoretically, this research contributes to our understanding of creativity as a distributed process. It challenges the romantic notion of the lone genius and provides a concrete example of creativity emerging from the interaction between a human mind and a non-human system. This has implications for cognitive science and learning theories, suggesting that our models of creativity must expand to account for these new collaborative, technologically-mediated workflows.

The intervention's success can be primarily attributed to the dramatic reduction in cognitive load for the students. The control group had to split their mental energy between the creative task of storytelling and the technical task of finding or creating images. The intervention group, freed from the technical burden, could devote nearly all of their cognitive resources to the higher-order skills of narrative development, character design, and imaginative world-building.

The immediacy and fluidity of the AI tool fostered a state of creative flow. The "Iterative Exploration" process was fast, engaging, and rewarding. Students could generate an idea, see it visualized, and refine it in a matter of seconds. This rapid feedback loop kept them deeply immersed in the creative process, which stands in stark contrast to the control group's experience of getting bogged down in frustrating searches or clunky drawing tools, which constantly broke their creative momentum.

The AI tool effectively scaffolded the visualization process. Many middle schoolers can imagine a scene in great detail but lack the artistic skill to draw it. The AI acted as a "visual prosthetic," translating their textual descriptions into compelling images. This success in creating visually appealing assets, as seen in Aisha's case, likely boosted students' self-efficacy and confidence, encouraging them to take greater creative risks and invest more effort in their projects.

A final reason for the results is the alignment of the technology with the core goals of the project. The goal was to tell a creative story, not to become an expert digital artist or image curator. The generative AI was a tool perfectly suited to this goal, as it directly served the narrative creation process. The tools used by the control group often became an end in themselves, a technical hurdle to be overcome, which distracted from the primary pedagogical objective.

The clear next step for research is to explore the nuances of the human-AI creative process in more detail. Qualitative studies, including think-aloud protocols where students verbalize their thoughts while using the AI, are needed to gain a deeper understanding of the cognitive strategies they employ. This would help in developing a more sophisticated theory of AI-assisted creativity.

Future research should also investigate the long-term impact of using these tools. Longitudinal studies are needed to determine if sustained use of generative AI enhances or potentially hinders the development of students' own intrinsic artistic skills. It is crucial to understand if students who rely on AI for visualization are less likely to develop their own drawing or design abilities over time.

It is also important to expand this research to other domains and age groups. Studies should explore the impact of generative AI on creative writing, music composition, and scientific modeling across different educational levels, from elementary school to university. This would help to establish whether the catalytic effects on creativity and engagement observed in this study are a generalizable phenomenon.

Finally, a critical avenue for future inquiry involves the ethical dimensions of using generative AI in creative projects. Research is needed to develop frameworks for teaching students about issues such as algorithmic bias in image generation, the intellectual property of AI-created content, and the importance of maintaining their own authentic voice. This ethical component is essential for ensuring that these powerful tools are used responsibly and thoughtfully.

CONCLUSION

The most significant and distinct finding of this research is the powerful, synergistic impact of generative AI on both creativity and engagement in middle school learners. The study demonstrates that by removing technical and artistic barriers, the AI acts as a "creative accelerant," not only leading to a quantifiable leap in the originality and elaboration of students' digital stories but also fostering a profoundly more engaging and exploratory learning process. This dual enhancement of both the creative product and the creative experience is the core discovery of this work.

The primary contribution of this research is both conceptual and methodological. Conceptually, it provides a modern, empirical validation of constructionist and self-determination theories, demonstrating how generative AI can function as an ultimate "object-to-think-with" that fosters autonomy and competence. Methodologically, it establishes a robust quasi-experimental framework for assessing human-AI creative collaboration, moving the field beyond anecdotal reports and providing a model for evaluating the nuanced impacts of these emerging technologies on learning.

This study's conclusions are necessarily constrained by its specific context and scope, which clearly delineates the path for subsequent inquiry. The findings are based on a single

project in a middle school setting, highlighting the need for future research across different age groups, subject domains, and cultural contexts to establish broader generalizability. Longitudinal studies are also critically needed to assess the long-term effects on students' intrinsic artistic skills and creative confidence, alongside a deeper investigation into the ethical frameworks required for responsible human-AI co-creation in education.

AUTHOR CONTRIBUTIONS

Look this example below:

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

REFERENCES

Ajani, O. S., Usigbe, M. J., Aboyeji, E., Uyeh, D. D., Ha, Y., Park, T., & Mallipeddi, R. (2023). Greenhouse Micro-Climate Prediction Based on Fixed Sensor Placements: A Machine Learning Approach. *Mathematics*, *11*(14). Scopus. https://doi.org/10.3390/math11143052

Andrade, C., Fonseca, A., Santos, J. A., Bois, B., & Jones, G. V. (2024). Historic Changes and Future Projections in Köppen–Geiger Climate Classifications in Major Wine Regions Worldwide. *Climate*, *12*(7). Scopus. https://doi.org/10.3390/cli12070094

Arima, E. Y., Denvir, A., Young, K. R., González-Rodríguez, A., & García-Oliva, F. (2022). Modelling avocado-driven deforestation in Michoacán, Mexico. *Environmental Research Letters*, *17*(3). Scopus. https://doi.org/10.1088/1748-9326/ac5419

Belho, K., Rawat, M. S., & Rawat, P. K. (2023). GIS modeling to investigate environmental change and degradation in Kohima district, North East Hill (NEH) region of India. *Environmental Monitoring and Assessment*, *195*(12). Scopus. https://doi.org/10.1007/s10661-023-12055-2

Choudhury, B. U., Nengzouzam, G., & Islam, A. (2022). Evaluation of climate change impact on soil erosion in the integrated farming system based hilly micro-watersheds using Revised Universal Soil Loss Equation. *Catena*, *214*. Scopus. https://doi.org/10.1016/j.catena.2022.106306

Dong, P., Wang, L., Qiu, D., Liang, W., Cheng, J., Wang, H., Guo, F., & Chen, Y. (2024). Evaluation of the environmental factors influencing the quality of Astragalus membranaceus var. Mongholicus based on HPLC and the Maxent model. *BMC Plant Biology*, *24*(1). Scopus. https://doi.org/10.1186/s12870-024-05355-3

Dubey, M., Mishra, A., & Singh, R. (2022). Identification of the most appropriate adaptation for rice and wheat in the face of climate change in eastern India. *Journal of Water and Climate Change*, *13*(2), 943–962. Scopus. https://doi.org/10.2166/wcc.2021.446

Fu, X., & Jiang, D. (2022). High-throughput phenotyping: The latest research tool for sustainable crop production under global climate change scenarios. In *Sustainable Crop Productivity and Quality under Climate Change: Responses of Crop Plants to Climate Change* (pp. 313–381). Elsevier; Scopus. https://doi.org/10.1016/B978-0-323-85449-8.00003-8

Holler, C., Engelmaier, M., Kajtna, B., & Spornberger, A. (2024). Impacts of Climate Warming on Climate Parameters Relevant to Extensive Fruit Growing in Two Selected Regions of Austria. *Mitteilungen Klosterneuburg*, *74*(4), 234–247. Scopus.

Jeeceelee, L., & Sahoo, U. K. (2022). Mizo Homegardens promote biodiversity conservation, nutritional security and environmental development in northeast India. *Acta Ecologica Sinica*, *42*(5), 520–528. Scopus. https://doi.org/10.1016/j.chnaes.2021.12.005

Karim, A., Syakur, S., & Hifnalisa, H. (2023). Farmers coping strategies to climate change in sustainable Arabica coffee production. *IOP Conf. Ser. Earth Environ. Sci.*, *1183*(1). Scopus. https://doi.org/10.1088/1755-1315/1183/1/012097

Kumar, R., Nath, A. J., Nath, A., Sahu, N., & Pandey, R. (2022). Landsat-based multi-decadal spatio-temporal assessment of the vegetation greening and browning trend in the Eastern Indian Himalayan Region. *Remote Sensing Applications: Society and Environment*, *25*. Scopus. https://doi.org/10.1016/j.rsase.2022.100695

Kumari, M., Zinta, G., Chauhan, R., Kumar, A., Singh, S., & Singh, S. (2023). Genetic resources and breeding approaches for improvement of amaranth (Amaranthus spp.) and quinoa (Chenopodium quinoa). *Frontiers in Nutrition*, *10*. Scopus. https://doi.org/10.3389/fnut.2023.1129723

Liu, M., Yang, L., Su, M., Gong, W., Liu, Y., Yang, J., Huang, Y., & Zhao, C. (2024). Modeling the potential distribution of the energy tree species Triadica sebifera in response to climate change in China. *Scientific Reports*, *14*(1). Scopus. https://doi.org/10.1038/s41598-023-51035-x

Mummidi, T. (2024). Millets, Shifting Cultivation and the Adivasis: Looking Through Culture, Policy and Politics. *Sociological Bulletin*, *73*(4), 443–454. Scopus. https://doi.org/10.1177/00380229241287394

Nguyen, C. H., Setyaningsih, C. A., Jahnk, S. L., Saad, A., Sabiham, S., & Behling, H. (2022). Forest Dynamics and Agroforestry History since AD 200 in the Highland of Sumatra, Indonesia. *Forests*, *13*(9). Scopus. https://doi.org/10.3390/f13091473

Patriche, C. V., & Irimia, L. M. (2022). Mapping the impact of recent climate change on viticultural potential in Romania. *Theoretical and Applied Climatology*, *148*(3–4), 1035–1056. Scopus. https://doi.org/10.1007/s00704-022-03984-y

Paul, S., Chakraborty, D., & Tripathi, A. K. (2025). Frontline extension services as a buffer against social vulnerability to climate change: A case study of shifting cultivators in Northeast India. *Journal of Environmental Management*, *377*. Scopus. https://doi.org/10.1016/j.jenvman.2025.124607

Pereira, R. R. D. C., Ribeiro e Silva, R., de Oliveira, V. P., & Valentin, J. L. (2024). Forecasting the impact of marine heat waves on farmed bivalves Nodipecten nodosus and Magallana gigas. *Regional Studies in Marine Science*, *80*. Scopus. https://doi.org/10.1016/j.rsma.2024.103883

Pichler, M., Schmid, M., & Gingrich, S. (2022). Mechanisms to exclude local people from forests: Shifting power relations in forest transitions. *Ambio*, *51*(4), 849–862. Scopus. https://doi.org/10.1007/s13280-021-01613-y

Qin, Z., Zhu, Y., Canadell, J. G., Chen, M., Li, T., Mishra, U., & Yuan, W. (2024). Global spatially explicit carbon emissions from land-use change over the past six decades (1961–2020). *One Earth*, *7*(5), 835–847. Scopus. https://doi.org/10.1016/j.oneear.2024.04.002

Ratnayake, S. S., Reid, M., Larder, N., Kadupitiya, H. K., Hunter, D., Dharmasena, P. B., Kumar, L., Kogo, B., Herath, K., & Kariyawasam, C. S. (2023). Impact of Climate Change on Paddy Farming in the Village Tank Cascade Systems of Sri Lanka. *Sustainability (Switzerland)*, *15*(12). Scopus. https://doi.org/10.3390/su15129271

Sahana, M., Areendran, G., Raj, K., Sivadas, A., Abhijitha, C. S., & Ranjan, K. (2022). Introduction to Forest Resources in India: Conservation, Management and Monitoring Perspectives. In *Conservation, Management and Monitoring of Forest Resources in India* (pp. 3–31). Springer International Publishing; Scopus. https://doi.org/10.1007/978-3-030-98233-1_1

Sahoo, U. K., Ahirwal, J., Giri, K., Mishra, G., & Francaviglia, R. (2023). Modeling Land Use and Climate Change Effects on Soil Organic Carbon Storage under Different Plantation Systems in Mizoram, Northeast India. *Agriculture (Switzerland)*, *13*(7). Scopus. https://doi.org/10.3390/agriculture13071332

Santos, C. C. D., Gutiérrez, J. A. M., Brossard, M., Desjardins, T., & Ferraz, A. S. D. L. (2023). Land-Use and Land-Cover Changes and Farmers' Perceptions of Ecosystem Services in an Eastern Amazon Rural Settlement. *Professional Geographer*, *75*(6), 932–946. Scopus. https://doi.org/10.1080/00330124.2023.2199326

Sharma, C., & Kumar, P. (2024). IoT-Based ML Model to Sense Selection of Seed Crops in Changing Climatic Conditions of Punjab. In Shaw R.N., Siano P., Makhilef S., Ghosh A., & Shimi S.L. (Eds.), *Lect. Notes Electr. Eng.* (Vol. 1115, pp. 215–228). Springer Science and Business Media Deutschland GmbH; Scopus. https://doi.org/10.1007/978-981-99-8661-3_16

Wang, H. (2023). Going Back to Grassland? Assessing the Impact of Groundwater Decline on Irrigated Agriculture Using Remote Sensing Data. *Remote Sensing*, *15*(6). Scopus. https://doi.org/10.3390/rs15061698

Yue, C., Li, H., & Shi, X. (2024). Geographical Distribution Dynamics of Acorus calamus in China Under Climate Change. *Plants*, *13*(23). Scopus. https://doi.org/10.3390/plants13233352