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Exploring Question AI as Pedagogical Tool in Higher Mathematics Education

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Abstract

This study explores the integration of Question.AI, an AI system, into mathematics education, examining its potential and limitations through a qualitative single-case study involving interviews and surveys with educators and students. Findings reveal that Question.AI offers personalized learning and reduces cognitive load, valued for its convenience by students and its pedagogical enhancement by teachers, aligning with Social Cognitive Theory (SCT) and Technology Acceptance Model (TAM). However, concerns regarding accuracy, reliability, and ethical implications, such as data privacy and inclusivity, are prominent. The research highlights the necessity for improvements in Question.AI's accuracy and features, alongside promoting its responsible use. Recommendations include teacher training programs for effective integration, encouraging student critical analysis and ethical awareness, curriculum integration aligned with educational objectives, and collaborative efforts between IT experts and developers to ensure reliability. Future research should focus on long-term effects and mitigation strategies, emphasizing the importance of verifying AI-generated answers to maintain academic integrity. The study underscores the need for a balanced approach, leveraging AI's benefits while addressing its challenges to optimize its role in mathematics education.

Keywords*: Artificial Intelligence, Challenges, Ethical Implications, Mathematics Education, Question.Ai, Technology, and Pedagogy*

1. INTRODUCTION

Mathematics plays a pivotal role in developing intellectual and analytical abilities, Kaushik and Hwang (2021) , particularly in higher education. In the Philippines, a robust understanding of mathematics is essential for problem-solving skills and serves as a foundation for STEM disciplines. As the global demand for a skilled STEM workforce grows, innovative pedagogical approaches are crucial. This research focuses on integrating Question.AI as a

pedagogical tool within the Bachelor of Secondary Education major in Mathematics program, aiming to blend technology with traditional educational practices.

The Fourth Industrial Revolution has underscored the importance of technology integration in education. This study addresses the gap between traditional teaching methodologies and the evolving needs of mathematics students by exploring the benefits and considerations of integrating Question.AI. The research aims to inform educators, policymakers, and stakeholders about the potential of AI chatbots in creating a more effective and inclusive learning environment.

The primary objectives of this research are to understand the perceptions of students and teachers regarding Question.AI and to propose a program of activities based on the study's findings. Key questions include: (1) What are the student respondents' perceptions of Question.AI in terms of learning purpose, enhancement, conceptual understanding, individualized learning, and challenges? (2) What are the teacher respondents' perceptions of Question.AI in terms of pedagogy, potential benefits, real-time assistance, challenges, and ethical considerations?

2. THEORETICAL FRAMEWORK

This study is grounded in four key theoretical frameworks:

Cognitive Load Theory (CLT): CLT posits that effective learning is influenced by the cognitive load imposed on learners' working memory. Understanding the intrinsic, extraneous, and germane loads is crucial for optimizing the integration of Question.AI to minimize extraneous load and maximize germane load, Chen (2019) and Saari (2016).

Social Cognitive Theory: This theory emphasizes the role of observational learning and modeling. Students' interactions with Question.AI, as a virtual model, can influence their mathematical learning experiences.

Technology Acceptance Model (TAM): TAM suggests that perceived ease of use and usefulness influence users' acceptance of technology. This framework helps understand how students and educators perceive and accept Question.AI.

Constructivism: This theory posits that learning is an active, social process where learners construct knowledge based on their experiences and interactions. Question.AI, as an interactive tool, can facilitate the construction of mathematical knowledge in a collaborative learning environment.

3. METHODOLOGY

This study employed an exploratory single-case study qualitative approach to investigate the experiences of mathematics teachers and students in Mandaluyong City, Philippines, during the 2023-2024 academic year. The focus was the integration of Question.AI, an AI chatbot, into the Bachelor of Secondary Education major in Mathematics program. This design was chosen due to the increasing prevalence of AI tools in education and the need to understand their impact on teaching and learning. The integration of Question.AI represents a significant pedagogical shift, making a case study ideal for examining its real-world implications.

An exploratory case study design was selected to allow for a nuanced, in-depth examination of the complex phenomenon within its natural context. This approach, as supported by Stake and Yin (2018), facilitates the exploration of "how" and "why" questions, crucial for understanding the impact and experiences associated with Question.AI. The research design adhered to the principles of contextual exploration, aiming to provide a focused analysis of the implications of AI integration for both teachers and students in mathematics education.

The population for this study consisted of students and teachers from Rizal Technological University (RTU), Jose Rizal University (JRU), and Arellano University (AU) who had incorporated Question.AI into their teaching and learning practices. A homogeneous purposive sampling method was used to select five students and five teachers. This approach ensured that participants shared relevant characteristics, such as being involved in mathematics education and having experience with Question.AI. The student participants ranged from 17 to 25 years old, encompassing first- to fourth-year mathematics majors with diverse gender identities. The teacher participants ranged from 25 to 60 years old, also representing diverse gender identities, to capture a broad spectrum of experiences.

The respondents were categorized into two groups: mathematics faculty and BSE-Mathematics students. Data analysis involved two primary methods: inductive thematic analysis and descriptive analysis. Inductive thematic analysis was used to identify recurring themes related to experiences, challenges, and perceived benefits of Question.AI, based on the perspectives of both students and teachers. This involved a detailed, iterative process of data familiarization and two levels of coding. Descriptive analysis was used to summarize and organize the gathered data, providing an overview of data distribution and identifying similarities among variables. This method facilitated the visualization of data and the drawing of preliminary conclusions, laying the groundwork for further analysis. The use of descriptive analysis, as described by Loeb et al. (2017), allowed the researchers to effectively understand the respondent's perceptions and prepare the data for further interpretation.

4. RESULT AND DISCUSSION

1. Students Perceptions Towards the Use of Question.AI based on their Experiences in terms of:

1.1. Learning Purpose

Table 1: Students' Perceptions towards the Use of Question.AI in terms of Learning Purpose

Category	Emerging Themes	Participants
Assistance and Accessibility	Offers Free Access Easy to Use Excellent Support for Users	1 1 and 5 1 and 2
Enhanced Understanding	Provides Detailed Explanation that Enhanced the Knowledge of Students	2 and 3

Accuracy Concerns	Uncertainty about the Accuracy of Provided Data	3 and 4

The study highlights that Question.AI significantly impacts math education by being free, user-friendly, and providing clear instructions. This accessibility helps students learn independently and grasp complex concepts more effectively. Users appreciated its cost-free nature and ease of use, which saved them time and effort when solving math problems.

However, concerns about accuracy and the need for critical analysis of the results were raised. Addressing these concerns through more training and increased awareness could enhance the tool's effectiveness and help more users benefit from its capabilities. This approach ensures that while leveraging the advantages of Question.AI, students also develop critical thinking skills and apply the concepts learned more effectively.

Recent studies highlight the potential of AI tools in mathematics education. Free AI-powered chatbots like Question.AI can provide accessible, personalized assistance to students, helping bridge financial gaps in educational resources (Hidayat et al., 2022; Wardani et al., 2024). These tools offer timely explanations, practice problems, and tailored feedback, enhancing students' learning experiences and motivation (Cai et al., 2021; Wardani et al., 2024). Recent studies have explored the impact of AI tools on students' learning and critical thinking skills, showing that students perceive AI as beneficial for saving time and effort in problem-solving, particularly in mathematics education (Xiaozhu Zou et al., 2023). The responses suggest that Question.AI is a supportive learning aid that enhances problem-solving skills and conceptual understanding in mathematics (Wardani et al., 2024).

1.2. Learning Enhancement

Table 2: Students' Perceptions towards the Use of Question.AI in terms of Learning Enhancement

Category	**Emerging Themes**	**Participants**
Access to Additional Information and Resources	Utilized to Solve General Questions, Essays, and Mathematical Problems	1 and 3
Enhanced Learning Experiences	Provides Practical Solutions Facilitates a Deeper Understanding of Concepts	2 and 4 2, 4, and 5
Limitations	Limitations in Complex Problem Solving Accuracy	3 3

The findings indicate that Question.AI significantly enhances classroom learning for students in math and other subjects. It provides access to abundant information, step-by-step instructions, and helpful answers, making it an excellent

tool for tackling math problems, writing articles, and addressing general questions. Participants appreciated its ease of use and time-saving features, which support independent learning and better comprehension of complex concepts.

Nevertheless, the tool's limitations in accuracy and handling intricate problems suggest that students should critically assess its results. Additionally, it is essential for the creators of Question.AI to address these issues to improve its effectiveness. By continuously refining the tool, its developers can ensure that it remains a valuable resource for students, promoting more meaningful and accurate learning experiences (Teodoro, et al., 2011). These responses demonstrate the effectiveness of the program in simplifying mathematics by breaking down problems into manageable parts (Abbasi, et al., 2019). Both responses suggest that Question.AI enhances the learning experience by offering diverse assistance, making it a helpful tool across different subjects (Kang, et.al2023).

1.3. Understanding Mathematical Concepts

Table 3: Students' Perceptions towards the Use of Question.AI in terms of Improving their Understanding in Mathematical Concepts

Category	Emerging Themes	Participants
Guided Learning and Dependency Awareness	Use the Tool to Independently Understand Math	1
Engagement and Reinforcement of Knowledge	Providing Engaging Math Questions and Problems	2
Process Understanding through Step-by-Step Solutions	Guided Explanations Writing Out Solutions	3 4
Challenges in Application	Copying Answers Without Understanding the Underlying Concepts	3 and 5

The research shows that Question.AI helps students understand math ideas better by giving them guided explanations, fun problem-solving tasks, and step-by-step answers. Students like the tool because it helps them remember things and figure out what they need to work on, but they also stress that they shouldn't rely on it too much. Challenges include sometimes giving short-cut answers and passively learning, like repeating answers without understanding them. People really like features like automatic question generation and instant feedback. However, adaptive learning pathways and customized material could be made better. This observation aligns with research highlighting how engagement and active participation in learning enhance knowledge retention. According to a study by Prince (2004), active learning strategies, such as solving challenging problems and engaging with the material, improve students' comprehension and performance. Similarly, a study by Lee and Hannafin (2016) found that interactive learning platforms, which provide immediate feedback and offer engaging content, significantly improve student motivation and understanding. Research supports the effectiveness of guided

explanations in learning. According to Mayer (2019), students learn better when they receive clear explanations and visual representations of problem-solving steps, as it helps them process and retain information more effectively. Similarly, Sokolowski (2020) highlights that providing step-by-step solutions enables students to develop a more vital conceptual understanding of mathematics, as they can follow the logical flow of each problem (Rittle-Johnson and Schneider (2015).

1.4. Individualized Learning

Table 4: Students' Perception towards the Use of Question.Ai in terms of Providing Individualized Support

Category	Emerging Themes	Participants
Support for Independent Study and Learning	Supports Independent Study Efforts Serves as Refreshing Source for Understanding Formulas and Processes	1 and 4 1
Comprehensive Explanation	Clarify Uncertainties Guide Students through the Problem-Solving Process	2 4 and 5
Customized Learning Experiences	Adjusting Difficulty Levels Instant Feedback	2 2

The study found that Question.AI helps students learn math on their own by giving them personalized help, clear explanations, and step-by-step answers. Students liked how the platform helped them figure out how to answer problems on their own, remember formulas, and fill in any knowledge gaps. Participants liked things like being able to choose their own levels of difficulty and getting feedback right away, which kept them interested and driven while also helping them get better over time. Some users did notice differences between the platform's answers and those of their teachers, but these differences often helped them learn more. Research supports this idea. Mayer (2019) suggests that learning from alternative explanations enhances understanding and flexibility in applying knowledge. Similarly, Schwartz et al. (2021) found that comparing different approaches to problem-solving improves students' ability to recall and apply concepts effectively. According to Hattie and Timperley (2017), clear and specific feedback helps students focus on the areas they need to improve, guiding them through the learning process. Furthermore, VanLehn (2021) emphasizes that step-by-step explanations can significantly enhance students' understanding of complex subjects by breaking down difficult concepts into manageable steps. Research supports this idea. VanLehn (2021) found that step-by-step guidance enhances students' ability to retain and apply problem-solving strategies. Similarly, Hattie and Timperley (2017) emphasize that structured feedback improves understanding and memory of key concepts.

1.5. Challenges

Table 5: Students' Perceptions towards the Use of Question.AI in terms of Challenges

Category	Emerging Themes	Participants
Discrepancies in Responses and Understanding	Uncertainty in Accuracy Response Understanding	3, 4 and 5 1, 2, and 4
Reliance on Explanation Variability	Dependency on the platform's support	1, 2 and 3
Technical Hurdles for Effective Learning	Connectivity Issues and Disruptions	2 and 3

Students' perceptions towards the use of Question.AI reveal several challenges. The platform's ability to facilitate understanding and the level of uncertainty in response accuracy are significant concerns, as disparities in responses and comprehension indicate difficulties in grasping concepts. Additionally, reliance on the platform's explanations and support highlights the variability in the quality of these explanations, leading to inconsistencies in the learning experience. Technical hurdles, such as disruptions and connectivity issues, further impede the platform's effectiveness and create frustration for students. Addressing these challenges is essential for enhancing the overall effectiveness of Question.AI and ensuring it provides consistent, accurate, and reliable support for students in their learning journey (Lee et al. (2023). To ensure students understand the material thoroughly, teachers could add their explanations to the ones provided by the AI. Research by Luckin et al. (2016) highlights the significance of integrating human instruction with AI in improving learning outcomes.

2. Teachers' Perceptions Towards the Use of Question.Ai based on their Experiences in terms of:

2.1. Pedagogy

Table: 6: Teachers Perceptions towards Question.Ai in terms of Pedagogy

Category	Emerging Themes	Participants
Enhanced Learning Experience through Accessibility nd Accuracy	Offers Free Access Platform Reliable Information	10 10
Efficiency and	Address Learners Needs Time Saving	7, 8 and 9 8

Supportive Learning Environment		
Optimizing Teaching Strategies	Comprehensive Support Mechanism Satisfaction	7, 8 and 10 6

Teachers identify that Question.AI has several pedagogical advantages. The platform enhances learning experience through accessibility and accuracy, as it offers free access and reliable information. By addressing students' needs and conserving time, it also fosters efficiency and a positive learning atmosphere. Furthermore, with extensive support systems, Question.AI facilitates the optimization of teaching strategies, resulting in teacher satisfaction. Question.AI can enhance learning by making it more accessible to more students by offering quick, accurate responses at no fee. It would be helpful to investigate how well Question.AI interacts with teachers' lesson plans and whether it aligns with their teaching objectives to further improve the platform's efficacy (Zhao & Frank, 2018). By ensuring that Question.AI is in line with curriculum objectives, educators may leverage this technology to its full potential.

2.2. Potential Benefits

Teacher 7: Teachers Perceptions towards Question.AI in terms of Potential Benefits

Category	Emerging Themes	Participants
Maximize Time Efficiency through Real time Assistance	Leverage Time Saving Features Comprehensive Assistance	6, 7, 8 and 10 6, 7, and 9
Enhanced Learning Through on Demand	Free Access to Personalized Assistance	9 and 10
Enhanced Teaching Effectiveness	Address Student Needs Accuracy Ensures Satisfactory Learning Outcomes	7, 8 and 9 6, 8 and 10 7

Teachers' perceptions towards Question.ai recognize several advantages in terms of potential benefits. Maximum time efficiency through real-time support is one important advantage; teachers acknowledge the platform's capacity to save time and offer comprehensive assistance. Enhanced learning through on-demand access is another significant benefit, and teachers appreciate the platform's free, personalized assistance. Moreover, the platform supports student needs, ensures accuracy, and improves learning outcomes, highlighting increased teaching efficacy. Maxwell Szymanski et al. (2024) explore teacher preferences for feedback, control, and explanations in AI-aided distractor

generation systems. Hugo Rodrigues et al. (2018) present GEN, a system that learns from teachers' implicit feedback to improve question generation over time. Danny C.L. Tsai et al. (2021) propose an automatic question generation system combining syntax and semantics-based approaches, showing improved student learning outcomes through repeated testing.

2.3. Real-time Assistance

Table 8: Teachers Perceptions towards Question.AI in terms of Real-time Assistance

Category	Emerging Themes	Participants
Maximize productivity and Reduce Workload Burden	Enhance Efficiency through Time Saving Support	7, 8 and 9
Provide Precise and Relevant Support for Optimal Learning Outcomes	Teaching Effectiveness through Accurate Alignment with Student Needs	6, 8 and 10
Provides an Opportunity for Growth and Innovation	Foster Resilience Adaptability in Learning	7

Teachers perceive Question.AI as a valuable tool for real-time assistance in their teaching practices. Teachers believe that Question.AI helps increase efficiency by saving time, enabling them to be more productive and manage their workload effectively. They also view it as a tool that enhances teaching effectiveness by aligning its support with the specific needs of students, contributing to better learning outcomes. Furthermore, teachers see Question.AI as an opportunity for growth and innovation, fostering resilience and adaptability in teaching and learning. Teachers regarded Question.AI as beneficial for making teaching more efficient, effective, and responsive to student needs. The ability of Question.AI to enhance efficiency by saving time is reflective of broader trends in the integration of AI tools in education. Research shows that AI can significantly reduce teachers' administrative and repetitive tasks, improving productivity and allowing them to dedicate more time to personalized teaching and student interaction. These improvements align with current findings in educational technology, where time-saving tools are linked to higher teacher satisfaction and improved classroom management, demonstrating how AI can be leveraged to optimize teaching and learning experiences. (Cai et al., 2021)

2.4. Challenges

Table 10: Teachers' Perceptions Towards Question.AI in terms of Challenges

Category	Emerging Themes	Participants
Uncertainty about the Accuracy, coupled with Technical Errors	Accuracy Reliability	6, 7, and 8
Limitations in addressing Student Needs	Limitations Constraints	6 and 10
Responsible	Ethics	9

Teachers identified several challenges associated with using Question.AI for real-time assistance. A primary concern is the uncertainty about its accuracy and reliability, often coupled with issues related to technical errors. Additionally, teachers observed that Question.AI has limitations in addressing the unique and varying needs of students, which can hinder its ability to support individualized learning outcomes effectively. Furthermore, ethical considerations were also raised, with teachers emphasizing the importance of using the tool responsibly to maintain fairness and integrity in educational settings. Teachers highlight the challenges and the need for ongoing improvements to ensure Question.AI is not only accurate and flexible but also aligns with the ethical standards expected in teaching. Incorporating AI into teaching mathematics can be helpful, but when dealing with more complex problems, the teacher's role in verifying answers becomes essential. Research shows that AI tools often face limitations when applied to more advanced subjects, reinforcing the need for human supervision to avoid miscommunication and ensure the content is accurate (Li & Hou, 2020). AI works best when supplemented with teacher guidance, especially when handling higher-level concepts.

2.5. Ethical Considerations

Table 10: Teachers Perceptions towards Question.AI in terms of Ethical Considerations

Category	Emerging Themes	Participants
Accurate	Accuracy	8
Equality and Representation	Diversity and Inclusivity	10
Confidentiality and Protection	Privacy Security	6 and 9
Responsible	Ethics	7 and 8

Teachers emphasized several ethical considerations regarding the use of Question.AI in educational settings. Accuracy was highlighted as an essential factor, as teachers expect the tool to deliver precise and reliable information. They also underlined the importance of promoting diversity and inclusivity, ensuring that the tool fairly represents different perspectives and caters to various learning needs. Privacy and security were significant concerns, with teachers stressing the need to protect sensitive data and maintain confidentiality when using the tool. Additionally, the importance of ethical responsibility was emphasized, focusing on the need for the tool to be used in ways that uphold fairness, transparency, and integrity. These considerations reflect the expectations of teachers for Question.AI to not only perform effectively but also align with ethical standards in its implementation. The ethical considerations surrounding privacy in AI are well-documented. Recent studies stress the need for robust data protection measures, particularly in educational settings where students' personal and academic information is vulnerable to misuse (Zhang & Zhao, 2023). AI literature underlines the importance of maintaining stringent security protocols. While many AI tools claim not to collect personal data, there are still concerns about inadvertent breaches or data leaks. Research suggests

that implementing end-to-end encryption and regular security audits is critical for protecting user information in AI systems (Burt et al., 2022).

3. Proposed Program of Activities: Integrating Question.AI in Mathematics Education

Table 11: Proposed Program of Activities

Key Result Area	Activity	Objectives	Persons Involved	Time Frame	Success Indicator
Accuracy and Reliability: Decrease in errors and improve user satisfaction.	Establish feedback mecha-nisms.	Collect actionable feedback for improvement.	Teachers	Month 1-2	Decrease in errors; positive usability feedback.
User Engagement: Enhance ethical usage and reduce misuse incidents.	Develop educational materials for ethical use.	Educate students on ethical considerations.	Students	Month 3-4	Increase ethical awareness; reduced misuse.
Curriculum Integration: Seamless integration into classroom instruction.	Pilot integration in classrooms.	Adapt teaching practices with AI tools.	Curriculum Makers	Month 5-6	Integration into diverse Lesson plans; improved student engagement.
Technical Assurance: Continuous improvement in functionality and security.	Analyze feedback and improve AI.	Ensure usability and security.	Developers	Month 7-8	Regular updates; effective security.
Research and Development: Evaluate long-term impacts and guide future improvements.	Conduct research studies.	Assess educational outcomes and inform development.	Researchers	Month 9-12	Publication of research findings; adoption of insights.

The proposed program of activities aims to enhance the integration of Question.AI in mathematics education by addressing key findings from the study.

Disclosure of Conflict of Interest

No conflict of interest.

Ethical Consideration

The respondents have given their informed consent for the data gathering, management, and disposal procedures to be implemented.

5. CONCLUSIONS

The study concludes that Question.AI is generally perceived as a valuable educational tool by both students and teachers, particularly for enhancing mathematics learning. Students appreciate its accessibility, ease of use, and ability to provide detailed explanations and individualized support, which aids in understanding complex concepts. However, they also encounter challenges such as occasional inaccuracies, potential over-reliance, and technical issues. Teachers recognize Question.AI's pedagogical benefits, including improved teaching effectiveness and real-time assistance, but emphasize the importance of responsible use, ethical considerations regarding accuracy and privacy, and the need for continuous improvements to address technical limitations.

Furthermore, the research highlights the necessity of active student engagement and ethical implementation to prevent over-dependence on Question.AI. Integrating the tool effectively into math instruction while addressing technical challenges is crucial for maximizing its potential. Both students and teachers agree that while Question.AI offers significant advantages, its successful integration requires careful consideration of its limitations and a commitment to ethical practices to ensure fairness and transparency in the learning environment.

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