PANTAO
The International Journal of the Humanities and Social Sciences
Volume 4, Issue 4
ISSN 3028-0877 | DOI 10.69651/2022PIJHSS

Embedding chat-based AI in gradual release strategy for teaching Mathematics

Solever G. Fajardo
Teacher III
Cawayan National High School
Cebu, Philippines

ABSTRACT

This study examined the effectiveness of embedding chat-based artificial intelligence within the Gradual Release Strategy to propose a teaching guide that enhances mathematics instruction for high school students. An embedded mixed method was used with 61 participants, divided into control and experimental groups. The control group was taught using the Direct Instruction Strategy, while the experimental group was taught using the Gradual Release Strategy, with Question.AI being embedded. Evaluating the effectiveness of embedding chat-based AI (Question.AI) in the Gradual Release Strategy, pretest and posttest scores from both groups were analyzed using a paired t-test. The findings showed that the mean gain between the groups was statistically significant ($p < .0018$). Additionally, to determine the experiences of the participants when exposed to Question.AI, comments and feedback from the participants in the experimental group were analyzed using thematic analysis. With the results, the conclusion that the tool (Question.AI) provided various opportunities to the participants in the forms of “efficiency,” “clear comprehension,” and “better performance.” was formulated. In summary, the study’s results highlight the importance of chat-based AI in supporting students’ active participation, social interaction, and collaboration in the learning process. Furthermore, the findings affirm that the tool (Question.AI), when integrated into effective teaching frameworks such as the Gradual Release Strategy, can be an asset in addressing key educational challenges.

Keywords: Chat-based Artificial Intelligence, gradual release strategy, mathematics instruction, teaching guide.

Date Submitted: November 18, 2025
Date Accepted: December 1, 2025
Date Published: December 28, 2025

INTRODUCTION

In every person's life and education, mathematics plays a significant role, as it supports understanding of other subjects, such as economics, science, music, arts, and physical education.

DOI: http://doi.org/10.69651/PIJHSS0404678

Recommended citation:
Fajardo, S. G. (2025). Embedding chat-based AI in gradual release strategy for teaching Mathematics. Pantao (The International Journal of the Humanities and Social Sciences) 4 (4), 7438-7451.
http://doi.org/10.69651/PIJHSS0404678

According to Park et al. (2008), mathematics is a primary component of human thought and logic, essential for understanding the real world. It provides an effective means of developing cognitive discipline and logical reasoning. Furthermore, in the K to 12 Curriculum Guide: Mathematics (2016), mathematics is recognized as a subject relevant to life regardless of a person's age and situation, with critical thinking and problem-solving as twin goals.

Critical thinking plays a significant part in every teaching and learning process (Shamboul, 2022). Hence, mathematics, as a requirement for critical thinking, should be taught purposefully at every grade and competency level. Likewise, the knowledge and skills learned at any level should be meaningful, as meaningful learning is the main goal in teaching mathematics, as set by the National Council of Teachers of Mathematics (Koskinen & Pitkaniemi, 2022). However, despite this teaching goal, the continuous decline in mathematics performance remains an alarming issue in many countries worldwide (NAEP Report Card, 2022), implying that mathematics achievement is worsening.

Several factors (such as fear of math, lack of effective teaching strategies, poor memory, and lack of basic knowledge) contribute to poor math performance (Varaidzaimakondo & Makondo, 2020). Among these, the failure to consider previous knowledge and interests is the most significant (Acharya, 2017). Prior knowledge is crucial for learning, yet if it is lacking, it can hinder progress (Hudson, 2016). Hence, the ability of the teachers to connect student's prior knowledge in constructing new information is a necessary skill in the learning process (Ningsih & Retnowati, 2020). Likewise, teaching strategies matter and have a positive connection with students' academic achievement, whether in a traditional or virtual education setting (Roblon et al., 2022).

The global disruption in the education systems due to the COVID-19 pandemic led to significant learning loss and inequality (World Bank, 2021). Despite the return to face-to-face classes, education systems are still recovering (UNESCO, 2023), and ensuring meaningful learning remains a challenge due to prior knowledge deficits. In the Philippines, the Department of Education (DepEd) mandated the resumption of in-person classes (Department of Education [DepEd], 2022) and continued the use of the spiral progression approach (DepEd, 2019). According to Cornell and Peer (2023), prior knowledge comprises all the knowledge a person takes into a new learning experience to make sense of a new lesson. Therefore, deficiencies in prior knowledge or failure to activate it can lead to poor learning outcomes. As a result, the challenge in resuming face-to-face classes lies in ensuring meaningful learning in every competency despite prior knowledge deficits caused by years of school closures and disruptions in the education system.

In the secondary schools of Dalaguete 2, some mathematics teachers observed that most students exhibited poor academic performance. Specifically, at Cawayan National High School, many students struggled to absorb new concepts, recall prior knowledge, relate it to new content, and retain information. This issue was also evident in the results of the Division Integration on Assessment of Learning, Monitoring, and Evaluation (DIAL ME) for School Year 2022–2023, where most students scored low. According to Bombaes et al. (2021), the teacher factor has the primary influence on the student's ability to assimilate, remember, or retain knowledge. Thus, considering that well-implemented teaching is significant in the success of the learning process and that the interaction between teachers, students, and learning outcomes is affected by the teaching strategies applied in the classroom (Panjaitan & Zuhri, 2019), these findings imply that learning of the students was not meaningful, which also indicates that the teaching strategy employed was not effective.

Teaching strategies are multifaceted, and their effectiveness depends on the context in which they are used (Edith Cowan University, 2021). Thus, identifying the most effective strategy for a specific group of students is a great challenge. However, Morris (2023) identified widely accepted teaching strategies for introducing new ideas, including the gradual release of responsibility, which follows the stages of teacher modeling, guided practice, and independent practice. For this approach to be successful, understanding new concepts should be done in small, structured steps: I do, we do, you do. Within this framework, the researcher found that some of its processes had already been tested multiple times during the learning process using another strategy. Hence, inspired by the goal of finding a new and effective teaching strategy to address the existing problem, the researcher decided to adopt this strategy with slight modifications.

UNESCO (2023) noted that artificial intelligence (AI) has the potential to address challenges in education, such as promoting innovative teaching and learning practices. Additionally, Melo (2023) stated that AI can help students personalize learning, support teachers in assisting their students meet their needs, and help students develop 21st-century skills such as critical thinking, problem-solving, and collaboration. Given that today is a period of rapid technological advancement where most students have access to smartphones and internet connectivity, the researcher believes that the teaching strategy "Gradual Release of Responsibility - I do, we do, and you do" could be enhanced through AI integration.

This belief led to the study titled Embedding Chat-Based Artificial Intelligence (AI) in the Gradual Release Strategy for Teaching Mathematics, which aims to evaluate the effectiveness of integrating chat - based AI (Question.AI) into this instructional approach and to develop a corresponding teaching guide to improve student performance in mathematics. After examining several AI tools, the researcher selected Question.AI as it offers a 98% solution accuracy rate, provides step-by-step explanations, and allows input through typing, file upload, or image submission (QuestionAI.ai, 2024). Likewise, the researcher selected the tool (Question.AI) for its high accuracy, detailed solutions, flexible input options, and 24/7 accessibility.

Building on earlier discussions about instructional strategies and academic performance, the researcher argues that mathematics achievement reflects the impact of the methods used. Therefore, assessing the integration of chat- based AI into the Gradual Release Strategy, and creating a teaching guide if proven effective, is a crucial step toward improving mathematics learning outcomes.

Statement of the problem

This study aimed to determine the effectiveness of embedding chat based Artificial Intelligence using Question.AI within a Gradual Release Strategy for teaching mathematics to Grade 11 students at Cawayan National High School during the school year 2023 to 2024, as a basis for the development of a proposed teaching guide. Specifically, the study examined students' performance in selected competencies on simple and compound interest, compared learning outcomes between a control group exposed to Direct Instruction and an experimental group exposed to the Gradual Release Strategy enhanced with chat-based AI, and explored learners' experiences to support and contextualize the quantitative findings of the study. Specifically, this study sought to answer the following research questions:

1. What is the pretest score distribution of the control group and the experimental group in the competencies on illustrating and distinguishing simple and compound interest and on

computing interest, maturity value, future value, and present value in simple and compound interest environments?

2. What is the posttest score distribution of the control group and the experimental group in the same competencies on simple and compound interest?
3. Is there a significant difference between the pretest and posttest scores of the control group taught using the Direct Instruction Strategy and the experimental group taught using the Gradual Release Strategy enhanced with chat-based AI?
4. Is there a significant difference in the mean gain scores between the control group and the experimental group?
5. What are the experiences of the participants when exposed to chat-based AI within the Gradual Release Strategy?
6. How do the experiences of the participants when exposed to chat-based AI within the Gradual Release Strategy support the quantitative findings of the study?
7. What learning guide can be proposed based on the findings of the study?

METHODOLOGY

This study employed an embedded mixed-methods design, utilizing quantitative data as the primary source of analysis, supported by qualitative data. In this approach, the quantitative data referred to the performance levels of student participants in the identified competencies, measured through pretest and posttest scores. On the other hand, the qualitative data referred to the comments and feedback from participants in the experimental group after the teaching - learning process with chat – based AI (Question.AI) being embedded in the teaching strategy (Gradual Release Strategy). All data were collected personally and handled with strict confidentiality to ensure safety of the respondents, and they were the focused of both the quantitative – qualitative analysis.

Data analysis, as explained by Calzon (2021) and cited by Rosales (2023), are rooted in two core areas: quantitative and qualitative analysis. Quantitative analysis utilizes numerical data or data that can be associated with numbers. In this research, the analysis was regarded as the primary method for analyzing the pretest and posttest performance of student participants.

In addition to the quantitative data, this study also employed qualitative data analysis. Qualitative data analysis is the process of organizing and analyzing non-numeric data, such as concepts and feedback (Content Square, 2024). In this study, the analysis focused on evaluating the experiences of the participants from the experimental group during the learning process.

To successfully attain the study's objectives with minimum effort and risk, it was crucial to select an environment that was both accessible and reflected the ongoing decline in mathematics performance. This approach minimized logistical challenges, ensured the smoother implementation of research activities, and increased the study's relevance and potential impact. Hence, considering that the problem also existed in the school where the researcher is presently connected, the study was conducted at Cawayan National High School. The familiarity of the researcher with the school's context and learners further supported the feasibility and effectiveness of the study's implementation.

The study was conducted at Cawayan National High School, located in Cawayan, one of the barangays of the Municipality of Dalaguete, Cebu Province. Cawayan which is situated at approximately 9.8082, 123.5343, in the island of Cebu. It had a population of 2957 in the year 2020, which represents 3.96% of the total population of Dalaguete (PhilAtlas, 2023). It is bounded by the following barangays: Casay, Dalaguete, Cebu; Lumbang, Dalaguete, Cebu; Malones, Dalaguete, Cebu; Pañas, Dalaguete, Cebu; and Banhigan, Dalaguete, Cebu. The school is accessible by different modes of land transportation; hence, teachers or school administrators from other neighboring schools or barangays, and future researchers can visit the school for educational concerns especially on matters related to the result and output of the study.

The study was composed of two parts: quantitative and qualitative. In the quantitative part, the participants were 61 Grade 11 students from Cawayan National High School who were enrolled in the General Mathematics subject. Specifically, the participants included 29 students from sections Athena and Aphrodite, and 32 students from section Venus. These participants represented the control and experimental groups in the study, respectively. Given the nature and purpose of the study, purposive sampling was employed to select participants for each group. The participants were chosen based on the following criteria: first, they were students enrolled in General Mathematics, in which the competencies considered in the study were taught; second, they were believed to have greater potential to accomplish learning tasks that involved ICT integration. On the other hand, for the qualitative part, the participants were 17 students from the experimental group. Purposive sampling was also employed to select these participants. They were chosen based on the following criterion: first, they were students who had experienced the strategy "Embedding AI in Gradual Release Strategy."

The study used purposive sampling and involved both quantitative and qualitative components. For the quantitative phase, the respondents were 61 Grade 11 students of Cawayan National High School enrolled in General Mathematics, grouped as 29 students from sections Athena and Aphrodite (control group) and 32 students from section Venus (experimental group). The participants were selected based on two criteria: (1) they were officially enrolled in General Mathematics where the targeted competencies were taught, and (2) they were considered capable of completing learning tasks that required ICT integration. For the qualitative phase, 17 students from the experimental group were also purposively selected, specifically those who experienced the strategy of embedding chat-based AI in the gradual release strategy.

Two research instruments were utilized. The first was a structured, multiple-choice questionnaire used to obtain the pretest and posttest scores of both control and experimental groups. The test items were aligned with the General Mathematics competencies on simple and compound interest (illustrating and distinguishing simple vs. compound interest, computing interest/maturity/future/present values, and solving related problems), and the difficulty level as well as item distribution were guided by a table of specifications. The instrument also underwent content validity procedures prior to pilot-testing and actual administration. The second instrument was an unstructured survey questionnaire (guided questions) used to collect qualitative data through students' essay responses describing their experiences after exposure to the chat-based AI tool (Question.AI).

Because the study followed an embedded mixed-method design, both quantitative and qualitative data were gathered through a systematic sequence. Quantitative data collection began with administering a pretest (structured multiple-choice test) to both groups, followed by the teaching sessions: the control group was taught using the Direct Instruction Strategy, while the experimental group was taught using the Gradual Release Strategy with Question.AI embedded. After the teaching-learning process, a posttest was administered to both groups to measure learning gains. For the qualitative component, feedbacking was conducted only among the experimental group through an essay-writing activity, using guided essay questions to ensure that responses were relevant to the learners' actual experiences with the embedded AI during instruction.

The data were analyzed using mixed-method (quantitative–qualitative) procedures. For quantitative analysis, the researcher conducted (1) frequency tabulation and percentage computation to describe pretest and posttest score distributions, (2) t-test for dependent samples to test within-group differences between pretest and posttest scores, and (3) t-test for independent samples (with corresponding p-values) to compare the groups and determine the effectiveness of embedding chat-based AI in the gradual release strategy versus the direct instruction approach. For qualitative analysis, the study employed thematic analysis to identify recurring patterns in the students' written feedback, specifically focusing on the opportunities and challenges experienced by the experimental group during the learning process with Question.AI embedded in instruction.

RESULTS AND DISCUSSION

This section presents and discusses the findings of the study, which examined the effectiveness of embedding chat-based Artificial Intelligence using Question.AI within a Gradual Release Strategy in teaching mathematics to Grade 11 students at Cawayan National High School during the 2023-2024 school year. A quasi-experimental mixed-methods research design was employed, involving a total of sixty-one participants who were assigned to either a control group taught using the Direct Instruction Strategy or an experimental group taught using the Gradual Release Strategy enhanced with chat-based AI. Quantitative data were gathered through a researcher-developed pretest and posttest aligned with competencies on simple and compound interest, while qualitative data were obtained through guided essay writing. Statistical analyses included frequency and percentage distributions, paired samples t-tests, and independent samples t-tests conducted at the 0.05 level of significance, while qualitative responses were analyzed using thematic analysis. The discussion that follows is grounded in the empirical data gathered and interprets the results in relation to the objectives of the study.

The participants consisted of twenty-nine students in the control group and thirty-two students in the experimental group. Prior to the intervention, both groups demonstrated comparable levels of mathematical proficiency in the targeted competencies, which included illustrating and distinguishing simple and compound interest and computing interest, maturity value, future value, and present value. Pretest results showed that most students in both groups were classified at the average competency level, with sixteen students or 55.17 percent of the control group and twenty-two students or 68.75 percent of the experimental group falling within this category. A smaller proportion of students scored below average, consisting of seven students or 24.14 percent in the control group and eight students or 25.00 percent in the experimental group, while only six students or 20.69 percent in the control group and two students or 6.25 percent in the experimental group achieved above average scores. These distributions indicate that both groups were relatively homogeneous in terms of prior knowledge, thereby establishing baseline comparability and strengthening the internal validity of the study. In line with Hornbuckle and Kuehn, the pretest functioned as a diagnostic assessment that reflected students' prior knowledge and highlighted areas requiring instructional support.

Following the instructional intervention, notable improvements were observed in the posttest performance of both groups. In the control group, twenty-five students or 86.21 percent attained an above average level, while four students or 13.79 percent remained at the average level, and none scored below average. Similarly, in the experimental group, twenty-four students or

75.00 percent achieved above average scores, eight students or 25.00 percent were classified as average, and none fell under the below average category. When compared with the pretest results, these findings indicate substantial gains in students' mathematical proficiency across both groups. The complete absence of below average scores in the posttest suggests that the instructional strategies applied were effective in addressing learning gaps and promoting mastery of the competencies. These improvements are consistent with social constructivist principles that emphasize structured guidance, interaction, and meaningful engagement during the learning process.

To determine whether the observed improvements in the control group were statistically significant, a paired samples t-test was conducted comparing pretest and posttest scores. The analysis revealed a mean gain of 6.59 with a standard deviation of 4.81. With twenty-eight degrees of freedom, the computed t-value of 7.38 yielded a p-value of less than 0.00001, indicating a statistically significant difference between the pretest and posttest scores. This result led to the rejection of the null hypothesis and confirmed that the Direct Instruction Strategy contributed significantly to students' improved understanding of simple and compound interest. The finding supports previous research demonstrating that explicit and structured instruction can effectively enhance mathematical comprehension and procedural fluency.

A parallel analysis was conducted for the experimental group to evaluate the impact of embedding chat-based AI within the Gradual Release Strategy. Results from the paired samples t-test showed a mean gain of 8.91 with a standard deviation of 4.68. With thirty-one degrees of freedom, the computed t-value of 10.77 produced a p-value of less than 0.00001, signifying a highly significant improvement in posttest scores. This outcome indicates that the experimental group experienced greater learning gains than the control group. The results provide strong empirical support for the effectiveness of integrating chat-based AI into a scaffolded instructional framework, suggesting that Question.AI enhanced guided practice, feedback, and independent learning.

To further compare the effectiveness of the two instructional approaches, an independent samples t-test was performed on the mean gain scores of the control and experimental groups. The control group recorded a mean gain of 6.59 with a standard deviation of 4.81, while the experimental group achieved a higher mean gain of 8.91 with a standard deviation of 10.77. With fifty-nine degrees of freedom, the computed t-value of 3.27 resulted in a p-value of less than 0.0018, indicating a statistically significant difference between the two groups. This finding confirms that the experimental group outperformed the control group and demonstrates that embedding chat-based Artificial Intelligence using Question.AI within the Gradual Release Strategy was more effective than the Direct Instruction Strategy in improving students' mathematical performance.

Qualitative findings further enriched the interpretation of the quantitative results by providing insights into students' learning experiences. Thematic analysis revealed that participants in the experimental group perceived several opportunities associated with the use of Question.AI, particularly in terms of efficiency, comprehension, and performance. Students reported improved time efficiency, reduced cognitive effort, and enhanced learning efficiency due to immediate feedback and step-by-step explanations. They also described clearer literal, interpretive, and critical comprehension of mathematical concepts, which contributed to improved knowledge acquisition and problem-solving skills. These perceived benefits aligned with the observed increase in test scores.

Despite these advantages, participants also reported challenges related to the functionality and limitations of the tool. These included reliance on stable internet connectivity, sensitivity to command phrasing, and limited capabilities in image and video processing. However, these challenges did not significantly hinder learning or diminish the overall effectiveness of the instructional approach. Instead, students indicated that the benefits of the tool outweighed its limitations, and the challenges were manageable within the instructional context.

The integration of quantitative and qualitative findings provided a comprehensive understanding of the effectiveness of embedding chat-based AI within the Gradual Release Strategy. The significantly higher mean gains achieved by the experimental group were supported by students' reported experiences of enhanced efficiency, comprehension, and performance. While technical challenges were acknowledged, they did not negate the positive learning outcomes observed. This convergence of findings reinforces the conclusion that the instructional strategy was effective not only in improving academic performance but also in enriching students' learning experiences. Overall, the results provide strong empirical support for the pedagogical value of embedding chat-based Artificial Intelligence using Question.AI within structured teaching strategies for mathematics instruction.

CONCLUSION

The findings of this study demonstrate that, although participants in the experimental group encountered challenges during the learning process, the integration of the Gradual Release Strategy with the instructional opportunities provided by Question.AI enabled them to achieve meaningful and statistically significant learning gains. This outcome was clearly reflected in the significant difference between the mean gains of the control and experimental groups, indicating that the technology enhanced instructional approach was more effective in improving students' mathematics performance. These results provide strong empirical support for Piaget's Cognitive Constructivism Theory, as discussed by McLeod, and Vygotsky's Social Constructivist Learning Theory, as discussed by Akpan and colleagues, both of which emphasize the critical role of active participation, social interaction, and collaboration in the learning process. By aligning with these theoretical perspectives, the study reinforces the premise presented in its theoretical framework that academic performance is shaped by how teachers facilitate learning and how students experience and engage with instructional activities and competencies. The findings further affirm that purposeful learning emerges from the meaningful application of prior knowledge, sustained learner engagement, collaborative interaction, and the effective integration of appropriate information and communication technology tools within the instructional process.

In addition to strengthening constructivist learning theories, the findings support existing research highlighting the advantages of using artificial intelligence in mathematics education. Consistent with the claims of Mohamed and colleagues, the study demonstrates that artificial intelligence can support clearer understanding, enhanced problem solving, and improved academic outcomes when thoughtfully integrated into classroom instruction. The results further validate the claim that chat based artificial intelligence is a valuable instructional tool that can be incorporated into established teaching strategies to enhance learning effectiveness. The observed improvement in students' performance confirms that embedding Question.AI within a structured instructional framework is an effective approach for supporting learners' conceptual understanding and skill development in mathematics.

Moreover, the study's findings align with broader educational perspectives advanced by UNESCO and Melo, which emphasize the potential of artificial intelligence to address persistent challenges in education by promoting innovative teaching practices and offering more personalized and engaging learning experiences. The evidence from this study suggests that the effectiveness of Question.AI, when embedded within the Gradual Release Strategy, is high, as the challenges encountered during the instructional process can be anticipated and addressed through proactive collaboration among teachers, school administrators, parents, and students. The challenges identified in the analysis were primarily technical and logistical in nature and require initiative and support from teachers and school leaders rather than fundamental changes to the instructional approach. As such, these challenges do not diminish the overall effectiveness of the strategy but instead point to areas where institutional support can further strengthen its implementation.

Drawing from the comprehensive analysis of the findings, this study also offers practical implications for addressing students' persistent difficulties in mathematics performance. The results suggest that the use of the developed teaching guide in classroom instruction can enhance student participation, promote learner independence, and lead to improved learning outcomes. At the institutional level, the findings highlight the importance of improving access to reliable internet connectivity within schools and fostering supportive policies that enable the responsible use of mobile devices for instructional purposes. Parental support also emerges as a key factor, as providing students with access to basic digital tools and allowing their appropriate use in school can further enhance learning opportunities. Finally, the study underscores the need for continued research on the integration of chat based artificial intelligence within scaffolded teaching strategies. Future studies may further refine and expand this approach to strengthen its effectiveness, support teachers in delivering high quality instruction, and enable students to achieve deeper and more meaningful learning in mathematics.

REFERENCES

Acharya, B. (2017). Factors affecting difficulties in learning mathematics by mathematics learners. International Journal of Elementary Education, 6(2), 8. https://doi.org/10.11648/j.ijeedu.20170602.11

Adams, M., Berkesch, C., Kra, B., Blackman, T., Kloefkorn, T., & Venkatesh, A. (2024, February 3). Artificial intelligence: Challenges and opportunities in postsecondary mathematics education. American Mathematical Society. https://www.ams.org/about-us/CoEwhitepaper2024.pdf

Akpan, V., Igwe, U., Blessing, I., Mpamah, I., & Okoro, C. (2020). Social constructivism: Implications on teaching and learning. European Journal of Education Studies, 8(8), 49–56. https://www.eajournals.org/wp-content/uploads/Social-Constructivism.pdf

Andriani, S., Nurlaelah, E., & Yulianti, K. (2019). The effect of process-oriented guided inquiry learning (POGIL) model toward students' logical thinking ability in mathematics. Journal of Physics: Conference Series, 1157(4), 042108. https://doi.org/10.1088/1742-6596/1157/4/042108

Antony, W. (2024). What is ethical consideration in research? Help for Assessment. https://www.helpforassessment.com/blog/ethical-consideration-in-research/

Baldwin, T., Mazarin, J., & Pisano, G. (n.d.). Effective teaching: Definition, principles, and methods. Study.com. https://study.com/learn/lesson/what-is-effective-teaching.html

Beers, B. (2024). P-value: What it is, how to calculate it, and examples. Investopedia. https://www.investopedia.com/terms/p/p-value.asp

Bhandari, P. (2024). Ethical considerations in research: Types and examples. Scribbr. https://www.scribbr.com/methodology/research-ethics/

Bombaes, A., Fuasan, J., & Garcia, W. (2021). Exploring the factors in student retention of e-learning mathematics: A case of Grade 12 senior high school students at the University of Perpetual Help System–Pueblo de Panay Campus. https://www.researchgate.net/publication/367602558

Bouslog, M. (2024). Effective teaching strategies used in today's classrooms. GraduateProgram.org. https://www.graduateprogram.org/blog/teaching-strategies-used-in-todays-classroom/

Catubig, M. B. (2023). Exploring student-centered approaches in mathematics education: A qualitative case study. Excellencia International Multi-Disciplinary Journal of Education, 1(3). https://multijournals.org/index.php/excellencia-imje/article/download/27/72/100

Cleave, R. (2023). Structured or semi-structured questionnaire? SmartSurvey. https://www.smartsurvey.co.uk/blog/structured-or-semi-structured-questionnaire

ContentSquare. (2024). Five qualitative data analysis methods. https://contentsquare.com/guides/qualitative-data-analysis/methods/

Cornel, D., & Drew, C. (2023). Prior knowledge (educational concept): Meaning and examples. Helpful Professor. https://helpfulprofessor.com/prior-knowledge/

Degree Doctor. (2024). Braun and Clarke thematic analysis: How to do the six-step process in your qualitative research project. https://www.thedegreedoctor.com/blog/braun-and-clarke-thematic-analysis-how-to-do-the-six-step-process-in-your-qualitative-research-project

Department of Education. (2015). DepEd Order No. 8, s. 2015: Policy guidelines on classroom assessment for the K to 12 basic education program. https://www.deped.gov.ph/wp-content/uploads/2015/04/DO_s2015_08.pdf

Department of Education. (2019). DepEd Order No. 021, s. 2019: Policy guidelines on the K to 12 basic education program. https://www.deped.gov.ph/wp-content/uploads/2019/08/DO_s2019_021.pdf

Department of Education. (2019). K to 12 curriculum guide: Mathematics (Grade 1 to Grade 10). https://www.deped.gov.ph/wp-content/uploads/2019/01/Math-CG_with-tagged-math-equipment.pdf

Department of Education. (2022). DepEd Order No. 034, s. 2022: School calendar and activities for the school year 2022–2023. https://www.deped.gov.ph/wp-content/uploads/2022/07/DO_s2022_034.pdf

Drew, C. (2023). Bruner's spiral curriculum: The three key principles. Helpful Professor. https://helpfulprofessor.com/spiral-curriculum/

Drew, C. (2023). Meaningful learning: Definition, benefits, and examples. Helpful Professor. https://helpfulprofessor.com/meaningful-learning/

Edith Cowan University. (2021). Teaching strategies. https://intranet.ecu.edu.au/learning/curriculum-design/teaching-strategies

Fournier, B. (2023). Quantitative vs. qualitative research in psychology. Verywell Mind. https://www.verywellmind.com/what-is-the-difference-between-quantitative-and-qualitative-research-4588136

Google Cloud. (n.d.). What is artificial intelligence (AI)? https://cloud.google.com/learn/what-is-artificial-intelligence

Hailikari, T., Nevgi, A., & Komolainen, E. (2007). Academic self-beliefs and prior knowledge as predictors of student achievement in mathematics: A structural model. Learning and Instruction, 28(1), 59–71. https://doi.org/10.1080/01443410701413753

Harvard Catalyst. (n.d.). Mixed methods research. https://catalyst.harvard.edu/community-engagement/mmr/

Hassan, M. (2023). Ethical considerations: Types, examples, and writing guide. ResearchMethod.net. https://researchmethod.net/ethical-considerations/

Hassan, M. (2023). External validity: Threats, examples, and types. ResearchMethod.net. https://researchmethod.net/external-validity/

Hassan, M. (2023). Reliability: Types, examples, and guide. ResearchMethod.net. https://researchmethod.net/reliability/

Hawthorne, H. (2022). What is effective teaching? High Speed Training. https://www.highspeedtraining.co.uk/hub/what-is-effective-teaching/

Hornbuckle, S. (2022). Five reasons pretests and posttests in education matter. YouScience. https://www.youscience.com/resources/blog/pretest-and-posttest-in-education/

Hudson, J. (2016). Prior knowledge as an unexpected obstacle to learning. Faculty Focus. https://www.facultyfocus.com/articles/course-design-ideas/prior-knowledge-unexpected-obstacle-learning/

Kendra, C. (2022). Overview of the problem-solving mental process. Verywell Mind. https://www.verywellmind.com/what-is-problem-solving-2795485

Koskinenn, R., & Pitkäniemi, P. (2022). Meaningful learning in mathematics: A research synthesis of teaching approaches. Educational Researcher, 17(2), emo679. https://files.eric.ed.gov/fulltext/EJ1336141.pdf

Kuehn, J. (2024). Function and importance of pre and post-tests. HubPages. https://discover.hubpages.com/education/PrePost-Test-A-Diagnostic-Tool-For-More-Effective-Teaching-of-EFL-Students

Lohman, D., & Hurst, J. (2023). Social constructivism: Definition, benefits, and examples. Study.com. https://study.com/academy/lesson/social-constructivism-and-the-mediated-learning-experience.html

Luzano, J. F. P. (2024). AI-powered pedagogies in mathematics education: A systematic review. International Journal of Academic Pedagogical Research, 8(5), 43–47. http://ijeais.org/wp-content/uploads/2024/5/abs/IJAPR240508.html

Maloy, R. W., Edwards, S. A., & Anderson, G. (2010). Teaching math problem solving using a web-based tutoring system, learning games, and students' writing. Journal of STEM Education: Innovations and Research, 11(1). https://www.jstem.org/jstem/index.php/JSTEM/article/view/1467

McLeod, S. (2023). Constructivism learning theory and philosophy of education. Simply Psychology. https://www.simplypsychology.org/constructivism.html

McLeod, S. A. (2023). P-value and statistical significance: What it is and why it matters. Simply Psychology. https://www.simplypsychology.org/p-value.html

Melchor, P. J., Lomibao, L., & Parcutilo, J. (2023). Exploring the potential of AI integration in mathematics education for Generation Alpha: Approaches, challenges, and readiness of Philippine tertiary classrooms. Journal of Innovations in Teaching and Learning, 3(1), 39–44. http://pubs.sciepub.com/jitl/3/1/8

Melo, N. (2023). Incorporating artificial intelligence into the classroom: An examination of benefits, challenges, and best practices. eLearning Industry. https://elearningindustry.com/incorporating-artificial-intelligence-into-classroom-examination-benefits-challenges-and-best-practices

Mihalca, L., Salden, R. J. C. M., Corbalan, G., Paas, F., & Miclea, M. (2011). Effectiveness of cognitive-load based adaptive instruction in genetics education. Computers in Human Behavior, 27(1), 82–88. https://doi.org/10.1016/j.chb.2010.05.027

Mohamed, M. Z. B., Hidayat, R., Suhaizi, N. N. B., Mat Sabri, N. B., Mahmud, M. K. H. B., & Baharuddin, S. N. B. (2022). Artificial intelligence in mathematics education: A systematic literature review. International Electronic Journal of Mathematics Education, 17(3), em0694. https://www.iejme.com/download/artificial-intelligence-in-mathematics-education-a-systematic-literature-review-12132.pdf

Morris, V. (2023). I do, we do, you do: Introducing new learning. Atom Learning. https://atomlearning.com/blog/gradual-release-of-responsibility

NAEP. (2022). 2022 NAEP mathematics assessment. National Center for Education Statistics. https://www.nationsreportcard.gov/highlights/mathematics/2022/

Ningsih, E., & Retnowati, E. (2020). Prior knowledge in mathematics learning. https://www.researchgate.net/publication/344147165_Prior_Knowledge_in_Mathematics_Learning

Olasedidun, O., Ganiyu, R., Makinde, S., & Hamzat, S. (2024). Evaluating instructional package for teaching mathematics to hearing-impaired students. Journal of Global Research in Education and Social Science, 18(3), 23–32. https://doi.org/10.56557/jogress/2024/v18i38761

Ompok, C., Mei Teng, L., & Sapirai, J. (2021). Effect of games towards children's mathematics performance. ERIC. https://eric.ed.gov/?id=EJ1296276

Opesemowo, O. A. G., & Ndlovu, M. (2024). Artificial intelligence in mathematics education: The good, the bad, and the ugly. Journal of Pedagogical Research, 8(3). https://doi.org/10.33902/JPR.202426428

Panjaitan, B., & Zuhri. (2019). The outcomes of learning mathematics in mathematics classrooms. https://www.researchgate.net/publication/340307501_The_Outcomes_of_Learning_Mathematics_in_Mathematics_Classroom

Park, K., Brombacher, A., Brocardo, J., & Steen, L. (2008). The role of mathematics in the overall curriculum. International Mathematical Union. https://www.mathunion.org/icmi/role-mathematics-overall-curriculum

PhilAtlas. (2023). Cawayan, Municipality of Dalaguete, Province of Cebu. https://www.philatlas.com/visayas/r07/cebu/dalaguete/cawayan.html

Question AI. (2024). Best AI homework help online for free. https://questionai.ai/

Qureshi, M., Khaskheli, A., Qureshi, J., Raza, S., & Yousufi, S. (2021). Factors affecting students' learning performance through collaborative learning and engagement. Interactive Learning Environments, 31(4). https://doi.org/10.1080/10494820.2021.1884886

Ramento, M. N. S., Natad, A. G. D., Habelito, V. C., & Gumiran, I. C. (2025). Exploring Question AI as a pedagogical tool in higher mathematics education. ICPD Journal of Global Multidisciplinary Innovations, 1(1), 1–16. https://www.icepd-ojs.org/index.php/ijglomi/article/view/5

Roblon, A., Cano, A., Miñoza, G., Recomo, J., Monares, J., Arriola, M., Polancos, Q., & Mutya, R. (2022). Business and education research. International Journal of Multidisciplinary: Applied, 3(12), 2498–2508. https://ijmaberjournal.org/index.php/ijmaber/article/view/652/402

Rosales, M. E. Q. (2023). Your modern business guide to data analysis methods and techniques. Scribd. https://www.scribd.com/document/610469750

Shamboul, H. (2022). The importance of critical thinking on the teaching-learning process. https://www.researchgate.net/publication/357652909_The_Importance_of_Critical_Thinking_on_Teaching_Learning_Process

Simonsmeier, B., Flaig, M., Deiglmayr, A., Schalk, L., & Schneider, M. (2021). Domain-specific prior knowledge and learning: A meta-analysis. Learning and Individual Differences, 86, 102007. https://doi.org/10.1080/00461520.2021.1939700

Stumpfegger, E. (2017). Trustworthiness of research. Munich Business School. https://www.munich-business-school.de/insights/en/2017/trustworthiness-of-research/

TeachThought Staff. (2024). What is the gradual release of responsibility model? TeachThought. https://www.teachthought.com/pedagogy/gradual-release-responsibility/

UNESCO. (2023). Artificial intelligence. https://www.unesco.org/en/artificial-intelligence

UNESCO. (2023). UNESCO's education response to COVID-19. https://www.unesco.org/en/covid-19/education-response/initiatives

Varaidzaimakondo, P., & Makondo, D. (2020). Causes of poor academic performance in mathematics at ordinary level: A case of Mavuzani High School, Zimbabwe. https://www.researchgate.net/publication/342010903_Causes_of_Poor_Academic_Performance_in_Mathematics_at_Ordinary_Level_A_Case_of_Mavuzani_High_School_Zimbabwe

Vinney, S. (2019, July 23). What is a schema in psychology? ThoughtCo. https://www.thoughtco.com/schema-definition-4691768

Widiyatmoko, A., Utaminingsih, S., & Santoso. (2021). Android-based math learning to improve critical thinking. Journal of Physics: Conference Series, 1823(1), 012091. https://doi.org/10.1088/1742-6596/1823/1/012091