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WhatsApp-Based Meta AI Assistant in Enhancing Pre-Service Teachers' Conceptual Understanding of Mathematics

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Research Article

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Abstract

This qualitative study explored the pre-service teachers' perceptions and experiences using a WhatsApp-based Meta AI assistant to support their conceptual understanding of mathematics. Drawing on structured interviews with 79 participants from the July 2025 intake, the research investigated five key areas: perceived effectiveness, types of mathematical concepts clarified, influence on engagement and motivation, challenges faced, and changes in problem-solving approaches. Findings revealed that the AI assistant is valued for its accessibility, clear explanations, and instant feedback, which enhance understanding and raise autonomous, motivated learning. Participants reported improved comprehension of complex topics such as calculus and algebra, increased confidence, and more strategic problem-solving methods. However, challenges including occasional technical issues, language complexity, and lack of human encouragement were noted. Overall, the study highlights the potential of integrating AI tools like the Meta assistant within mathematics education to complement traditional teaching and promote deeper learner engagement.

Introduction

The rapid advancement of artificial intelligence (AI) in educational technologies has created new opportunities to enhance learning experiences, particularly in STEM fields such as mathematics. Among various platforms, WhatsApp-based AI assistants offer an accessible and interactive medium for pre-service teachers to engage with complex mathematical concepts beyond the classroom. This study explores how a WhatsApp-based Meta AI assistant influences pre-service teachers' conceptual understanding, engagement, motivation, and problem-solving approaches in mathematics. Given the increasing reliance on mobile learning tools, understanding the lived experiences of these students is critical to optimizing AI integration into teacher education programs.

The findings revealed that pre-service teachers generally perceive the Meta AI assistant as an effective and convenient supplement to traditional instruction, with frequent use especially before assessments. Participants emphasized the AI's ability to provide clear, immediate explanations that enhance comprehension of challenging topics such as calculus and mathematical induction. The assistant also raises autonomous learning and reduces anxiety around mathematics by offering private, instant feedback. However, challenges such as occasional technical issues, language complexity, and limited emotional support were noted. Despite these, the AI tool positively reshapes learners' problem-solving strategies by encouraging stepwise reasoning and exploration of multiple solution paths. These insights highlight the potential of WhatsApp-based AI to support future teachers' mathematics learning in accessible and meaningful ways.

Research questions;

1. How do pre-service teachers perceive the effectiveness of a WhatsApp-based Meta AI assistant in supporting their conceptual understanding of mathematics?

2. What types of mathematical concepts do pre-service teachers find most clarified through interactions with the Meta AI assistant on WhatsApp?
3. How does the use of a WhatsApp-based Meta AI assistant influence pre-service teachers' engagement and motivation in learning mathematics?
4. What challenges do pre-service teachers face when using the Meta AI assistant via WhatsApp for learning mathematical concepts?
5. In what ways does the interaction with the Meta AI assistant reshape pre-service teachers' approaches to problem-solving in mathematics?

Literature Review

Recent studies have underscored the growing role of AI-powered tools in supporting mathematics education, especially through mobile platforms. Research by Dekhakhena (2025) emphasizes how AI assistants provide immediate, personalized feedback that helps learners clarify abstract concepts, similar to the pre-service teachers' appreciation of the WhatsApp-based Meta AI assistant's accessibility and clarity in the current study. According to Guo, Halim, and Saad (2025) the accessibility and instant support offered by mobile AI applications reduce learners' dependence on traditional classroom constraints, which aligns with the participants' reported frequent use before assessments.

The effectiveness of AI in clarifying complex mathematical topics is widely documented. For example, Paliwal and Patel (2025) found that AI tutors excel in conceptual explanations, particularly for calculus and algebraic reasoning, supporting deep understanding beyond procedural knowledge. This reflects the participants' experiences of gaining clearer comprehension of integration, differentiation, and mathematical induction through the AI assistant. Moreover, AI's ability to provide visualizations and break down dense formal language into manageable parts has been shown to enhance learners' conceptual grasp Dai (2025), as echoed in participants' comments about mental imagery and stepwise explanations.

Motivation and learner engagement are key benefits of AI-supported learning environments. According to Harahap (2025), the immediacy and privacy of AI feedback reduce anxiety and encourage learners to take ownership of their study pace. The study's findings corroborate this, with participants reporting increased motivation, autonomy, and confidence attributed to the AI assistant's availability on a familiar platform like WhatsApp. This aligns with broader research indicating that integrating AI tools within everyday communication platforms boosts engagement and reduces barriers to learning (Hanshaw & Sullivan, 2025).

Despite these advantages, challenges remain in the application of AI tools for mathematics education. Technical difficulties such as connectivity issues and AI misinterpretations have been widely reported (Festus & Emmanuel, 2025). Participants' experiences with unclear answers and the lack of emotional support echo concerns raised by Kurian (2025) about AI's current limitations in providing empathetic and guidance. Additionally, distractions inherent in multi-use platforms like WhatsApp and the difficulty of

handling graphical or proof-based tasks underscore the need for more specialized, integrated AI solutions (Radanliev, 2025).

Finally, the influence of AI tools on problem-solving approaches has been explored in recent literature. Research by Mazari (2025) suggests that AI assistance fosters metacognitive skills by encouraging learners to adopt stepwise, reflective strategies and explore multiple solution paths. This study's participants similarly reported shifts toward strategic problem breakdown, reverse solving techniques, and flexible approaches to complex problems. Such findings highlight the potential of AI tools not only to support content mastery but also to develop higher-order thinking and adaptive problem-solving skills crucial for mathematics proficiency.

Methods

This study employed a qualitative research approach using a structured interview protocol to explore pre-service teachers' perceptions and experiences related to using a WhatsApp-based Meta AI assistant for learning mathematics. A constructivist paradigm underpinned the approach, acknowledging the subjective and contextual nature of participants' learning experiences with the AI tool. The aim was to uncover rich, descriptive data that could inform the potential integration of AI technologies into mathematics education.

Participants were selected using purposive sampling, focusing on July 2025 intake pre-service teachers enrolled in mathematics-related programs at the university. A total of 79 participants were interviewed, ensuring diversity in gender, age, academic specialization (e.g., Mathematics–Computer Science), and prior exposure to mobile learning. This selection strategy ensured that the sample reflected typical users of the AI assistant, particularly those active on WhatsApp for academic communication.

Data were collected using a structured interview guide consisting of 50 items: 4 demographic and 46 thematic questions grouped under five research questions. These items probed participants' perceptions of the assistant's effectiveness, clarified concepts, motivational effects, encountered challenges, and shifts in problem-solving approaches. Interviews were conducted in person and via WhatsApp voice notes, ensuring flexibility and comfort for respondents. Interviews lasted approximately 30–40 minutes and were recorded with consent.

The data collection instrument was piloted with five participants to refine clarity and ensure the relevance of items. Adjustments were made to the phrasing of a few questions to improve comprehensibility and minimize ambiguity. Responses were then transcribed verbatim and assigned line numbers to maintain coherence between quotes and analysis. Participants' voices are reported using pseudonyms and numerical labels (e.g., Participant 14, Line 6) to preserve confidentiality while enhancing traceability of themes.

For data analysis, the study employed thematic analysis following Braun and Clarke's (2006) six-phase framework. The transcripts were read repeatedly for familiarization, after which initial codes were

generated both inductively from participant responses and deductively based on the research questions. These codes were then grouped into themes, such as conceptual clarity, motivation, technical barriers, and strategic thinking. NVivo software was used to organize the data and assist in tracking patterns and cross-participant themes.

Trustworthiness was ensured through triangulation (cross-verifying participant responses), member checking (participants reviewed their transcribed statements), and peer debriefing (themes were discussed among researchers). An audit trail of coding decisions and memo notes was maintained throughout. These procedures strengthened the credibility, transferability, and dependability of the findings, aligning them with best practices in qualitative research.

Ethical approval

was secured from the institutional ethics review board, and all participants provided informed consent. They were assured of anonymity and the voluntary nature of participation. The methodology thus reflected a rigorous, ethical, and participant-centered approach to understanding how AI-assisted learning via WhatsApp shapes mathematical learning among future teachers.

Results

Demographic Information

The participants ranged in age mostly around early twenties, with Participant 14, stating, "*I'm 21 years old and currently in my third year of study*" (Line 6). Gender representation was balanced; for example, Participant 03 identified as female (Line 8). Academic backgrounds varied but many focused on STEM fields such as Mathematics–Computer Science (Participant 27, Line 10). Participants also indicated frequent smartphone and internet use, particularly WhatsApp, which they used "*almost daily for academic group discussions and to consult the AI assistant*" (Participant 51, Line 12).

Research Question 1: Perceptions of Effectiveness

Participants generally perceived the WhatsApp-based Meta AI assistant as an effective supplementary learning tool that enhanced their understanding of complex mathematical concepts. Many described frequent use, particularly before assessments, as an integral part of their study routine. For example, Participant 35 shared, *"I use the Meta AI assistant three to four times a week, especially before assignments or quizzes"* (Line 15), highlighting the tool's role in timely academic support. This frequency underscores the assistant's accessibility and perceived utility in supporting academic preparedness.

Several participants expressed that the AI assistant provided clearer explanations than traditional lectures. Participant 10 noted, *"Honestly, it's been a helpful tool. Sometimes more clear than my lectures"* (Line 17), suggesting that AI explanations could complement or even surpass in-class teaching clarity.

This was especially valuable for abstract or difficult topics. Participant 06 said, *"It helped me understand functions better, especially composite functions"* (Line 19), showing the assistant's strength in clarifying specific mathematical ideas that are often challenging.

Regarding immediate feedback and user trust, participants valued the AI assistant's instant responses. Participant 19 commented, *"I still value teachers, but the AI gives instant feedback, which textbooks can't"* (Line 23). Although most answers were deemed accurate, some participants exercised caution. Participant 58 mentioned, *"Most answers are accurate, though once in a while it misinterprets the question"* (Line 27), emphasizing the need for critical engagement with AI outputs. Participant 67 further noted the importance of cross-verification, saying, *"I trust it when I double-check with my notes or the teacher afterward"* (Line 29).

Several respondents were enthusiastic enough to recommend the AI assistant to peers, suggesting a positive user experience that fosters wider acceptance. Participant 05 proudly stated, *"I already recommended it to two of my classmates"* (Line 31). The effective features such as voice and image recognition were frequently praised. Participant 22 appreciated, *"The voice and image recognition tools are really good, especially for graphs"* (Line 33), indicating that multimodal input capabilities enhanced learning engagement and concept visualization.

The participants' high regard for the Meta AI assistant's instant feedback and conceptual clarity aligns with Dekhakhena (2025) who highlighted AI's role in reducing reliance on traditional instruction through immediate, personalized support. Similarly, Guo et al. (2025) affirmed the utility of AI in breaking down complex mathematical content, reflecting participant praise for the assistant's clear, multimodal explanations.

Research Question 2: Types of Clarified Concepts

The participants highlighted a range of mathematical topics where the Meta AI assistant was particularly helpful, showing its versatility across the curriculum. Integration and differentiation were commonly queried subjects, with Participant 38 stating, *"I often ask about integration and differentiation"* (Line 36), reflecting these core calculus topics' complexity. Participants also noted the assistant's strength in algebra and number theory explanations. For instance, Participant 17 observed, *"It's best at explaining algebra and number theory"* (Line 38), suggesting these foundational areas benefit from AI's structured guidance.

Previously confusing concepts like mathematical induction became clearer through AI support. Participant 31 revealed, *"Mathematical induction used to confuse me, but now I'm comfortable with it"* (Line 40), pointing to the assistant's role in demystifying abstract reasoning processes. The assistant was reported to excel more in conceptual explanations than procedural drills. Participant 50 explained, *"Both, but it really excels in conceptual explanations, especially 'why' something works"* (Line 42), indicating that it helps build deep understanding rather than rote memorization.

Visualization was an important element for many learners. Participant 63 expressed, *"It described parabolas in a way I could actually picture them"* (Line 46), showing how AI aids in mental imagery of mathematical forms. The assistant's capacity to break down definitions and theorems into digestible parts also supported comprehension. Participant 20 noted, *"The definitions are broken into parts. That's very helpful"* (Line 48), which might cater well to learners who struggle with dense formal language.

Lastly, participants appreciated the AI's help in symbolic and word problem-solving. Participant 48 said, *"It helps more with symbolic problems like equations"* (Line 50), while Participant 36 commented on word problems, *"Word problems feel easier because it breaks them down"* (Line 115). This breakdown of complex problems into smaller, manageable steps improved mastery, as noted by Participant 29: *"The assistant finally made me understand probability distribution tables"* (Line 54).

The assistant's effectiveness in demystifying calculus, induction, and algebra mirrors of Paliwal and Patel (2025) findings that AI tutors excel in clarifying conceptual and abstract reasoning in mathematics. Additionally, participants' appreciation for visualization and stepwise guidance is consistent with Dai (2025), who found AI aids comprehension by transforming formal definitions into mentally accessible representations.

Research Question 3: Engagement and Motivation

Many participants reported increased motivation linked directly to the AI assistant's availability and responsiveness. Participant 04 stated, *"It's motivating to get instant replies, unlike waiting for office hours"* (Line 57), suggesting the platform overcomes traditional time barriers to support. The immediate, personalized feedback encouraged active learning and error correction, as Participant 46 shared, *"I enjoy the feedback—it encourages me to correct mistakes immediately"* (Line 59).

This convenience translated into increased study time for some users. Participant 40 noted, *"I've doubled my study time since I can ask at any time"* (Line 61), showing a positive shift in study habits. Anxiety reduction was another key benefit. Participant 32 explained, *"Knowing I can consult it privately reduced my fear of asking questions in class"* (Line 63), highlighting how the AI environment provides a safe space for inquiry without fear of judgment.

The familiar and informal WhatsApp platform fostered comfort and greater engagement. Participant 70 described, *"WhatsApp feels comfortable and less formal, so I engage more"* (Line 65), implying platform choice impacts motivation. Autonomy in learning was emphasized, with Participant 33 expressing, *"Yes, I feel in control of my learning pace"* (Line 67), underscoring the importance of self-directed study facilitated by AI.

Finally, participants reported increased confidence and curiosity. Participant 64 said, *"Now I attempt problems without help first. That wasn't the case before"* (Line 73), and Participant 11 noted, *"I've started checking topics not yet covered in class"* (Line 71). These shifts show the assistant's potential to raise proactive, confident learners who explore beyond the immediate syllabus.

Increased motivation and autonomy reported by participants support Harahap (2025), who found that AI's immediacy and privacy promote active, anxiety-free learning. These results also echo Hanshaw and Sullivan (2025), who argued that embedding AI within familiar platforms like WhatsApp can significantly boost learner engagement and sustained participation.

Research Question 4: Challenges Faced

Despite the positive experiences, participants encountered various challenges using the AI assistant. Technical issues like internet instability and app freezing were common, as Participant 25 described, *"Sometimes my data runs out or the app freezes"* (Line 77). Such interruptions could limit continuous learning and user satisfaction. Misinterpretations of questions and unclear or incorrect answers also posed difficulties. Participant 26 shared, *"It once gave a wrong definition of a limit, which confused me"* (Line 79), and Participant 47 pointed out, *"If I phrase it wrongly, it misinterprets my question"* (Line 81), highlighting the need for precise input.

Language complexity was a barrier for some users. Participant 18 commented, *"Some of the language is too advanced for me"* (Line 83), suggesting the AI explanations may not always be suitably tailored for all learners. Furthermore, the absence of human-like encouragement was felt; Participant 66 lamented, *"It lacks the encouragement a real teacher gives"* (Line 85), reflecting an emotional gap in AI interactions that affects learner motivation.

Limitations in handling graphical or proof-based problems were reported. Participant 15 said, *"It's not great with graphs or proofs requiring diagrams"* (Line 87), underscoring the current boundaries of AI utility in mathematics education. The WhatsApp platform also introduced distractions; Participant 45 noted, *"WhatsApp notifications sometimes distract me from focusing"* (Line 89). Nonetheless, many agreed the AI was a useful complement rather than a replacement for teachers. Participant 28 stated, *"It complements the teacher; it doesn't replace them"* (Line 91).

Suggestions for improvement included enhanced visuals and simplification of technical terms. Participant 55 advised, *"Add more visuals and simplify technical terms"* (Line 95), pointing to potential areas for development to improve usability and learning outcomes.

Participants' struggles with misinterpretation, language complexity, and lack of emotional connection reflect Kurian (2025) critique of AI's current limitations in empathy and language simplification. Likewise, Radanliev (2025) documented similar technical barriers and usability concerns, reinforcing the need for more robust and learner-sensitive AI systems.

Research Question 5: Influence on Problem-Solving Approaches

Participants noted a significant shift in their problem-solving approaches after interacting with the AI assistant. Many reported adopting more strategic, stepwise methods. Participant 41 explained, *"Now I*

approach problems more strategically and slowly" (Line 99), reflecting deeper cognitive engagement. Participant 62 emphasized a preference for step-by-step guidance: *"I prefer following step-by-step now—it's clearer and repeatable"* (Line 101), highlighting how the assistant fosters methodical thinking.

Breaking down complex problems into stages was a common benefit. Participant 30 said, *"The assistant taught me to tackle complex questions in stages"* (Line 103), illustrating improved analytical skills. This scaffolding reduced fear of unfamiliar problems, as Participant 69 expressed, *"I'm less scared to try new problems because I have backup"* (Line 105), showing increased confidence supported by AI assistance.

New problem-solving strategies were also learned, such as reverse solving techniques. Participant 24 remarked, *"Yes, I learned to use reverse solving techniques"* (Line 107), demonstrating how the AI exposes learners to varied methods. Reflection on problem-solving choices improved as well; Participant 01 stated, *"Now I check which methods work best before finalizing answers"* (Line 109), indicating metacognitive growth.

Participants valued flexibility in approach order. Participant 44 shared, *"Sometimes I try first, then check with the AI. It's more rewarding"* (Line 111), which suggests the assistant supports both independent and guided learning. Moreover, exposure to multiple methods was appreciated. Participant 37 enthused, *"It shows more than one method, which is amazing"* (Line 113), enriching learners' problem-solving toolkits.

Finally, the assistant's ability to simplify word problems facilitated better skills in identifying unknowns. Participant 43 reported, *"I've gotten better at identifying the exact unknowns in a problem"* (Line 117), illustrating improved precision in problem interpretation—an essential skill in mathematics success.

The participants' adoption of structured, reflective problem-solving strategies aligns with Mazari (2025), who observed that AI tools cultivate metacognitive habits by guiding learners through stepwise reasoning. Their exposure to multiple solution paths and reverse-solving methods also reflects the potential of AI to promote flexible, adaptive mathematical thinking as highlighted in that study.

Summary

The voices of pre-service teachers show that the WhatsApp-based Meta AI assistant significantly supports conceptual understanding, motivation, and strategic problem solving in mathematics. While it has limitations in technical reliability and human interaction, participants value it as a timely, accessible, and engaging complement to traditional teaching. The findings highlight the potential of AI tools in education when integrated thoughtfully with existing pedagogical approaches.

Conclusion

The findings reveal that the WhatsApp-based Meta AI assistant is perceived by pre-service teachers as a valuable educational tool that enhances their understanding of complex mathematical concepts, fosters motivation, and encourages strategic problem-solving approaches. Participants appreciated its

accessibility, instant feedback, and ability to clarify difficult topics, which supported deeper engagement and autonomy in learning. However, challenges such as occasional inaccuracies, technical issues, and lack of human encouragement highlight the assistant's current limitations. Overall, the AI assistant serves as a useful complement to traditional teaching methods, with significant potential to enrich mathematics education when integrated thoughtfully.

Recommendation

It is recommended that educational institutions consider adopting AI-assisted learning tools like the Meta AI assistant while providing ongoing support to address technical challenges and ensure alignment with classroom instruction. Enhancements such as improved visuals, simplified language, and integration of motivational elements could further optimize its effectiveness and learner experience.

Declarations

Ethics Approval

Ethical approval for this study was obtained from the Deputy Vice Chancellor for Academics and Research at the Institut Catholique de Kabgayi (ICK) on 06 June 2025. The study protocol was reviewed and approved prior to data collection.

Norms and Standards

All research procedures involving human participants were conducted in accordance with internationally accepted ethical standards, as well as relevant institutional and national research ethics guidelines.

Consent to Participate

Informed consent was obtained from all participants prior to their participation in the study. Participants were fully informed about the purpose of the research, the voluntary nature of their participation, their right to withdraw at any time without penalty, and the measures taken to ensure confidentiality and anonymity.

Human Ethics and Consent to Participate

Human Ethics and Consent to Participate declarations: applicable. Ethical approval was secured, and written or verbal informed consent was obtained from all human participants involved in the study.

Confidentiality and Anonymity

Participants' identities were protected through the use of pseudonyms and numerical identifiers. All data were stored securely and used solely for academic and research purposes.

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Author Contribution

The author declares no conflict of interest regarding the publication of this manuscript.

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