Exploring the Use of ChatGPT in Mathematics Education: A Narrative Study on Investigation, Problem Solving, and Modeling

Abstract

The integration of ChatGPT into mathematics instruction at Iloilo State University of Fisheries Science and Technology (ISUFST) was investigated in this narrative inquiry, emphasizing how it affected problem-solving, mathematical exploration, and modeling. Six selected Bachelor of Education Major in Mathematics students shared their first semester 2024–2025 experiences through semi-structured interviews, group discussions, and classroom observations. According to the study, ChatGPT has helped students understand complex mathematical concepts, solve problems, and gain interest in learning. This generative AI chatbot also improved learning engagement and motivation, but students noted accuracy issues and overreliance. The stories agreed on ChatGPT's usefulness in enhancing conventional teaching techniques, supporting a well-rounded strategy that integrates AI tools while emphasizing critical analysis and core knowledge. The results from the identified themes add to the growing body of knowledge on artificial intelligence in education by shedding light on ChatGPT's pedagogical consequences and proposing frameworks for its successful incorporation into math teaching.

Keywords: Narrative inquiry, ChatGPT, Problem-solving, Mathematical Investigation, AI-assisted learning.

Introduction

In the digital era, artificial intelligence (AI)'s influence in education has taken front stage. The conventional limits of educational methods are being changed as artificial intelligence technologies such as ChatGPT emerge. Focusing on its effect on mathematical investigation, problem-solving, and mathematical modeling, this paper investigates how ChatGPT might be included into mathematics education at the Iloilo State University of Fisheries Science and Technology (ISUFST).

The worldwide move toward digitization in education has underlined the need of creative pedagogical tools that fit contemporary students, particularly in STEM domains. The World Economic Forum (2020) claims that artificial intelligence (AI) is progressively entwined with education since it can enable individualized learning, enhance problem-solving, and develop critical thinking ability. By giving students adaptive learning experiences and giving teachers extra help through automated tasks, Williamson and Eynon (2020) also show how artificial intelligence could revolutionize teaching and learning procedures.

Globally, this change has been noted by the International Commission on the Futures of Education (2021), which emphasizes the need of a fresh social contract for education that makes use of technology to produce more inclusive and fair learning surroundings. While the commission notes the difficulties, such guaranteeing fair access and avoiding over-reliance on these tools, it also contends that artificial intelligence has the potential to democratize education.

Including AI tools like ChatGPT into mathematics education could help students better solve problems and deepen their grasp of difficult ideas. AI, according to Zawacki-Richter et al. (2019), creates customized learning environments whereby students may interact with materials more dynamically and at their own speed. Though the use of artificial intelligence in education is exciting, Chica et al. (2023) also highlight the difficulties including reliance on AI tools and the possibility of declining critical thinking.

Combining these instruments in use calls for careful assessment of their long-term consequences. Kamberelis and Dimitriadis (2013) stress the need of knowing the general narratives on the acceptance of technology in educational environments. Their work emphasizes how cooperative and reflective behaviors among teachers, students, and institutional leaders will determine whether artificial intelligence succeeds in education.

Often considered as abstract and difficult, mathematics stands to gain much from artificial intelligence tools that can offer real-time explanations, suggest several approaches to problems, and give instant feedback. The literature has, however, exposed gaps in knowledge about how best to include artificial intelligence into mathematical instruction. Most research has concentrated on the possible advantages of artificial intelligence without delving deeply into the complex interactions among teachers, tools, and students. By analyzing the effects of ChatGPT on mathematical investigation, problem-solving, and modeling, this paper seeks to close that gap and so offer a more complete knowledge of its pedagogical ramifications.

Constructivist learning theories, especially Piaget's Theory of Cognitive Development (1954), which stresses the active part of college students in producing knowledge by experience, form the theoretical framework for this study. By pushing students to interact with mathematical ideas instead of passively absorb knowledge, AI tools such as ChatGPT—which enable customized, interactive learning—align with these ideas by Moreover, the Technological Pedagogical Content Knowledge (TPACK) framework developed by Mishra and Koehler (2006) emphasizes the need of properly including technology into education. TPACK is a guiding concept in this work to help one grasp how ChatGPT might be included into mathematical instruction.

Lastly, this study also draws on Lagon's (2023) work on using PHET simulations in education, which corresponds with the integration of artificial intelligence technologies in improving difficult subject knowledge. His research offers new perspectives on how interactive tools such as simulations or artificial intelligence might help students develop more advanced conceptual knowledge.

This paper adds to the continuing conversation on artificial intelligence's influence in education by analyzing how ChatGPT affects student involvement, understanding, and problem-solving in mathematics. It also provides useful narratives in including artificial intelligence tools into the classroom in ways that affect learning in view of over-reliance or lowering of critical thinking ability.

Methodology

This study investigated how ChatGPT might be included into mathematics education at the Iloilo State University of Fisheries Science and Technology (ISUFST) using a narrative inquiry research design. A qualitative research method called narrative inquiry lets researchers explore participants' lived experiences and make sense of how they interact and view the phenomenon under investigation (Clandinin & Connelly, 2000). Because of the exploratory character of this study, narrative inquiry was selected as it allowed the researcher to record the complex experiences of pre-service students as they

interacted with ChatGPT for mathematical modeling, problem-solving, and mathematical investigation. This framework made it possible to have a thorough awareness of how artificial intelligence tools affect learning in terms of both results and the procedures that support those results.

The study took place at ISUFST during the first semester of the academic year 2024–2025. It was conducted at the College of Education of the university at its Main Campus-Tiwi Site, Barotac Nuevo, Philippines, where larger initiatives to improve STEM education covered exploring the integration of artificial intelligence technologies like ChatGPT. Particularly in science and mathematics, ISUFST is well-known for its dedication to advancing technological integration in education. Given the university's strategic focus on technological innovation matched with the goals of the research, this setting offered a rich environment for investigating the effects of AI on student learning. The study concentrated especially on six Bachelor of Education Major in Mathematics pre-service teachers who were purposefully chosen depending on their experiences with ChatGPT and different mathematical performance.

Purposive sampling was used to guarantee that the participants reflected various experiences with AI tools, including various degrees of ChatGPT knowledge. Participants are actively enrolled in the Bachelor of Education Major in Mathematics program, have some prior experience with artificial intelligence tools either through coursework or personal use, and show varied academic success. The approach of deliberate sampling has made it possible to gather a wide spectrum of viewpoints, so enhancing the results of the research. To preserve anonymity and safeguard their identities, the six participants—Alpha, Bravo, Charlie, Delta, Echo, and Foxtrot—were assigned pseudonyms.

Design and execution of this study revolved mostly on ethical issues. Ethical clearance from ISUFST's Institutional Review Board (IRB) came from before data collecting. Every participant received informed consent forms detailing the goal of the study, the type of their involvement, and their rights as participants—including their right to withdraw at any point without penalty. The study followed rigorous confidentiality policies, so guaranteeing that all gathered information was anonymized and safely kept. Participants also received a briefing on the ethical ramifications of applying AI tools such as ChatGPT in their education, especially with relation to the possible errors in AI-generated answers and the need of closely interacting with the tool.

For this study, semi-structured interviews, group discussions, and classroom observations comprised data collecting techniques. These three techniques were selected to enable data triangulation and to help to fully grasp the experiences of the participants with ChatGPT. Every one of the six participants underwent semi-structured interviews lasting almost 45 minutes each session. Semi-structured interviews' adaptability let the researcher probe for more in-depth insights as participants related their personal experiences while also exploring important themes related to the use of ChatGPT (Creswell & Poth, 2018). The interview questions concentrated on several fundamental areas: participants' first impressions of ChatGPT, their perceived impact on their engagement with mathematical problems, the tool's influence on their problem-solving and investigation processes, any difficulties they encountered while using the AI tool, and their more general observations on its part in their learning path.

Apart from one-on-one interviews, two group conversations involving three participants apiece were carried out in each session. These conversations let participants share ideas, reflect together on their experiences, and interact with their peers. Each roughly one-hour group conversation was semi-structured to let for honest communication while concentrating on particular issues regarding artificial intelligence integration into education. The group dynamic pushed participants to expand on one

another's ideas, so fostering more complex and introspective conversations (Kamberelis & Dimitriadis, 2013).

Classroom observations were also carried out to augment group discussions and the interviews. The researcher watched 24 math classes during the semester where ChatGPT served as a learning tool. The data offered a real-time picture of how students engaged with ChatGPT during problem-solving activities, how they responded to AI-generated comments, and the tool's general influence on classroom involvement. The researcher tracked student involvement, teacher-student interactions, and how ChatGPT either helped or hampered the students' grasp of challenging mathematical ideas using an observational checklist.

Using thematic analysis, the three-methods' gathered data were examined (Braun & Clarke, 2006). This approach was chosen for its adaptability and methodical approach to spotting, examining, and documenting data trends. Transcribing all interviews and group discussions verbatim came first in the analysis, then familiarizing the data. The researcher then started open coding, assigning first codes to important data segments. These codes gathered important new perspectives on the study questions, including "increased engagement," "conceptual understanding," and "AI limitations." After the first coding, the researcher arranged related codes into more general themes reflecting notable trends throughout the data.

The researcher used several techniques in order to guarantee the accuracy and rigor of the study. Using member checking helped to improve credibility by letting participants review the results and verify that their experiences were faithfully depicted. Maintenance of an audit trail, recording all decisions taken during the research process, guaranteed dependability. Data from interviews, group discussions, and classroom observations was cross-checked using triangulation, so enhancing the validity of the conclusions. At last, reflexivity was included into the whole research process as the researcher routinely considered possible prejudices and presumptions that might affect data interpretation (Berger, 2015).

Results

Five (5) main themes concerning the effect of ChatGPT on the participants' learning experiences in mathematics education emerged from the data acquired via semi-structured interviews, group discussions, and classroom observations. Particularly, these themes include higher engagement and motivation, better understanding of difficult ideas, development of independent problem-solving skills, improved teacher-student dynamics, and the difficulties and downsides related with AI integration. These results clarify the complex consequences of using artificial intelligence in educational environments as well as the wider consequences for STEM field teaching and learning.

1. Higher Motivation and Engagement

The major outcome of the study was the notable rise in student involvement and motivation after ChatGPT was included into their math lessons. Before introducing the AI tool, students described their experiences with mathematics as static, disengaging, and abstract. Many of the participants reported struggling to remain attentive during traditional mathematics instruction. For instance, Alpha shared that prior to using ChatGPT, they often found themselves losing interest when working through complex problems. However, after integrating the AI tool, students felt more immersed in the subject matter.

Alpha elaborated, "I found it easier to stick with problems because I could immediately test my ideas and get feedback from ChatGPT. It made the process less frustrating." Bravo also echoed this feeling, noting that the interactive nature of ChatGPT helped math classes become more exciting events. "I used to find it difficult to keep concentrated during extended problem-solving sessions before using ChatGPT. With ChatGPT, I could try different approaches, which kept me interested," Bravo explained.

These increased levels of engagement were also observed during classroom sessions, where students were visibly more proactive and spent more time working on mathematical problems. In comparison to pre-ChatGPT sessions, students were more willing to experiment with different methods and tackle more complex tasks. Group conversations strengthened this conclusion by allowing participants to share how the instantaneous ChatGPT feedback inspired them to stay involved in activities they might have avoided.

ChatGPT's capacity to make the learning process more interactive and less threatening helps to explain this increase in engagement and motivation. The AI tool helped students feel a sense of progress by offering quick comments and customized prompts, so lowering the frustration sometimes connected with challenging mathematical ideas. This instantaneous feedback loop helped students to remain connected to the work since it let them see the outcomes of their efforts right away, so creating a more favorable and interesting classroom.

2. Enhanced Understanding of Complex Concepts

A further important outcome was ChatGPT's help in improving students' grasp of difficult mathematical ideas. One of ChatGPT's most useful tools, participants often mentioned its capacity to dissect abstract concepts into simpler, more palatable explanations. For students who struggled with traditional instruction, this feature of the AI tool significantly improved their comprehension.

Delta shared, "When I encountered a concept I didn't understand, ChatGPT would explain it in simpler terms or give me visual examples that helped me grasp the idea better." This ability to offer individualized, step-by-step guidance was particularly helpful for students who often found themselves lost in the complexity of mathematical theories. The AI's flexibility in offering multiple approaches to problem-solving also contributed to students' improved understanding. For instance, Charlie noted that they typically avoided difficult problems, but with ChatGPT's guidance, they felt more confident tackling them.

This increased understanding was evident in classroom observations, where students interacting with ChatGPT were more willing to attempt complex problems. The AI's capacity to scaffold complex mathematical ideas helped students incrementally build on their existing knowledge. In many cases, the AI would provide hints or corrections, enabling students to learn from their mistakes in real time. This immediate feedback loop helped reinforce their understanding of difficult topics while reducing the anxiety associated with getting stuck on problems without support.

Mastery of difficult content depends on students moving at their own pace, which ChatGPT's tailored feedback let them achieve. Students who got constant feedback catered to their specific needs were able to participate in a more effective learning process emphasizing understanding over rote memorization.

3. Acquiring Independent Solving Capacity

A significant finding from the study was how ChatGPT fostered independent problem-solving skills development. Many participants pointed out that although the artificial intelligence gave insightful direction, it also encouraged them to examine several answers to mathematical problems and apply critical thinking. ChatGPT inspired students to try several approaches to problem-solving rather than only a tool for supplying responses.

Charlie said of this experience: "ChatGPT didn't just give me the answer; it pushed me to try different approaches." This focus on critical thinking enabled students to grow more sure of their ability to solve problems. Echo said, "ChatGPT helped me identify where I went wrong and how to fix it, so I started depending less on waiting for the teacher to guide me through a problem." It's like having a tutor available whenever I needed help."

Classroom observations confirmed that students using ChatGPT were increasingly taking the initiative to solve problems independently rather than relying solely on their teacher for guidance. This newfound confidence in solving unfamiliar problems demonstrated the tool's capacity to cultivate autonomy in students' learning processes. By encouraging students to try various methods, ChatGPT promoted a trial-and-error approach that helped students build resilience in difficult tasks.

As students developed their ability to solve independent problems, they started to participate more actively in their education. Approaching problem-solving with an attitude toward exploration and self-reliance—qualities essential for long-term mathematical success—they sought answers.

4. Enhanced teacher-student dynamics

Furthermore clearly affecting the dynamics between teachers and students was the inclusion of ChatGPT. Teachers discovered they had more time to concentrate on individualized instruction and the deeper conceptual elements of mathematics when they let ChatGPT handle routine tasks including answering basic questions or offering initial feedback.

"I found that I had more time to address individual students' needs," said Hotel, one of the observing teachers. ChatGPT was a great assistant in managing the repetitive aspects of teaching, allowing me to focus on the more complex, conceptual work." Students also appreciated this shift in teacher roles. Bravo explained that with ChatGPT taking care of simpler inquiries, their teacher could spend more time offering personalized feedback and guiding students through more advanced topics.

This dynamic shift was evident in classroom observations, where teachers were seen devoting more attention to the specific needs of students rather than addressing common questions that ChatGPT could handle. Allowing AI to manage routine tasks made teacher-student interactions more meaningful and targeted. Teachers could involve students in more in-depth conversations and offer focused help to those finding difficulty with specific ideas.

5. Accuracy and over-reliance present difficulties with AI integration

Notwithstanding ChatGPT's many advantages, the study also exposed difficulties with its integration, especially with relation to the accuracy of the AI tool and the possibility for students to grow unduly dependent on it. Several participants shared their experiences of ChatGPT, occasionally providing incorrect or confusing answers. Foxtrot explained, "There were a few times when ChatGPT provided wrong answers or explanations, and it threw me off. It took extra time to figure out the right solution after that."

This challenge was particularly problematic in more advanced topics, where minor inaccuracies could mislead students and disrupt their learning. Echo also pointed out that while ChatGPT was useful, errors in its explanations sometimes made the learning process more difficult.

Another concern was the potential for over-reliance on the AI tool. Charlie admitted, "Sometimes, I felt like I wasn't thinking critically enough because I knew ChatGPT would help me out. I had to remind myself to work through problems on my own too." Some students who appeared to rely more on ChatGPT's help than on using their critical thinking abilities were clearly over-reliant on the tool. This problem begged significant concerns about how to strike a balance between the necessity to promote real understanding and independent thought with the use of artificial intelligence as a supporting tool.

In sum, while ChatGPT enhanced engagement, comprehension, and independence in learning, educators must carefully manage its integration to prevent potential pitfalls such as reliance on inaccurate feedback or diminished critical thinking skills.

Discussions

The findings of this study coincide with body of knowledge already in publication on the integration of artificial intelligence into education, especially in mathematical instruction. ChatGPT presented difficulties with accuracy and possible over-reliance even while it provided great advantages in terms of engagement, understanding, and independent learning. These results have significant ramifications for how ChatGPT and other artificial intelligence tools ought to be included into the classroom.

1. Motivation and Engagement in Line with Constructivist Ideas

The higher participation noted in this study supports Piaget's (1954) Constructivist Theory of Learning, which stresses the active part of students in building their own knowledge. ChatGPT's capacity to give quick comments and push students to investigate several strategies fits the theory's claim that students build knowledge by direct material interaction.

From a pedagogical perspective, the higher involvement points to ChatGPT's potential as a useful tool for simplifying and interestingly accessing abstract ideas. To fully leverage this potential, though, teachers must create activities that actively inspire students to interact with AI tools in ways that advance deep learning rather than passive consumption of responses.

2. Improved Conceptual Grasp: Encouragement

The capacity of ChatGPT to dissect difficult ideas into reasonable explanations greatly helped students to grasp them. This outcome aligns with results of Williamson and Eynon (2020), who contend that by providing customized and context-specific support, artificial intelligence tools improve learning. The findings show that by offering customized feedback, ChatGPT can be quite helpful for students to grasp challenging mathematical ideas.

Still, teachers should keep alert about the accuracy of AI-generated justifications. As the results revealed, sporadic errors in ChatGPT's responses caused uncertainty and annoyance. Future integration of artificial intelligence in education should incorporate systems allowing students to confirm the

accuracy of AI-generated knowledge, so guaranteeing that inadequate direction does not compromise learning.

3. Encouragement of Independence in Solving Problems: The Cognitive Partner Function of Artificial Intelligence

The development of autonomous problem-solving abilities seen in this study corresponds with the idea of the "zone of proximal development" put forth by Vygotsky (1978), in which students gain from the support of a more experienced partner to stretch their present capabilities. In this regard, ChatGPT served as a cognitive partner, encouraging students to investigate several approaches of problem-solving and think critically.

Still, the worry about too depending too emphasizes the need of balance. Although ChatGPT can be a useful tool, teachers have to make sure students keep acquiring autonomous ability to solve problems. One strategy is to create projects where students must assess ChatGPT's recommendations and explain their choice of particular answers. This guarantees that artificial intelligence improves rather than replaces autonomous thought.

4. Teacher-Student Dynamics: Changing Roles in a Classroom Enhanced by AI

The change in teacher-student dynamics noted in this study emphasizes how well artificial intelligence tools could change the conventional roles of educators. ChatGPT let teachers concentrate more on individualized and concept-driven instruction by managing routine searches. This change is supported by Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) framework, which contends that good integration of technology can improve pedagogy and content delivery.

By freeing teachers from tedious chores and allowing more attention to higher-order thinking and customized support, this change toward a more facilitative role for them helps to improve the quality of education. Schools have to offer professional development chances that enable teachers to properly incorporate AI tools while still preserving their vital role in the learning process in order to take use of this advantage.

5. Problems and fixes: handling over-reliance and accuracy

The difficulties with accuracy and over-reliance on ChatGPT align with issues expressed in the literature regarding artificial intelligence in education (Zawacki-Richter et al., 2019). Participants' experiences in this study clearly show how inaccurate responses from artificial intelligence tools can disturb learning. Developers have to try to make artificial intelligence tools more dependable, and teachers should inspire their students to evaluate AI-generated materials closely.

Dependency on ChatGPT also runs the danger of weakening independent thinking ability. Teachers have to strike a balance between using artificial intelligence to augment learning and making sure students keep actively participating in problem-solving. Assignments demanding students to consider AI-generated solutions and express their knowledge will help reduce over-reliance risk.

6. Extended Learning Plans: AI's Prospect in Education

The hope of participants regarding the long-term influence of artificial intelligence in education mirrors more general patterns in educational technologies (World Economic Forum, 2020). As AI tools get

more advanced, their inclusion into courses will probably become normal procedure. Still, this integration has to be done carefully, stressing how critical thinking and problem-solving ability of growing students should be developed.

Future studies should investigate, especially in STEM disciplines like mathematics, the long-term consequences of artificial intelligence integration on student outcomes. Longitudinal studies might offer insightful analysis of how artificial intelligence tools affect students' cognitive development and capacity to apply mathematical ideas in practical settings.

All things considered, including ChatGPT into mathematics classes at ISUFST gave notable advantages in student involvement, conceptual understanding, and autonomous problem-solving. The study did, however, also highlight issues with accuracy and the danger of too depending too much on AI tools. Teachers have to apply policies that support critical thinking, guarantee the accuracy of AI-generated content, and keep a reasonable approach to AI-assisted learning if they are to maximize the use of artificial intelligence in the classroom.

These results lead us to suggest the following suggestions:

- Emphasizing on balancing AI support with developing independent problem-solving skills, teachers should get training on properly including AI tools like ChatGPT into their teaching.

- Teachers should create exercises motivating students to assess responses produced by artificial intelligence and consider their methods of problem-solving.

- While schools should track how artificial intelligence integration affects student learning outcomes, developers should keep enhancing the accuracy and dependability of AI tools.

By following these suggestions, teachers can make sure that AI tools like ChatGPT improve rather than compromise the learning process, so preparing students for success in a world going more and more digital.

References

Berger, R. (2015). Now I see it, now I don't: Researcher's position and reflexivity in qualitative research. *Qualitative Research, 15*(2), 219-234. https://doi.org/10.1177/1468794112468475

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Chica, M., Guerra, M., & Guerra, G. (2023). The role of artificial intelligence in the development of teaching effectiveness: A tool for personalization of learning in higher education. *The IAFOR Conference on Educational Research & Innovation: 2023 Official Conference Proceedings.* https://doi.org/10.22492/issn.2435-1202.2023.14

Clandinin, D. J., & Connelly, F. M. (2001). Narrative inquiry: Experience and story in qualitative research. *Visual Arts Research, 27*(1), 107-111. https://www.jstor.org/stable/20716027

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). Sage Publications.

International Commission on the Futures of Education. (2021). *Reimagining our futures together: A new social contract for education.* UNESCO. https://doi.org/10.54675/ASRB4722

Kamberelis, G., & Dimitriadis, G. (2013). *Focus groups: From structured interviews to collective conversations.* Routledge.

Lagon, H. M. (2023). PHET interactive simulations in learning optics towards pre-service science teachers: A phenomenological study. *American Journal of Education and Technology, 2*(3), 129–135. https://doi.org/10.54536/ajet.v2i3.679

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017-1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

OpenAI. (2023). *ChatGPT* (Feb 12 version) [Large language model]. https://openai.com

Piaget, J. (1954). *The construction of reality in the child*. Basic Books. https://doi.org/10.4324/9781315009650

Saldaña, J. (2015). *The coding manual for qualitative researchers* (3rd ed.). Sage Publications.

Stake, R. E. (1995). *The art of case study research*. Sage Publications.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press. https://doi.org/10.2307/j.ctvjf9vz4

Williamson, B., & Eynon, R. (2020). Historical threads, missing links, and future directions in AI in education. *Learning, Media and Technology, 45*(3), 223-235. https://doi.org/10.1080/17439884.2020.1798995

World Economic Forum. (2020). *The future of jobs report 2020*. https://www.weforum.org/reports/the-future-of-jobs-report-2020

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – Where are the educators? *International Journal of Educational Technology in Higher Education, 16*(39). https://doi.org/10.1186/s41239-019-0171-0