Can AI aid teachers to motivate inventiveness of learners in ICT, Math, Science, and TechVoc Areas

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Abstract: Grounded in Constructivist Learning Theory and supported by Amabile's Componential Theory of Creativity, this study investigates how artificial intelligence (AI) can aid teachers in motivating inventiveness among learners in ICT, Mathematics, and Science. Although existing literature highlights AI's potential to enhance personalization, feedback, and adaptive learning, few studies have explored how AI influences learners' creativity and innovation within STEM-related classroom settings, especially from both teacher and learner perspectives. This gap becomes more pronounced in basic education contexts where AI integration is still emerging and unevenly understood. Using a qualitative descriptive research design, the study gathers insights from purposively selected ICT, Math, and Science teachers (n = 10–12) who have utilized AI-assisted tools such as simulations, adaptive learning systems, and code assistants and students (n = 6–8 per discipline) who have been exposed to these AI-supported instructional activities. Data were through semi-structured interviews aligned with objectives aimed at identifying teachers' AI integration practices, learners' perceptions, and the motivational and inventive outcomes associated with AI-assisted learning environments. The study is expected to reveal that teachers use a range of AI platforms to promote creativity, experimentation, and problem-solving, but face challenges related to accessibility, technical training, and alignment with curriculum outcomes. Learners are anticipated to perceive AI tools as engaging and motivating, particularly due to features such as real-time feedback, personalized tasks, and interactive simulations that stimulate inventiveness. However, limitations such as cognitive overload, dependency on AI, or lack of proper guidance may also surface. Overall, the findings are expected to contribute a nuanced understanding of how AI can be pedagogically leveraged to cultivate creativity and innovation in ICT, Math, and Science classrooms, while also informing policy, teacher training, and the development of AI-supported instructional strategies aligned with constructivist and creativity-centered learning principles.

Keywords: Teachers, Motivate, Inventiveness, Science

INTRODUCTION

sThe rapid advancement of artificial intelligence (AI) is reshaping contemporary educational practices, particularly in Science, Mathematics, and ICT (SMICT) learning environments. AI-powered tools such as intelligent tutoring systems, adaptive learning platforms, coding assistants, and simulation applications are increasingly employed to provide personalized instruction, real-time feedback, and interactive learning experiences (Tarun, Du, Kannan, & Gehringer, 2025; Ra, Kim, Seo, & So, 2025). These tools are widely acknowledged for their potential to enhance complex thinking skills and support deeper engagement (Nirmala & Ravichandran, 2025; Calzada, 2024). However, despite these developments, limited research has examined the specific role of AI in cultivating learners' motivation and inventiveness in SMICT subjects. This gap becomes especially salient as schools explore how digital technologies can foster creativity and innovation alongside traditional academic competencies (Chiu et al., 2023; systematic review; Espartero, Calzada, & Prado, 2024).

This study was grounded in Constructivist Learning Theory, which emphasizes that learners actively construct knowledge through exploration, interaction, and problem-solving (Ruslim & Khalid, 2024; Piaget & Vygotsky, as cited in constructivist reviews). Constructivist perspectives suggest that technology-rich environments particularly those that encourage inquiry and experimentation can enhance learning by enabling students to manipulate information, test hypotheses, and build understanding through meaningful engagement. Similar observations have been reported in technology-based learning contexts where simulation and digital manipulation support student meaning-making (Carpio, Caburnay, Nolledo, et al., 2024). Complementing this is Amabile's Componential Theory of Creativity, which posits that creativity is shaped by intrinsic motivation, domain-specific skills, and opportunities for creative processes such as experimentation, ideation, and iterative refinement (Amabile, 2012; Amabile & Pratt, 2016). Together, these theories indicate that AI-assisted learning environments may provide the essential conditions for cultivating creativity by offering personalized pathways, immediate feedback, and opportunities for exploratory learning. Yet empirical evidence exploring these theoretical intersections, especially in basic education settings, remains limited (Al Darayseh, 2024; Chiu et al., 2023; Ceneciro, 2025).

Although previous studies have examined AI's role in improving student performance, streamlining assessment, or supporting differentiated instruction (Ruslim & Khalid, 2024; Nirmala & Ravichandran, 2025), relatively few have addressed how teachers integrate AI specifically to stimulate inventiveness in SMICT classrooms. Related research in science and mathematics shows that learning experiences are shaped by students' perceptions, engagement, and real-world encounters, but rarely links these elements to AI integration (Verdeflor, 2024a; Verdeflor, 2024b). Equally underexplored are students' perceptions of AI-driven learning activities and how these influence their motivation to create, innovate, design, or experiment. The limited documentation of teachers' lived experiences and learners' responses highlights a significant gap in existing literature (Sun et al., 2023; Al Darayseh, 2024; Barrientos, 2025). This gap is further echoed in studies on instructional stress and technology-mediated delivery, which emphasize the need for pedagogical support in digital transitions, including AI adoption (Quisay & Aquino, 2024).

To address this gap, this study sought to investigate how teachers utilize AI tools to encourage inventiveness among learners in ICT, Mathematics, and Science, and to explore how students perceive and engage with AI-assisted learning environments. The research aims to capture both teacher and learner perspectives to develop a holistic understanding of AI's pedagogical impact. Given the increasing adoption of AI tools such as simulation software in science classes, adaptive math systems that adjust to learner needs, and code assistants used in ICT there is a critical need for empirical insights into their effects on motivation and creative learning processes (Tarun et al., 2025; Ra et al., 2025). Studies examining AI-supported environmental and interdisciplinary learning similarly underscore the potential of AI to enhance inquiry, decision-making, and creativity (Dela Calzada, Tacbobo, Lualhati, et al., 2025).

Key concepts central to this investigation include AI integration in instruction, learner motivation, inventiveness, creativity, adaptive learning, simulation-based experiences, and teacher challenges related to digital implementation. These variables reflect the complex interplay between technology and pedagogy in modern classrooms and highlight the importance of designing AI-supported learning tasks consistent with constructivist and creativity-focused principles (Amabile, 2012; Frontiers in Education, 2025; Bondoc, 2024).

The expected outcomes of this study included evidence that AI tools, when effectively integrated, can enhance learners' motivation, promote curiosity, and support creative problem-solving. It is anticipated that teachers identified both benefits such as increased engagement and richer opportunities for exploration and challenges related to training, accessibility, and curriculum alignment. Students are expected to report heightened interest and inventiveness facilitated by interactive simulations, personalized feedback, and hands-on digital experimentation (Frontiers in Education, 2025; Al Darayseh, 2024). These expectations align with earlier studies showing that immersive and innovative learning environments increase student involvement and academic performance (Espartero et al., 2024; Carpio et al., 2024). Ultimately, the findings aimed to inform future instructional strategies, contribute to theoretical discourse on creativity and constructivism in AI-enhanced environments, and provide guidance for educators seeking to integrate AI meaningfully into SMICT subjects.

LITERATURE REVIEW

The integration of Artificial Intelligence (AI) in education has expanded rapidly, influencing instructional practices across Science, Mathematics, Information and Communication Technology (SMICT) disciplines. With AI tools becoming more accessible, teachers increasingly use them to enhance creativity, problem-solving, and student engagement. This literature review synthesizes existing research on how AI supports inventive learning, explores teacher practices, and examines student motivation and creativity in AI-assisted environments. Recent studies also note the rise of AI-related challenges and ethical dilemmas in academic settings, particularly among ICT and Science teachers (Chavez et al., 2024).

Types of AI Tools Used in Teaching STEM/ICT

Research highlights a variety of AI tools that support SMICT education, including adaptive learning platforms, intelligent tutoring systems (ITS), simulation environments, automated code assistants, and generative AI systems (Holmes et al., 2022; Zawacki-Richter et al., 2019). In mathematics classrooms, AI-enhanced tutoring platforms such as DreamBox or ASSISTments provide real-time feedback and individualized problem sets (Pane et al., 2021). Science teachers frequently use AI-powered simulations and virtual laboratories that allow students to model complex phenomena (Chen & Tsai, 2021). In ICT, intelligent code editors (e.g., machine-learning-based autocompletion tools) support algorithmic thinking and creative programming tasks (Kim et al., 2023). Recent findings also show that AI-assisted learning helps learners cope with math anxiety and low confidence (Inoferio et al., 2024), reinforcing the growing role of AI in STEM education.These tools expand instructional opportunities by enabling personalized pacing, supporting experimentation, and helping students navigate complex STEM tasks that traditionally require human expert guidance.

Instructional Strategies for Innovation-Driven Learning

Teachers employ AI in various ways to cultivate inventiveness, including inquiry-based learning, project-based activities, and design thinking approaches. AI can generate multiple problem variations, scaffold unfamiliar concepts, and offer feedback that encourages iterative improvement (Luckin & Cukurova, 2019). In science learning environments, teachers use AI simulations to promote hypothesis testing and experimentation beyond the constraints of physical laboratories (Dede et al., 2020). For mathematics, AI helps facilitate creative problem-solving by allowing students to explore multiple solution paths (Kaur & Natarajan, 2021). Educators in science and mathematics have also expressed nuanced perspectives on generative AI, particularly regarding its implications for academic integrity (Mundo et al., 2024). In ICT, generative AI tools and intelligent debugging assistants allow learners to prototype applications, visualize algorithms, and troubleshoot code creatively (Li & Xu, 2023). These practices demonstrate how AI enhances teacher capacity to create conditions conducive to student innovation, although teachers handling multiple subject areas report varying degrees of readiness and adaptation to such tools (Castro et al., 2024).

Challenges Faced by Teachers in Implementing AI.

Despite the benefits, teachers report significant barriers to successful AI integration. Common challenges include limited technical expertise, insufficient training, and concerns about over-reliance on AI systems (Holmes et al., 2022). Teachers also express uncertainty about how to design AI-supported activities that genuinely stimulate creativity rather than automate tasks (Zawacki-Richter et al., 2019). Infrastructure limitations, such as inconsistent internet access and lack of school resources, further inhibit implementation in many contexts (Wright & Ulmer, 2020). Ethical concerns such as algorithmic bias, data privacy, and transparency also influence teachers' willingness to adopt AI (Crompton & Burke, 2021). These concerns are reflected in discourse analyses showing educators' apprehensions regarding AI's impact on academic integrity and classroom practices (Chavez et al., 2023; Chavez et al., 2024). These factors highlight the importance of targeted professional development and clear pedagogical guidelines for meaningful AI integration.

Perceptions of AI Tools by Students

Students generally view AI tools positively, associating them with improved engagement, personalized support, and increased confidence (Chan et al., 2021). Learners appreciate instant feedback and adaptive pathways, especially in mathematics and science subjects where conceptual difficulty can hinder motivation (Pane et al., 2021). ICT students often value AI-powered coding assistants for reducing cognitive load and enabling faster iteration in programming tasks (Kim et al., 2023). Evidence also suggests that digital learning contexts—such as those shaped by AI tools affect communication patterns and engagement, especially in online settings (Cuilan et al., 2024; Chavez & Prado, 2023). However, some students express concerns that AI may reduce the need for critical thinking if overused, particularly when tools provide solutions too readily (Chen & Tsai, 2021). Balancing support and productive struggle remains a key consideration.

Enhancing Learners' Creative and Experimental Capacities.

AI tools contribute to inventiveness by enabling students to visualize ideas, simulate outcomes, and engage in open-ended experimentation. Research in STEM education shows that AI-supported environments allow learners to generate hypotheses, test multiple iterations, and design creative solutions with fewer constraints (Dede et al., 2020). Generative AI models have also demonstrated the ability to co-create with students, sparking creativity in coding, design, and scientific modeling (Kaur & Natarajan, 2021). Students report increased motivation to innovate when AI activities include personalized feedback, interactive interfaces, and opportunities for exploration (Chan et al., 2021). These features align with theories of constructivist and inquiry-based learning, which emphasize learner agency and creative problem-solving. Additional research highlights how social learning processes shape student engagement with technologically mediated tasks (Adalia et al., 2025).

Limitations and Risks to Inventiveness.

Conversely, AI may limit creativity when tools are overly directive or reduce learners' autonomy. Studies warn that automated feedback can encourage correctness rather than creative reasoning if poorly implemented (Holmes et al., 2022). Additionally, some AI tutoring systems may narrow learning pathways, restricting divergent thinking (Crompton & Burke, 2021). Recent findings further show that learners' motivation and persistence can be affected by external factors such as personal responsibilities or social pressures which may interact with technological learning environments (Garcia et al., 2025). Ensuring that AI supports rather than replaces learner creativity remains an ongoing challenge.

Existing research suggests that AI has substantial potential to support inventiveness, motivation, and creativity in ICT, Math, and Science education. Teachers leverage AI tools to enhance experimentation, scaffold problem-solving, and personalize learning. However, challenges such as limited training, ethical concerns, and the risk of over-automation complicate integration. Learners generally respond positively to AI-assisted environments, though the impact on creativity depends heavily on instructional design. This review underscores the need for pedagogically informed AI implementation to maximize benefits for both teachers and learners.

METHODS

Research design

This study employed a qualitative descriptive research design, which is appropriate for exploring and understanding experiences, perceptions, and practices related to AI integration in teaching and learning. The design allows for in-depth examination of how teachers incorporate AI tools to motivate inventiveness among learners in ICT, Mathematics, and Science (SMICT) subjects, as well as how learners respond to AI-assisted learning environments. Through descriptive qualitative inquiry, rich data were obtained from participants' narratives, experiences, and reflections, providing insights into real-life classroom practices and learner engagement.

Population and sampling

The study involved two groups of participants: teachers and learners. The teacher population consisted of ICT, Mathematics, and Science educators who have utilized at least one AI-assisted instructional tool, such as simulation applications, adaptive learning systems, or code assistants. A total of 10–12 teachers were purposively selected, with equal representation from each discipline, comprising four Science, four Math, and four ICT teachers. The learner population included students from ICT, Mathematics, or Science classes who have been exposed to AI-based instructional activities. Six to eight students per discipline was purposively sampled, ensuring that all participants have direct experience with AI-assisted learning. This study employed purposive sampling, a non-probability sampling technique that enables the selection of participants based on specific criteria aligned with the research objectives. Using this approach ensures that both teachers and learners can provide meaningful insights into the integration of AI tools in SMICT classrooms and their influence on learners' motivation and inventiveness.

Instrument

Data for this study were collected through semi-structured interviews, which provide flexibility while ensuring that key topics are addressed. Two separate interview guides were developed: one for teachers and one for learners. The teacher interview guide included questions regarding the AI tools they utilize, how they integrate AI to foster creativity, experimentation, and problem-solving, and the challenges they encounter in implementing AI for innovation-driven instruction. The learner interview guide was focused on students' perceptions of AI tools, the impact of AI on their motivation to innovate, create, or experiment, and which aspects of AI-assisted activities such as feedback, interactivity, personalization, and simulation enhance or limit their inventiveness. The semi-structured format allowed participants to provide detailed explanations, examples, and reflections, facilitating the collection of rich and meaningful qualitative data. Table 1 presents the list of guide questions used by this research study.

Data Gathering Procedure

Data were collected following a systematic procedure to ensure accuracy, ethical compliance, and minimal disruption to the participants' learning environment. Approval was first obtained from the relevant school authorities, and informed consent were secured from all participants, with confidentiality and voluntary participation emphasized. Individual interviews with teachers and focus interviews with small groups of learners were scheduled at convenient times to avoid interfering with instructional activities. Each interview was conducted in a quiet setting, recorded with participants' consent, and supplemented with field notes to capture non-verbal cues and contextual observations. Finally, all interviews were transcribed verbatim to ensure accuracy and completeness of the data for subsequent analysis.

Data Analysis

Data were analyzed using thematic analysis, a qualitative method for identifying, analyzing, and reporting patterns or themes within the data. The analysis process began with familiarization, during which the researchers read and re-read the interview transcripts to gain a deep understanding of the content. Key statements, ideas, and concepts were then highlighted and assigned preliminary codes. Related codes were grouped into categories, and overarching themes were developed based on patterns and insights emerging from the data. These themes were subsequently interpreted in relation to the research objectives, linking the findings to the theoretical frameworks of Constructivist Learning Theory and Amabile's Componential Theory of Creativity. To enhance the credibility and accuracy of the analysis, member checking with selected participants was conducted. Through this systematic process, the study aims to provide comprehensive insights into how AI tools are integrated by teachers to foster inventiveness and how learners perceive and respond to AI-assisted learning in ICT, Mathematics, and Science classrooms.

RESULTS

Research Objectives 1. To identify how teachers integrate AI tools to encourage inventiveness among ICT, Math, and Science learners.

Question No. 1. What specific AI tools or platforms do teachers use in teaching SMICT subjects?

Theme 1: ***AI tools like ChatGPT are effective for simplifying concepts***

Four (4) respondents expressed that they tried ChatGPT in class for algorithm explanation and pseudo-code. It's helpful for beginners because it provides clear analogies that textbooks don't, like comparing sorting algorithms to everyday processes, which makes concepts easier to grasp. However, it sometimes produces explanations that sound correct but contain subtle errors or inefficiencies. Because of this, they no longer treat it as an authoritative source but as a peer explainer. Additionally, they mentioned that when students use it, they must verify the output by testing the pseudo-code in their Integrated Development Environment or IDE, comparing it with class notes, and identifying any errors or misconceptions. They also submit short reflections on what the AI explained well and what it misunderstood. This approach transforms AI use into a critical thinking exercise, helping students question, analyze, and refine information rather than depend on it blindly.

"I tried ChatGPT in class for algorithm explanation and pseudo-code. It's helpful for beginners because it provides clear analogies that textbooks don't, like comparing sorting algorithms to everyday processes, which makes concepts easier to grasp. "

" When students use it, they must verify the output by testing the pseudo-code in our Integrated Development Environment or IDE, comparing it with class notes, and identifying any errors or misconceptions."

Theme 2: ***Photomath and Microsoft Math Solver as immediate but create dependency***

Four (4) respondents shared that they used Photomath and Microsoft Math Solver as homework helpers, letting students snap a problem and access step-by-step solutions. They emphasized that these tools should only be used to check their work, not replace it, and required them to document which specific step they learned from. The apps provide immediate feedback that improves procedural fluency and helps students correct mistakes in real time. Additionally, they mentioned that they require students to document which step from the app helped them understand the solution, rather than just copying the entire explanation. But some students skip the thinking part and jump straight to scanning, especially when they're tired or pressed for time. To address this, they gamified the process by having students annotate which step they got stuck on, what misconception they had, and how the app clarified it. This turned the apps into tools for diagnosing thinking rather than shortcuts.

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"I require students to document which step from the app helped them understand the solution, rather than just copying the entire explanation."

Theme 3: ***Lack of Reinforcement at Home***

Four (4) respondents expressed that they used PhET simulations for concept exploration and paired them with an AI chatbot for follow-up questioning. After manipulating variables in PhET, students worked in groups to ask a classroom ChatGPT bot conceptual question, and they graded the quality of their questions and their synthesis of the AI's responses. Additionally, they shared that this approach keeps students accountable and encourages them to articulate confusion and verify explanations. Pairing simulations with AI fosters **metacognitive skills**, helping students identify misconceptions, evaluate the AI's accuracy, and refine their understanding through a cycle of exploring, questioning, and critiquing.

"We used PhET simulations for concept exploration and paired them with an AI chatbot for follow-up questioning. "

"This approach keeps students accountable and encourages them to articulate confusion and verify explanations."

Question No. 2. How do teachers incorporate AI to support creativity, experimentation, and problem-solving?

Theme 1: ***AI helps students prototype faster, so they spend more time innovating.***

Four (4) respondents expressed that when their students code websites or simple apps, they use AI code assistants to debug or generate starter templates. This removes the fear of a blank screen. With a basic scaffold already in place, they can immediately visualize what they want to create instead of getting stuck on syntax or setup. Additionally, they mentioned that they also notice stronger collaboration because groups compare AI outputs, critique suggestions, and blend ideas, treating the AI as a shared creative resource. AI shifts the classroom culture from doubting themselves to being confident that they can do it, which is exactly the mindset that fuels creativity and problem-solving.

"When my students code websites or simple apps, they use AI code assistants to debug or generate starter templates."

"I also notice stronger collaboration because groups compare AI outputs, critique suggestions, and blend ideas, treating the AI as a shared creative resource."

Theme 2: ***AI helps personalize problem-solving challenges.***

Four (4) respondents expressed that by letting AI take over repetitive skill drills and basic computation practice, they free up class time for tasks that require actual thinking projects where students interpret data, justify decisions, or solve authentic problems. They come to class with more energy and curiosity because they're not mentally drained from repetitive exercises. Additionally, they mentioned that their focus shifts from getting the right answer to understanding why this solution works and what it means. They see them becoming more analytical as they ask deeper questions, compare methods, and explain their reasoning more confidently. AI doesn't replace math thinking instead it creates breathing room for richer, more meaningful thinking to happen.

"By letting AI take over repetitive skill drills and basic computation practice, I free up class time for tasks that require actual thinking projects where students interpret data, justify decisions, or solve authentic problems."

"During career talks, speakers highlight global companies using English. The Filipino language is rarely mentioned in the narrative of success."

2.3 AI helps students develop scientific reasoning

Theme 3: ***AI as a Learning Guide***

Four (4) respondents mentioned that when students ask science-based questions in the classroom, AI gives hints, not answers. It pushes them to rethink their hypotheses, revisit the variables they may have overlooked, and test alternative explanations. Instead of shutting down when they reach a confusing result, they start exploring more possibilities. The AI's guided questioning trains them to think like scientists who investigate rather than guess. Additionally, they mentioned that because the AI responds instantly, they don't lose momentum. They can try out new ideas right away, leading to more natural inquiry-driven learning. This kind of scaffolded inquiry makes them more curious because every suggestion becomes a new angle to explore, and they begin to see scientific problems as puzzles with multiple dimensions rather than something with a single, fixed answer.

"When students ask science-based questions in the classroom, AI gives hints, not answers. It pushes them to rethink their hypotheses, revisit the variables they may have overlooked, and test alternative explanations."

"Because the AI responds instantly, we don't lose momentum. We can try out new ideas right away, leading to more natural inquiry-driven learning."

Question No. 3. What challenges do teachers face when using AI for innovation-driven instruction?

Theme 1: ***Struggling to balance AI-assisted coding with teaching core programming concepts***

Four (4) respondents expressed that balancing AI-based exercises with teaching core programming concepts is tricky because AI tools can quickly provide complete solutions, which may shortcut the learning process. They often have to carefully design tasks that require students to engage with the AI output critically for example, by asking them to explain, modify, optimize, or debug the AI's suggestions rather than just copying them. Additionally, they mentioned that the over-reliance on AI can create gaps in foundational knowledge, which becomes evident when students are tested without AI support or when they face novel problems that AI cannot solve immediately. They also spend extra time scaffolding assignments, providing prompts that balance autonomy and guidance, and emphasizing process over product, so students learn to reason through problems rather than only producing working code.

"Balancing AI-based exercises with teaching core programming concepts is tricky because AI tools can quickly provide complete solutions, which may shortcut the learning process."

"Over-reliance on AI can create gaps in foundational knowledge, which becomes evident when students are tested without AI support or when they face novel problems that AI cannot solve immediately."

Theme 2: ***Students often over-rely on AI for answers***

Four (4) respondents expressed that students often approach AI tools as answer-generators rather than learning aids, using them to get immediate solutions instead of testing hypotheses, exploring alternatives, or reasoning through problems. They notice that even when AI outputs are available, students may accept them at face value without questioning correctness, efficiency, or applicability to different contexts. Additionally, they mentioned that they also find it challenging to assess true understanding, as AI-generated answers can mask gaps in knowledge, making it harder to identify areas where students need support. Without these deliberate strategies, AI can inadvertently reduce cognitive engagement, turning a rich learning experience into a passive task.

"Students often approach AI tools as answer-generators rather than learning aids, using them to get immediate solutions instead of testing hypotheses, exploring alternatives, or reasoning through problems."

"I also find it challenging to assess true understanding, as AI-generated answers can mask gaps in knowledge, making it harder to identify areas where students need support."

Theme 3: ***Hesitate to fully integrate AI simulations with advanced features due to their own limited mastery***

Four (4) respondents expressed that they sometimes encounter AI simulations or tools with complex, advanced features such as customizable parameters, multi-layered modeling, or integration with data analysis modules that they themselves haven't fully explored or mastered. This lack of familiarity can lead to hesitation in fully integrating these tools into lessons, as they worry about troubleshooting issues, answering student questions, or ensuring the activity aligns with learning objectives. Additionally, they mentioned that they only use the basic features, which limits the potential for deeper student engagement and experimentation. Sometimes they may spend disproportionate time preparing tutorials or guides for students, which can reduce instructional efficiency.

"I sometimes encounter AI simulations or tools with complex, advanced features such as customizable parameters, multi-layered modeling, or integration with data analysis modules that I myself haven't fully explored or mastered."

"We only use the basic features, which limits the potential for deeper student engagement and experimentation."

***Research Objectives* 2.** To explore learners' motivation and inventiveness when exposed to AI-assisted learning environments.

Question No. 1. How do learners perceive the use of AI tools in ICT, Math, and Science classes?

Theme 1: *Enhanced Learning and Curiosity*

Two (2) respondents expressed that they generally find AI tools both helpful and challenging. They appreciate AI for providing hints, step-by-step guidance, or alternative approaches, which encourages experimentation, curiosity, and deeper thinking. They value AI for debugging and suggesting code improvements, though some admit they sometimes rely on it too heavily without fully understanding the solution. Additionally, they mentioned that a recurring concern is when AI provides multiple solutions to a problem. While they appreciate seeing different approaches, it can be overwhelming and confusing. They are unsure which solution is best, which aligns with teacher expectations, or which is the most efficient. Without context or explanation, these alternatives sometimes lead to second-guessing and uncertainty, highlighting the need for careful teacher mediation.

"I generally find AI tools both helpful and challenging. I appreciate AI for providing hints, step-by-step guidance, or alternative approaches, which encourages experimentation, curiosity, and deeper thinking."

"A recurring concern is when AI provides multiple solutions to a problem. While we appreciate seeing different approaches, it can be overwhelming and confusing. We are unsure which solution is best, which aligns with teacher expectations, or which is the most efficient."

Theme 2: *Reduces Anxiety and Builds Confidence*

Five (5) respondents expressed that they find AI especially valuable for conceptual understanding and experimental planning. They like asking AI why a reaction slows down or why something happens, as it pushes them to rethink assumptions and test alternative explanations. AI also allows them to run mental simulations before actual experiments, reducing anxiety and helping them plan steps carefully. Additionally, they mentioned that AI helps them run simulations in their mind before doing experiments, which makes labs feel less stressful. They can anticipate what might happen and plan their steps carefully.

" I find AI especially valuable for conceptual understanding and experimental planning. I like asking AI why a reaction slows down or why something happens, as it pushes me to rethink assumptions and test alternative explanations."

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Theme 3: *Limited Conceptual Explanation*

Two (2) respondents expressed that sometimes they get overconfident, thinking AI's solution is automatically correct. It reminds them that they still need to check their own understanding. They often feel a tension between convenience and understanding when using AI. While it can quickly provide solutions, this sometimes encourages passivity or shortcut thinking, where they follow steps without truly grasping the reasoning. Additionally, they mentioned that AI also lacks the depth of human explanation especially in Math so they recognize the need for teacher guidance to connect procedures to underlying concepts, ensuring they learn rather than just replicate answers. They recognize that AI can make problem-solving easier, but it cannot fully replace human guidance for conceptual understanding, reasoning, and independent thinking.

"Sometimes I get overconfident, thinking AI's solution is automatically correct. It reminds me that I still need to check my own understanding."

"AI also lacks the depth of human explanation especially in Math so we recognize the need for teacher guidance to connect procedures to underlying concepts, ensuring they learn rather than just replicate answers."

Question No. 2. In what ways does AI influence their motivation to innovate, design, create, or experiment?

Theme 1: ***Presenting multiple approaches that spark new ideas***

Four (4) respondents expressed that AI acts as a catalyst for thinking and experimentation by offering new ways to approach a problem. Even if they don't use its solutions directly, seeing multiple AI-generated suggestions sparks ideas they hadn't considered, broadening their mental solution space and encouraging divergent thinking. This exposure lowers the psychological barrier to experimentation, making them more willing to test unconventional ideas without fear of failure. Additionally, they mentioned that AI also fosters creative confidence, helping them trust their ideas and combine AI hints with their own knowledge to generate unique solutions, while enhancing metacognitive awareness about why certain approaches may succeed or fail. AI suggestions serve as starting points that promote iterative problem-solving, as they mentally simulate outcomes, reflect on different approaches, and refine their own methods.

"AI acts as a catalyst for thinking and experimentation by offering new ways to approach a problem."

" AI also fosters creative confidence, helping us trust our ideas and combine AI hints with our own knowledge to generate unique solutions, while enhancing metacognitive awareness about why certain approaches may succeed or fail."

Theme 2: ***Enabling rapid experimentation and presenting multiple solution approaches***

Two (2) respondents expressed that AI motivates them to experiment and innovate by enabling rapid simulation and iteration, allowing them to test multiple versions of a code, experiment, or design without wasting time. It provides immediate feedback, helping them quickly identify mistakes, refine their approach, and improve their work independently. Additionally, they mentioned that by presenting multiple possible solutions, broadens thinking, and encourages divergent problem-solving, while reducing the fear of failure and supporting low-risk experimentation. This combination of fast feedback, iterative testing, and exposure to alternative approaches fosters creative confidence, deeper conceptual understanding, and metacognitive awareness, making them more willing to explore, design, and innovate.

"AI motivates us to experiment and innovate by enabling rapid simulation and iteration, allowing us to test multiple versions of a code, experiment, or design without wasting time."

"By presenting multiple possible solutions, broadens thinking, and encourages divergent problem-solving, while reducing the fear of failure and supporting low-risk experimentation."

Theme 3: ***Supporting collaborative problem-solving***

Three (3) respondents expressed that AI enhances their motivation to innovate by supporting both individual and collaborative problem-solving. It enables rapid experimentation and iteration, provides immediate feedback, and presents multiple solution approaches that spark ideas and reduce fear of failure. Additionally, they mentioned that AI gives a common reference point that makes discussions more focused and productive, while allowing them to test ideas independently and then compare results, fostering balanced participation, critical evaluation, and reflective teamwork. This combination of fast feedback, exposure to alternative strategies, and collaborative scaffolding builds creative confidence, deeper conceptual understanding, and metacognitive awareness, making students more willing to explore, design, and innovate both individually and collectively.

" AI enhances our motivation to innovate by supporting both individual and collaborative problem-solving. "

"AI gives a common reference point that makes discussions more focused and productive, while allowing us to test ideas independently and then compare results, fostering balanced participation, critical evaluation, and reflective teamwork."

Question No. 3. What aspects of AI-assisted activities (feedback, interactivity, personalization, simulation) enhance or limit their inventiveness?

Theme 1: ***AI that provides hints and instant feedback encourages students to explore***

Five (5) respondents expressed that when AI provides hints instead of full solutions, it creates a cognitive space where they must actively engage with the problem rather than passively accepting answers. This nudges them to generate multiple strategies, compare outcomes, and weigh pros and cons, essentially practicing divergent thinking, which is a core aspect of inventiveness. Additionally, they mentioned that instant feedback reinforces this by acting as a rapid reality check wherein we can test one idea, see if it works, and quickly adjust their approach. This reduces the fear of failure, encourages iterative problem-solving, and promotes experimentation. They learn to develop alternative strategies proactively, and explore unconventional solutions they might not attempt in a traditional setting.

"When AI provides hints instead of full solutions, it creates a cognitive space where we must actively engage with the problem rather than passively accepting answers."

"Instant feedback reinforces this by acting as a rapid reality check wherein we can test one idea, see if it works, and quickly adjust their approach."

Theme 2: ***Rigid or solution-focused AI simulations can restrict creative exploration***

Four (4) respondents shared that when simulations are too pre-set or rigid, they are limited to the paths the AI allows, which constrains creative exploration. Instead of experimenting freely or trying unconventional approaches, they may stick to the allowed solutions, reducing opportunities for inventiveness. Additionally, they mentioned that knowing that the AI can quickly generate the optimal outcome can create cognitive dependency. Some of them may rely on AI to show the best path rather than thinking critically about alternatives, which can diminish problem-solving initiative and original idea generation. Over time, this can lead to a more passive learning style, where they experiment less and accept AI suggestions rather than testing their own hypotheses.

" When simulations are too pre-set or rigid, we are limited to the paths the AI allows, which constrains creative exploration."

" Knowing that the AI can quickly generate the optimal outcome can create cognitive dependency."

Theme 3: ***Providing appropriately challenging tasks***

Two (2) respondents mentioned that AI that personalizes learning to a their pace and skill level helps maintain an optimal challenge. tasks are neither too easy which leads to boredom nor too hard which leads to frustration. This sweet spot of challenge encourages them to experiment with different strategies and take intellectual risks, which is essential for inventiveness. Additionally, they shared that it also enables self-directed learning, letting them identify areas where they can innovate rather than just follow prescribed steps. By gradually increasing difficulty, AI allows them to build confidence and competence incrementally, making them more willing to explore unconventional solutions or try creative approaches they might otherwise avoid.

"AI that personalizes learning to our pace and skill level helps maintain an optimal challenge. Tasks are neither too easy which leads to boredom nor too hard which leads to frustration."

" It also enables self-directed learning, letting us identify areas where we can innovate rather than just follow prescribed steps."

DISCUSSION

The findings of this study demonstrate that AI tools can meaningfully support both teacher practices and learner engagement in ICT, Mathematics, and Science classrooms, aligning closely with the principles of Constructivist Learning Theory. This theory emphasizes that learners actively construct knowledge through experience, reflection, and social interaction, rather than passively receiving information. Teachers' integration of AI platforms such as ChatGPT, Photomath, Microsoft Math Solver, and PhET simulations reflects this constructivist approach, as AI serves as a scaffold that encourages learners to explore, experiment, and critically evaluate solutions. For example, when students verify pseudo-code generated by ChatGPT or document steps learned from Math Solver, they are actively engaging in reflective and metacognitive practices, constructing understanding through guided inquiry rather than rote memorization. Similarly, pairing PhET simulations with AI chatbots encourages learners to ask questions, articulate misconceptions, and synthesize responses, fostering a cycle of exploration, questioning, and refinement consistent with constructivist principles.

From the perspective of Amabile's Componential Theory of Creativity, AI tools contribute to the development of the key components that support innovation: domain-relevant skills, creativity-relevant processes, and intrinsic motivation. Teachers reported that AI facilitates rapid prototyping and problem-solving by reducing procedural barriers, enabling learners to focus on higher-order thinking and creative experimentation. For instance, AI-assisted coding platforms provide scaffolds that lower the cognitive load of syntax and setup, allowing learners to focus on idea generation, collaboration, and solution refinement practices that foster both creative confidence and divergent thinking. Similarly, learners reported that AI's multiple solution approaches spark new ideas, reduce fear of failure, and support iterative experimentation, which directly enhances their intrinsic motivation to innovate and explore.

The study's first objective to identify how teachers integrate AI tools to encourage inventiveness reveals that teachers strategically use AI to scaffold learning while maintaining critical engagement. By requiring students to test AI outputs, document reasoning, and critique solutions, educators ensure that learners interact with AI as a cognitive partner rather than a passive answer generator. This approach not only nurtures inventiveness but also mitigates challenges such as over-reliance on AI or gaps in foundational knowledge. However, teachers still face constraints, including balancing AI use with core content instruction and hesitating to adopt advanced AI features due to limited mastery, highlighting the need for professional development and careful instructional design.

The second objective to explore learners' motivation and inventiveness in AI-assisted environments shows that learners perceive AI as a catalyst for creative engagement. AI promotes curiosity, reduces anxiety, and supports scientific reasoning and problem-solving, enhancing learners' willingness to experiment and iterate. Instant feedback, personalized challenges, and collaborative scaffolding help learners develop metacognitive awareness and refine their strategies, consistent with both constructivist learning and Amabile's framework for creativity. Nevertheless, learners noted potential limitations: overly rigid AI simulations can constrain exploration, and the absence of deep conceptual explanations may require teacher intervention to fully translate AI-facilitated tasks into meaningful understanding.

Overall, the findings suggest that when thoughtfully integrated, AI tools function as both cognitive and creative scaffolds. Grounded in constructivist principles, AI encourages active knowledge construction, experimentation, and collaborative learning, while supporting the essential components of creativity outlined by Amabile. This dual alignment demonstrates the potential for AI-assisted learning to foster both inventive thinking and motivated, reflective learners in STEM classrooms, provided that instructional design addresses the balance between autonomy, guidance, and critical engagement.

CONCLUSION

The findings indicate that AI tools play a significant role in motivating inventiveness and supporting learning in ICT, Mathematics, and Science. Teachers reported using platforms such as ChatGPT, Photomath, Microsoft Math Solver, and PhET simulations to facilitate conceptual understanding, experimentation, and creative problem-solving. AI was found to scaffold learning by providing immediate feedback, multiple solution approaches, and personalized support, which allowed students to focus on innovation, iterative thinking, and collaborative exploration. Learners generally perceived AI positively, noting that it enhanced curiosity, reduced anxiety, and fostered confidence while encouraging them to test ideas, prototype solutions, and engage in reflective thinking. However, challenges were also highlighted. Teachers faced difficulties balancing AI use with core concept instruction, managing student over-reliance, and navigating complex AI features. Learners noted that overly rigid or solution-focused AI simulations could limit creative exploration, while improper guidance might lead to passive learning or misconceptions. Overall, when thoughtfully integrated, AI-assisted learning provides opportunities for richer engagement, personalized experimentation, and enhanced creative thinking, though careful instructional design and monitoring remain essential to maximize its benefit.

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