EXPLORING THE ROLE OF CHATGPT IN LEARNING MATHEMATICS AMONG PRE-SERVICE MATHEMATICS TEACHERS

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ABSTRACT: *This study explores the profile, experiences, attitudes, and perceptions of pre-service Mathematics teachers regarding the use of ChatGPT in learning mathematics. The findings reveal that most participants are female, aged 20-22, with limited financial resources but strong parental support, factors that may influence their interaction with AI tools. The majority of respondents are first-year pre-service teachers, while those in higher years face more challenges in learning mathematics, impacting their engagement with ChatGPT. Despite limited challenges in accessing technology, with all respondents owning smartphones and many possessing multiple devices, their self-perceived mathematical proficiency is intermediate, though their GPAs are outstanding. Pre-service teachers use ChatGPT primarily for problem-solving, clarifications, and step-by-step solutions, often in courses like "Problem Solving in Mathematics" and "Mathematical Investigation." The study also reveals a positive attitude towards ChatGPT, recognizing its role in enhancing motivation, engagement, and confidence in mathematics. Gender and year level influence its usage, while financial resources and parental support show weak correlations. Suggested improvements include integrating ChatGPT with other resources, enhancing interactivity, and ensuring ethical AI use. Overall, the study highlights ChatGPT's growing role in mathematics education, suggesting that AI tools should complement traditional teaching methods, with future research focusing on their long-term impact on learning and teaching practices.*

Keywords: ChatGPT, AI in Mathematics Education, Pre-service Mathematics Teachers, Digital Competence, Mathematical Proficiency, AI-assisted Learning, Educational Technology, Problem-Solving, Conceptual Understanding, AI Literacy.

1. INTRODUCTION

The integration of artificial intelligence (AI) in education has gained significant traction, with tools like ChatGPT offering new possibilities for enhancing learning experiences. In mathematics education, AI-powered chatbots provide instant feedback, personalized explanations, and adaptive learning strategies that can support student engagement and comprehension. *Limited Research on AI's Role in Deep Mathematical Understanding* - While AI-powered tools like ChatGPT enhance engagement and provide personalized learning, their effectiveness in fostering deep mathematical understanding, critical thinking, and problem-solving skills remains underexplored, especially for preservice Mathematics teachers. *Lack of Studies on Preservice Mathematics Teachers' Engagement with AI* - Existing research on AI in Education primarily focuses on general student populations or in-service teachers. Leaving a gap in understanding how preservice Mathematics teachers perceive, adopt, and integrate ChatGPT into their instructional practices. *Usability, Adaptability, and Instructional Alignment* - With AI's potential, studies emphasize usability, adaptability, and alignment with pedagogical goals, suggesting a need for research on how ChatGPT can be optimized to better support Mathematics instruction. *Barriers Related to AI Literacy and Digital Preparedness* - Many educators, including preservice teachers may lack sufficient AI literacy and digital preparedness, highlighting a gap in research on the effectiveness of structured training programs for AI integration in Mathematics education. *Research Contribution* This study addresses these gaps by examining how preservice Mathematics teachers interact with ChatGPT, and its effectiveness in developing mathematical thinking. The findings will inform the development of targeted AI strategies that enhance teacher training while upholding academic integrity and critical thinking.

2. REVIEW OF RELATED LITERATURE AND STUDIES

ChatGPT: A Leading AI-Powered Tool - ChatGPT, developed by OpenAI, is a leading AI chatbot that uses deep learning to generate human-like responses. Trained on vast text data, it predicts and formulates replies by analyzing linguistic patterns. OpenAI continually refines its performance for improved accuracy and fluency.In a study of Opesemowo, O. A. G., &Adewuyi, H. O. (2024), results revealed that ChatGPT was the primary AI tool used in mathematics education, among other AI tools, as identified in this review **[11,24,19,43,21,23,8,42,33,16,7,32].**

Adoption and User Demographics - ChatGPT has a strong global user base, particularly in the U.S., India, and parts of Asia. Younger users (18–44) engage more, mainly for text generation, while older groups show lower adoption. A survey found 86% of students use AI, with ChatGPT being the most popular—69% for information retrieval, 42% for grammar checking, and 33% for summarization. Its accessibility makes it a key tool in education and work**[11,24,19,43,21,23,8,42, 33,16,7].**

ChatGPTs Impact and Growth - With 180 million users and 600 million monthly visits, ChatGPT is rapidly growing. ChatGPT Plus, launched in 2023, provides access to GPT-4, expanding its reach. Businesses save over $100,000 through AI automation, while 87% of marketers use it for content creation and research. Its impact on productivity and workflows cements its role as a transformative AI tool**[11,24,19,43,21,23,8,42,33],16,7].**

How to Use ChatGPT? - Despite widespread AI adoption, many students feel uncertain about their AI literacy. A recent survey found that 58% of students believe they lack sufficient AI knowledge and skills, while 48% feel unprepared for an AI-driven workforce. Additionally, 80% of students expressed that their university's integration of AI tools does

not fully meet their expectations. Fortunately, using ChatGPT is simple and intuitive—much like texting a friend. To get started, visitchat.openai.com on a web browser or open the ChatGPT app on your smartphone. You can create an account for full access or use it in a limited capacity without one. Once logged in, enter a prompt in the text box at the bottom of the screen. You can ask a question, request a summary, or even instruct ChatGPT to generate content, such as "Write a short story about a dog named Clarence." Press the arrow icon to submit your request, and ChatGPT will generate a response in real-time, mimicking the way a person types. ChatGPT also allows interaction beyond single queries. It remembers the context within a conversation thread, so you can follow up with additional prompts or shift topics entirely. You can also listen to responses aloud, copy them to your clipboard, regenerate an answer, or provide feedback. With its user-friendly interface, ChatGPT makes AI-powered assistance accessible to everyone, whether for learning, creativity, or productivity**[11]**.

Socio-Demographic Profile and Use of ChatGPT **-** ChatGPT's adoption varies by age, gender, and income. Millennials and Gen-Z are the most engaged, with 25–34-year-olds leading usage. Men use ChatGPT more than women. High schoolers rely on it more than younger students, while household income influences awareness—84% of teens in high-income homes know of ChatGPT, compared to 67% in lower-income households. The U.S. (14.8%) and India (8.2%) dominate its global user base. Workplace adoption is rising, with 80% of professionals using ChatGPT for emails, reports, and marketing. As AI becomes more accessible, engagement across demographics is expected to grow [**23,40,43,30,3,9,7,8,**
34,24,23,2,42,33,16,11,19,21].

Technological Profile and Use of ChatGPT **-** A study highlights the importance of Task-Technology Fit (TTF) in AI adoption for education, emphasizing alignment with students' learning needs to boost engagement and outcomes. While it extends TTF to AI tools in higher education, findings show variability in social factors like privacy, security, and institutional support. Technology readiness and extrinsic motivation were not consistent predictors, indicating that ChatGPT adoption depends on personal, contextual, and technological factors**[4,3].**

Usage Patterns in ChatGPT **-** ChatGPT usage trends show peak activity on Mondays and Thursdays, reflecting its growing role in workplace productivity and automation. Teen awareness has risen to 79%, with deeper familiarity driving higher academic use—56% of well-informed teens use it for schoolwork, compared to 18% with limited exposure. Acceptance in education also varies, with 79% of knowledgeable users supporting its role in research. Businesses increasingly adopt ChatGPT for efficiency. A study based on the Technology Acceptance Model (TAM) found that perceived usefulness and ease of use shape user attitudes, while trust in AI-generated content moderates adoption behaviors**[34,40,43,50].**

Attitude Towards Use of ChatGPT **-** Students generally respond positively to ChatGPT, with curiosity and calmness being the most common emotions, reinforcing its value as a learning tool. Key adoption factors include responsible use, frequent engagement, and usability, while perceived risk and boredom have a lesser negative impact. A study of 608 participants found 91% were aware of ChatGPT, 85.4% had used it, and positive attitudes correlated with lower anxiety and greater social acceptance. Male students and those with lower GPAs engaged more due to its usefulness and ease of use. Academics appreciate ChatGPT's efficiency but raise ethical concerns, favoring careful implementation. Perceived usefulness, ease of use, and credibility drive adoption, though social influence negatively impacts usage. Younger students and those in non-education majors show higher enthusiasm. Five key factors shape willingness to use ChatGPT: enjoyment, usability, educational benefits, responsiveness, and its advantage over traditional learning methods **[4,3,37,39,47,**
48,44].

Perception on the Impact of ChatGPT in Education **-** ChatGPT is widely used by university students in the UAE, driven by its usefulness, ease of use, and cognitive engagement. Positive attitudes, lower perceived risks, and reduced anxiety further shape adoption. While 75% of studies highlight AI's academic potential, key challenges include pedagogical integration (31.25%), student engagement (15.63%), content accuracy (25%), and personalized learning (21.88%). Research on pre-service teachers reveals difficulties in identifying AI-generated errors, emphasizing the need for AI literacy and critical evaluation skills. To maximize ChatGPT's impact, institutions should integrate AI strategically, enhance critical assessment skills, and position AI as a collaborative learning tool**[39,22,28].**

Benefits of the Use of ChatGPT **-** ChatGPT enhances students' knowledge acquisition through personalization, novelty, and perceived benefits, shaping AI adoption. While privacy concerns and technophobia pose challenges, innovative students embrace AI more effectively. ChatGPT aids learning by simplifying concepts, summarizing information, and providing clear explanations, though concerns remain about reliability, cheating, and social isolation. Despite this, students recognize its role in improving study efficiency, access to knowledge, and academic success. It fosters engagement, critical thinking, and motivation, making it a transformative educational tool. Future research should focus on personalized learning while addressing ethical and pedagogical challenges in AI integration**[18,37,52]**.

ChatGPT in Education **-** A synthesis of 40 studies highlights that while traditional technology adoption models offer insights, contextual and psychological factors are key to ChatGPT's integration in education. Successful adoption requires a tailored approach considering regional, cultural, and technological influences. With 89% of students using ChatGPT for homework, educators are adapting by developing personalized study plans and interactive learning methods. However, concerns about academic integrity, misinformation, and AI dependency persist. Institutions can address these by establishing clear policies, designing AI-resistant assessments, and promoting responsible AI use. ChatGPT supports tutoring, research, and administrative tasks but may impact critical thinking and creativity. To maximize benefits while minimizing risks, AI should complement

traditional education through ethical guidelines, continuous monitoring, and student engagement strategies **[4,3,36,21,2,1,17,34].**

Mathematical Profile and Use of ChatGPT in Learning Mathematics **-** Studies suggest a positive correlation between students' interest in mathematics and their engagement with ChatGPT, with motivated students finding AI tools beneficial. However, ChatGPT's direct impact on mathematics achievement is negative but not statistically significant, indicating that while it enhances engagement, it does not necessarily improve performance. Interest in mathematics moderates AI-assisted learning effectiveness, reinforcing the need to foster curiosity alongside AI integration. ChatGPT aids mathematical learning by offering diversified responses, lesson planning support, and personalized learning experiences, though it struggles with complex problems in spatial geometry and calculus. AI-driven tools can revolutionize mathematics education through adaptive assessments, interactive learning, and AI-assisted tutoring, but successful implementation requires ethical considerations and transparency. Educators should encourage a critical approach to AI-generated responses, use ChatGPT as a supplementary tool, and promote AI literacy to ensure balanced and effective mathematics learning. Future research should refine AI strategies to enhance problem-solving skills and conceptual understanding in mathematics **[6,5,31,38,14,40,27,32]**

3. THEORETICAL BACKGROUND OF THE STUDY

The integration of ChatGPT into mathematics education requires a multidimensional theoretical approach. This study draws upon multiple established theories to analyze the impact of ChatGPT on learning mathematics. By triangulating these theories, we can comprehensively understand how ChatGPT influences cognitive processes, technological acceptance, and pedagogical practices in mathematics education.

1. Constructivist Learning Theory (Piaget, 1950; Vygotsky, 1978) **-**Constructivist Learning Theory posits that learning is an active, constructive process where students build knowledge through experience and interaction.**[30]** ChatGPT fosters a constructivist learning environment by promoting active engagement and exploration. Through Vygotsky's Zone of Proximal Development (ZPD), ChatGPT serves as a scaffolding tool, offering hints and step-by-step explanations that help students develop independent problem-solving skills. By interacting with AI, pre-service teachers can construct knowledge through inquiry and experimentation, aligning with constructivist principles.

2. Cognitive Load Theory (Sweller, 1988) **-**Mathematics learning often imposes a high cognitive load. ChatGPT reduces extraneous cognitive load by providing clear, structured explanations, allowing students to focus on problem-solving rather than struggling with comprehension barriers. It also supports germane cognitive load by helping learners internalize mathematical concepts through interactive problem-solving techniques.

3. Technology Acceptance Model (TAM) & Unified Theory of Acceptance and Use of Technology (UTAUT) **-** The adoption of ChatGPT in mathematics learning is influenced by perceived usefulness and ease of use (TAM). Additionally, UTAUT expands on this by incorporating social influence and facilitating conditions. If pre-service teachers perceive ChatGPT as an effective and user-friendly tool, they are more likely to integrate it into their learning and future teaching practices.

4. Technological Pedagogical Content Knowledge (TPACK) Framework (Mishra & Koehler, 2006) **-** Effective mathematics instruction requires a balance of technological, pedagogical, and content knowledge. ChatGPT enhances pre-service teachers' technological knowledge (TK) by familiarizing them with AI-driven problem-solving. It also supports pedagogical knowledge (PK) by demonstrating varied instructional approaches, aiding in lesson planning and mathematical instruction.

5. Bloom's Taxonomy (Anderson & Krathwohl, 2001) **-** ChatGPT facilitates different levels of mathematical learning: Remembering: Definitions, formulas, and mathematical properties. Understanding: Step-by-step explanations of concepts. Applying: Solving mathematical problems interactively. Analyzing: Comparing different problem-solving approaches. Evaluating: Assessing AI-generated solutions for accuracy. Creating: Designing lesson plans and problem sets using AI tools.

6. SAMR Model of Technology Integration (Puentedura, 2006) **-**ChatGPT's role in mathematics learning can be analyzed through the SAMR model: Substitution: Using ChatGPT as a digital reference tool. Augmentation: Enhancing learning with AI-generated interactive solutions. Modification: Transforming traditional mathematics instruction through AI-assisted tutoring. Redefinition: Creating new learning experiences, such as AI-driven adaptive assessments.

7. Social Learning Theory (Bandura, 1986) **-**ChatGPT supports observational learning and self-regulation. Pre-service teachers can learn by observing AI-generated solutions and modeling effective teaching strategies. The interactive nature of ChatGPT encourages self-directed learning and engagement.

8. Connectivism Theory (Siemens, 2005) **-**As a digital learning tool, ChatGPT aligns with connectivist principles by providing instant access to vast mathematical knowledge. It facilitates networked learning, where students connect with AI-generated explanations, different problem-solving methods, and external resources.

9. Self-Determination Theory (Deci & Ryan, 1985) **-** ChatGPT influences intrinsic motivation in mathematics learning by fostering autonomy, competence, and relatedness. Pre-service teachers can independently explore mathematical problems, receive personalized guidance, and develop confidence in their problem-solving abilities.

Conclusion **-**By triangulating these theories, this study provides a comprehensive framework for understanding ChatGPT's role in mathematics education. The synergy between constructivist learning, cognitive load management, technology acceptance, pedagogical integration, and motivation highlights ChatGPT's potential as a transformative educational tool. However, responsible implementation, guided by pedagogical and ethical considerations, is essential to maximize its benefits while

addressing limitations such as accuracy, critical thinking, and academic integrity.

4. STATEMENT OF THE PROBLEM

This study seeks to investigate the socio-demographic, mathematical, and technological profiles of preservice mathematics teachers and their relationship to the use of ChatGPT as a tool for learning mathematics. It aims to understand their experiences with ChatGPT, such as their usage experiences of ChatGPT, attitude towards the use of ChatGPT, perception on the impact of ChatGPT on mathematics performance. Additionally, the study explores relationships between these factors across different respondent profiles. Insights from the findings will be used to develop a conceptual framework and propose an intervention program to enhance the effectiveness of ChatGPT in Mathematics education. The following are the specific research questions of the study:

1. What is the profile of the preservice mathematics teachers in terms of

- **1.1.** socio-demographic:
  - **1.1.1.** gender,
  - **1.1.2.** age,
  - **1.1.3.** year level,
  - **1.1.4.** number of available gadgets,
  - **1.1.5.** amount of weekly allowance, and
  - **1.1.6.** extent of parental support;
- **1.2.** mathematical:
  - **1.2.1.** perceived mathematical proficiency, and
  - **1.2.2.** grade point average (GPA) in Mathematicscourses; and
- **1.3.** technological information:
  - **1.3.1.** perceived digital competence, and
  - **1.3.2.** number of AI tools used in learning Mathematics?

2. What is the preservice mathematics teachers' extent of

- **2.1.** usage experience of ChatGPT,
- **2.2.** attitude towards the use of ChatGPT, and
- **2.3.** perception on the impact of ChatGPT on mathematics learning?

3. Is there a relationship between the preservice mathematics teachers' profile and their extent of

- **3.1.** usage experience of ChatGPT,
- **3.2.** attitude towards the use of ChatGPT, and
- **3.3.** perception on the impact of ChatGPT on mathematics learning?

4. When grouped according to profile, is there a difference between the preservice mathematics teachers'

- **4.1.** usage experience of ChatGPT,
- **4.2.** attitude towards the use of ChatGPT, and
- **4.3.** perception on the impact of ChatGPT on mathematics learning?

5. Is there a relationship between the profile of the preservice Mathematics teachers and their

- **5.1.** usage experience of ChatGPT,
- **5.2.** attitude towards the use of ChatGPT, and
- **5.3.** perception on the impact of ChatGPT on mathematics learning?

6. What conceptual framework can be formulated from the findings of this study?

7. What are the suggestions for enhancement of ChatGPT for the improvement of teaching and learning in mathematics? **8.** What recommendations can be proposed from the findings of this study?

5.SIGNIFICANCE OF THE STUDY

This study provides valuable insights into the role of ChatGPT in learning mathematics among preservice mathematics teachers. By examining the socio-demographic, academic, and technological profiles of preservice teachers and their relationship with ChatGPT usage, this research contributes to a deeper understanding of AI integration in mathematics education.

1.Contribution to Mathematics Education **-** The study sheds light on how ChatGPT influences mathematics learning by analyzing preservice teachers' usage experiences, attitudes, and perceptions. Understanding these aspects will help educators and institutions refine teaching strategies, ensuring that AI tools effectively complement traditional instruction.

2. Technological Integration in Education **-** By assessing the technological competence of preservice mathematics teachers and the extent of their AI tool usage, this study informs policymakers and curriculum developers about the readiness of future educators to integrate AI-driven technologies in mathematics instruction. The findings will provide a foundation for developing AI literacy programs tailored to mathematics education.

3. Insights on Equity and Accessibility **-** This study explores socio-demographic factors such as gender, age, financial capacity, and access to technology, revealing potential disparities in ChatGPT adoption. Identifying these gaps can guide institutions in developing inclusive AI-driven educational initiatives, ensuring that all preservice teachers benefit from technological advancements.

4. Development of a Conceptual Framework and Intervention Program **-** A significant outcome of this study is the formulation of a conceptual framework that encapsulates the relationship between preservice teachers' profiles, their ChatGPT usage, and their learning experiences. Additionally, based on the findings, an intervention program will be proposed to enhance the effectiveness of ChatGPT in mathematics education, ensuring that it serves as a meaningful and pedagogically sound learning tool.

5. Guidance for Future Research **-** This research lays the groundwork for future studies on AI-driven learning in mathematics. By identifying key factors influencing ChatGPT adoption and its impact, the study opens avenues for further exploration into the optimization of AI tools for mathematics instruction.

In summary,this study contributes to educational research, technology integration, and instructional design by offering a comprehensive understanding of how ChatGPT can enhance mathematics learning for preservice teachers. The insights gained will inform future improvements in AI-based learning strategies, fostering a more effective, equitable, and engaging mathematics education landscape.

5. CONCEPTUAL FRAMEWORK

Figure 1 is the Conceptual Framework of this study, considering the independent and dependent variables, and the research output. The independent variables are the socio-demographic profile, mathematical profile, and technological

profile. The dependent variables are the ChatGPT usage, attitude, and perception towards the use of ChatGPT in learning Mathematics. Effective integration of ChatGPT in Mathematics Education is the desired output.

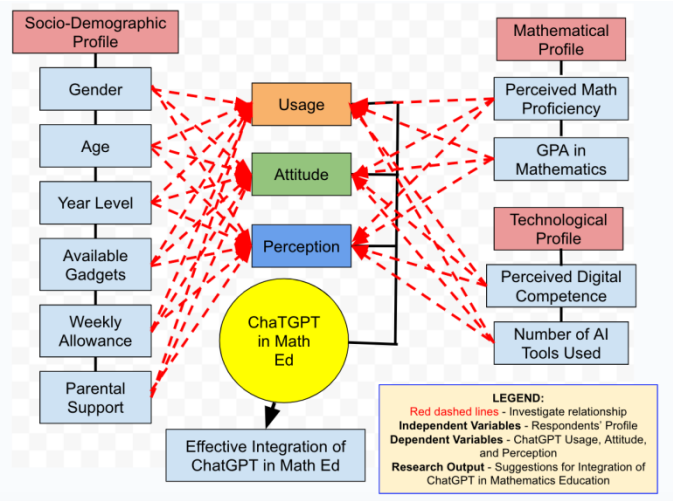

Figure 1: Schematic Diagram of the Conceptual Framework

6. METHODOLOGY

Research Design **-** This study employs a quantitative exploratory research design. The first part employs a descriptive-correlational research design to examine the relationship between pre-service Mathematics teachers' demographic profiles, digital competence, and their experiences, attitudes, and perceptions of ChatGPT in learning Mathematics. The descriptive aspect aims to present an overview of the respondents' usage patterns, while the correlational approach identifies relationships between different variables.

Research Respondents **-** The respondents of this study are all pre-service Mathematics teachers, enrolled in the First Semester of School Year 2024-2025, in a teacher education program - BSED Mathematics at Negros Oriental State University, Main Campus 1. The participants constitute a population of students who may be using or not using ChatGPT. The study includes students across different year levels to analyze variations in ChatGPT usage and perception.

Research Environment **-** The study was conducted in a higher education institution offering Mathematics teacher education program, particularly Negros Oriental State University, Main Campus I, Dumaguete City, Negros Oriental, Philippines. The research setting includes both in-class and independent learning environments where students utilize AI-powered tools such as ChatGPT for Mathematics learning.

Research Instrument **-**A structured survey questionnaire was developed to collect quantitative data on respondents' demographic profiles, technological access, perceived mathematical proficiency, digital competence, and their experiences, attitudes, and perceptions regarding ChatGPT. The questionnaire consists of multiple-choice questions and Likert-scale items. The instrument was validated by subject matter experts for content accuracy and reliability. Moreover, the instrument was conducted to a pilot group garnering an overall Cronbach's alpha of 0.8394.

Statistical Treatment of Data **-** *Descriptive Statistics* – Mean, standard deviation, frequency, and percentage were used to summarize the demographic data and usage patterns. *Tabular and Graphical Aids* - Tables, Doughnut 3D Charts,Bar Graphs, and Boxplots were used to describe the data distribution and the differences when grouped according to profile. *Correlation Analysis* – Spearman correlation coefficient and Chi-square for Independence were utilized to determine the relationships between demographic factors, digital competence, and ChatGPT usage, attitudes, and perceptions.

Ethical Considerations **-***Informed Consent* – Participants were fully informed of the study's objectives, procedures, and their right to withdraw at any time without penalty. *Confidentiality* – All responses were kept to ensure participant privacy and data confidentiality. *Data Protection* – Collected data was securely stored and only accessible to the research team. *Academic Integrity* – The study adhered to ethical guidelines in research, including accurate data reporting and proper citation of sources. *Non-Maleficence* – The research ensured that no harm or undue stress was caused to the participants. In summary, this methodology ensures a systematic approach in analyzing the extent of ChatGPT usage and its impact on pre-service Mathematics teachers with AI integration in Mathematics education.

7. PRESENTATION OF DATA

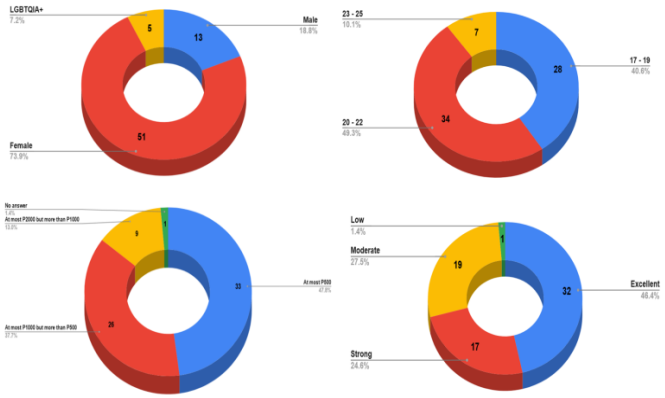

Figure 2: Distribution of the Respondents' Socio-Demographic Profile in terms of Gender, Age, Weekly Allowance, and Extent of Parental Support (N = 69)

Figure 2 disclosed that the majority of the respondents are female pre-service Mathematics teachers between 20 to 22 years of age, at most P500 weekly allowance, and excellent parental support. Gender, age, socio-economic status which may be described by weekly allowance, and parental support may affect the usage experience, attitude, and perception of the use of ChatGPT. Williams [49] opined that ChatGPT appeals to users across various age groups: ages 18 to 29-year-olds landed second in rank who have used ChatGPT to generate text**.** The Frank Agency [43] also found that the second largest age group of users is between 18 to 24 years old**.**

Figure 3 revealed that there are more first year pre-service Mathematics teachers. Higher levels have higher challenges than the first year students, which could be a factor of their usage experience, attitude, and perception on the use of ChatGPT. All the pre-service Mathematics teachers have

smartphones, while more than 50% of the pre-service Mathematics teachers have more than one (1) gadget.

As shown in Figure 4, the majority of the respondents perceived their extent of mathematical proficiency as Intermediate, but obtained Outstanding GPAs. Sağlam Arslan, A., et.al. [38] opined that the pre-service teachers often engaged in self-assessment, which may include reflecting on their extent of mathematical proficiency.

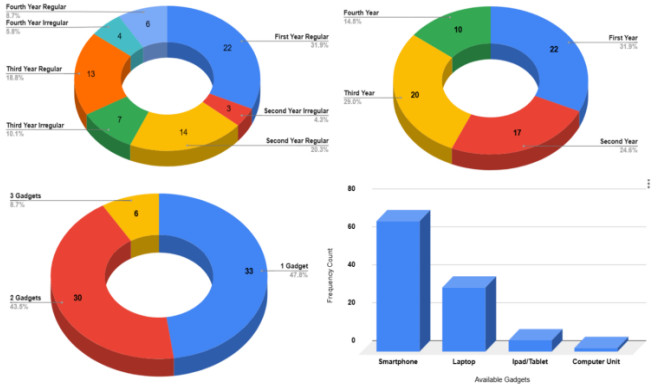

Figure 3: Distribution of the Respondents' Socio-Demographic Profile in terms of Year Level and Number of Available Gadgets (N = 69)

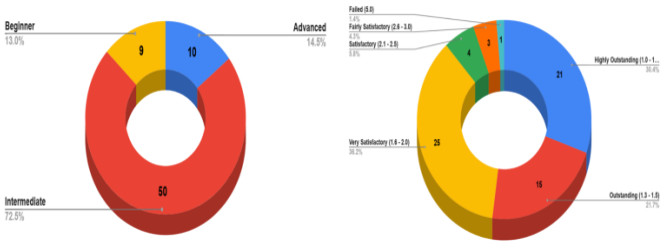

Figure 4: Distribution of the Respondents' Mathematical Profile in terms of Perceived Extent of Mathematical Proficiency and Grade Point Average (GPA) in Mathematics Courses (N = 69)

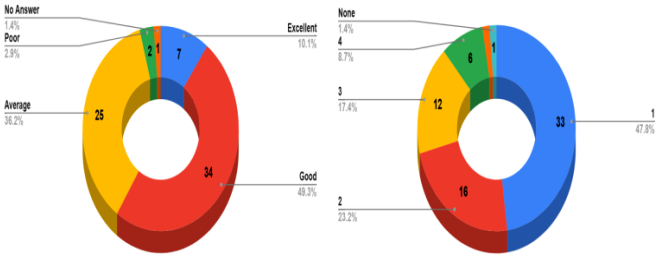

Figure 5: Distribution of the Respondents' Technological Profile in terms of Perceived Digital Competence, Number of AI Tools Used in Learning Mathematics and Number of Tools Used in Learning Mathematics (N = 69)

Most of the preservice Mathematics teachers, shown in Figure 5, perceived that their digital competence is good, and used one (1) AI tool. Others have used 2 – 6 AI tools.

The usage of ChatGPTamong pre-service mathematics teachers remains moderate, as indicated by the weighted means in Table 1. This suggests that while PSTs occasionally use ChatGPT for learning mathematics, their engagement is limited in several aspects. Specifically, they discuss only a few mathematical courses with ChatGPT, employ a restricted number of strategies (typically three) in their mathematical inquiries, and report general satisfaction with ChatGPT's responses. However, their agreement on the accuracy and clarity of ChatGPT's explanations for mathematical problems is only partial, indicating some reservations about its reliability.

Despite this moderate engagement, existing research highlights ChatGPT's potential to support PSTs in various educational activities. PişkinTunç [35] found that ChatGPT significantly contributed to lesson plan development, aiding in defining subject scope, generating creative ideas, explaining mathematical concepts, structuring course flow, and designing learning activities, problems, and assessment tools.

Usage Experience of ChatGPT	$w\bar{x}$	VD	SD	5	4	3	2	1
Frequency of Use for Learning Mathematics (Daily, Weekly, Occasionally, Never, Not Interested)	3.261	Occasionally	0.798	6 (9%)	12 (17%)	48 (70%)	3 (4%)	0 (0%)
Number of Mathematical Courses Discussed with ChatGPT (Plenty, Adequate, Limited, Very Limited, None)	3.130	Limited	1.083	9 (13%)	17 (25%)	18 (26%)	24 (35%	1 (1%)
Number of Ways of Using ChatGPT for Learning Mathematics (5-6, 4, 3, 2, 1)	3.319	3 Ways	1.480	20 (29%)	14 (20%)	14 (20%)	9 (13%)	12 (18%)
Satisfaction of ChatGPT's Responses on Mathematics Questions (Very Satisfied, Satisfied, Neutral, Unsatisfied, Very Unsatisfied)	3.580	Satisfied	0.716	5 (8%)	33 (48%)	29 (42%)	1 (1%)	1 (1%)
Perception on the Accuracy and Clarity of Explanations for Mathematical Problems (Always, Often, Sometimes, Rarely, Never)	3.188	Sometimes	0.733	0 (0%)	24 (35%)	36 (52%)	7 (10%)	2 (3%)
Average Extent of Usage Experience (Very High, High, Moderate, Low, Very Low)	**3.435**	**Moderate Usage Experience**	**0.915**	**10 (15%)**	**19 (28%)**	**32 (46%)**	**7 (10%)**	**1 (1%)**

Table 1: Respondents' Extent of Usage Experience of ChatGPT (N = 69)

Additionally, PSTs used ChatGPT to deepen their understanding of mathematical concepts, teaching strategies, and pedagogical models.[35] However, challenges exist in effectively integrating ChatGPT into mathematics education. Magat and Sangalang [20] reported that many educators remain unfamiliar with ChatGPT and require substantial technical and pedagogical training to maximize its potential. While there is a cautious optimism about its ability to enhance learning outcomes and student engagement, concerns persist regarding excessive reliance on AI-generated content.The effectiveness of ChatGPT's mathematical reasoning has also been a subject of critical analysis. Gurl, Markinson, and Artzt [15] emphasized the importance of evaluative reflection when using AI tools in education. Their study revealed that while PSTs accurately critiqued ChatGPT's pedagogical suggestions—often noting its teacher-centered and repetitive nature—they struggled to assess its mathematical accuracy. Some PSTs mistakenly interpreted incorrect solutions as valid alternative approaches, underscoring the need for a structured framework to critically examine AI-generated mathematical content.Furthermore, Getenet [13] examined ChatGPT's mathematical strategies in primary education. While PSTs demonstrated diverse problem-solving approaches, these strategies were not always developmentally appropriate for young learners. Similarly, ChatGPT mirrored PSTs' reasoning processes but often generated incorrect solutions, reinforcing the necessity of contextualizing AI-generated content within educational settings.

Table 2 presents data on the mathematical courses that pre-service mathematics teachers discussed with ChatGPT, showing the frequency count and percentage of respondents

who utilized ChatGPT for each course. The most discussed courses were "Problem Solving in Mathematics, Mathematical Investigation, and Mathematical Modeling" (82.86%) had the highest engagement, followed closely by "Elementary and Advanced Statistics and Probability" (80.00%). "History of Mathematics" (75.71%) and "Plane, Solid, Analytic, and Modern Geometries" (74.29%) also had significant usage. In the Moderate Discussion, around 45.71% of respondents used ChatGPT for courses related to teaching methodologies, assessment, calculus, and algebra.These include "Principles and Strategies in Teaching Mathematics," "Differential, Integral, Advanced Calculus and Differential Equations," and "Elementary/College and Advanced Algebra." The Less Frequently Discussed Courses such as "Logic, Set Theory, Number Theory, and Abstract Algebra" (31.43%), "Research in Mathematics" (27.14%), and "Mathematics of Investment" (27.14%) were discussed by fewer students. "Plane and Spherical Trigonometry" had 20.00% engagement, and "Competency-Based Assessment in Mathematics" had the least (10.00%). A small fraction (2.86%) reported not using ChatGPT for any mathematical courses.

Table 2: Respondents' Usage Experience of ChatGPT in terms of Mathematical Courses Discussed with ChatGPT (N = 69)

Mathematical Courses Discussed with ChatGPT	Frequency Count	Percent (%)
Problem Solving in Mathematics, Mathematical Investigation, and Mathematical Modeling	58	82.86
Elementary and Advanced Statistics and Probability	56	80.00
History of Mathematics	53	75.71
Plane, Solid, Analytic, and Modern Geometries	52	74.29
Principles and Strategies in Teaching Mathematics, Technology for Teaching and Learning Mathematics, and Assessment and Evaluation in Mathematics	32	45.71
Differential, Integral, Advanced Calculus and Differential Equations	32	45.71
Elementary/College and Advanced Algebra, and Linear Algebra	32	45.71
Logic, Set Theory, Number Theory, and Abstract Algebra	22	31.43
Research in Mathematics	19	27.14
Mathematics of Investment	19	27.14
Plane and Spherical Trigonometry	14	20.00
Competency-Based Assessment in Mathematics	7	10.00
None	2	2.86

The data suggests that pre-service teachers primarily used ChatGPT for problem-solving, statistics, history, and geometry. Teaching methodologies and advanced mathematics (like calculus and algebra) were moderately explored. More abstract and specialized topics, such as logic, investment, and trigonometry, saw less engagement. The low percentage of respondents not using ChatGPT indicates its broad adoption among future mathematics educators.

Table 3 reveals that pre-service mathematics teachers frequently utilize ChatGPT to request explanations of mathematical concepts, clarify doubts after class or independent study, and seek step-by-step solutions to problems.This suggests that ChatGPT serves as a supplementary learning resource, supporting PSTs in three key areas: *Conceptual Understanding* – ChatGPT helps pre-service teachers deepen their grasp of mathematical ideas, highlighting its potential as an effective tutoring aid alongside traditional instruction; *Bridging Learning Gaps* – By using ChatGPT for clarification after class or during independent study, PSTs reinforce their understanding outside formal instruction, filling gaps in their knowledge; *Step-by-Step Problem Solving* – PSTs value ChatGPT's structured explanations, which help them develop problem-solving strategies rather than merely providing final answers.

These findings align with broader trends in AI adoption for education. According to a recent survey by the Digital Education Council [19], a significant majority of students (86%) reported using AI tools in their studies. AI usage is frequent, with 24% of students using AI daily, 54% using it daily or weekly, and another 54% using it at least once a week. On average, students engage with 2.1 AI tools for academic purposes, with ChatGPT being the most widely used (66%), followed by Grammarly and Microsoft Copilot (each at 25%). The most common applications include searching for information (69%), checking grammar (42%), summarizing documents (33%), paraphrasing text (28%), and generating first drafts (24%).

Table 3: Respondents' Usage Experience of ChatGPT in terms of Ways of Using ChatGPT in Learning Mathematics (N = 69)

Ways of Using ChatGPT in Mathematics Learning	Frequency Count	Percent (%)
Requesting explanations of mathematical concepts.	59	84.29
Clarifying doubts after class or independent study.	48	68.57
Asking for step-by-step solutions to problems.	41	58.57
Seeking practice problems or exercises.	36	51.43
Asking for assistance in solving problems from assignments or examinations.	32	45.71
Discussing applications of mathematical concepts.	25	35.71
Other: Inquiring additional ideas.	1	1.43

Additionally, research on technology integration in mathematics education suggests that digital tools are becoming an essential component of learning. Mulenga and Marbán[25] found that pre-service teachers demonstrated moderate use of social media tools for mathematics learning. Their study also proposed a predictive model for the future integration of social media in mathematics instruction, indicating that digital resources—including AI-powered tools—are likely to play an increasingly prominent role in pre-service teacher education.Pre-service mathematics teachers are incorporating ChatGPT into their learning processes as a supplementary tool to enhance conceptual understanding, clarify doubts, and develop problem-solving strategies. These findings are consistent with broader trends in AI adoption in education. As technology continues to evolve, structured guidance and best practices will be essential to ensure that AI tools effectively support mathematical learning without fostering over-reliance.

As shown in Table 4, pre-service mathematics teachers generally hold a positive attitude toward the use of ChatGPT in learning. They found the tool somewhat helpful in staying motivated, somewhat engaging compared to traditional learning methods, and slightly confidence-boosting in their mathematical abilities. As a result, they are likely to

recommend ChatGPT to other students studying mathematics.

These findings suggest that pre-service teachers perceive ChatGPT as a valuable supplementary learning tool, though they recognize its limitations. Their openness to integrating AI tools in their future classrooms reflects a broader trend toward technology-assisted learning. ChatGPT provides immediate feedback and explanations, offering reassurance and helping students feel more comfortable with mathematical concepts.

The increasing acceptance of AI in mathematics education may lead to wider adoption, influencing how future educators incorporate AI in their teaching practices. However, AI tools alone may not be sufficient to replace traditional learning methods; rather, they should be integrated with interactive learning activities, problem-solving discussions, and teacher-led instruction for maximum effectiveness. Research by Ravšelj et al. [37] supports the notion that students experience mostly positive emotions, such as curiosity and calmness, when using ChatGPT.However, attitudes toward AI also involve ethical considerations. Wilkinson et al. [47] found that while academics generally held positive attitudes toward ChatGPT, they expressed concerns about its unethical use, highlighting discrepancies in how they viewed their own ethical use versus potential misuse by others.

Table 4 :Respondents' Extent of Attitude Towards Using ChatGPT in Learning Mathematics (N = 69)

Attitude Towards Using ChatGPT in Learning Mathematics	$\bar{wx}$	VD	SD	5	4	3	2	1
It is helpful in staying motivated to learn mathematics. (Very helpful, Somewhat helpful, Neutral, Not very helpful, Not helpful at all)	3.928	Somewhat helpful	0.913	16 (23%)	40 (58%)	7 (10%)	4 (6%)	2 (3%)
It affects engagement with learning mathematics compared to traditional methods (e.g., textbooks, classroom instruction). (Much engaging, Somewhat engaging, Neutral, Less Engaging, Not engaging at all)	3.870	Somewhat engaging	0.765	9 (13%)	47 (68%)	10 (15%)	1 (1%)	2 (3%)
It makes one feel confident in his mathematical abilities. (Significantly confident, Somewhat confident, No change in confidence, Less confident, Not confident at all)	3.536	Somewhat confident	0.739	2 (3%)	39 (57%)	24 (34%)	2 (3%)	2 (3%)
It is likely to be recommended to other students learning Mathematics. (Very likely, Likely, Neutral, Unlikely, Very Unlikely)	3.449	Likely	0.850	6 (9%)	27 (39%)	30 (44%)	4 (6%)	2 (2%)
Average Extent of Attitude (Very Positive, Positive, Neutral, Negative, Very Negative)	**3.884**	**Positive Attitude**	**0.883**	**14 (20%)**	**40 (58%)**	**10 (15%)**	**3 (4%)**	**2 (3%)**

Several studies have examined factors influencing students' attitudes toward ChatGPT. Timilsena and Bhandari Ghimire [44] determined that perceived usefulness, ease of use, and credibility significantly impact students' attitudes toward ChatGPT. Interestingly, perceived social influence had a negative effect on attitudes, suggesting that external opinions may discourage students from fully embracing the tool**.**Similarly, Foroughi [12] applied the Technology Acceptance Model (TAM) and found that perceived usefulness (PU) and perceived ease of use (PEU) are key predictors of students' attitudes toward ChatGPT, with system quality influencing both. However, trust in AI-generated information negatively moderated these relationships, indicating that skepticism about the tool's reliability could reduce its perceived benefits.Tiwari and Bhat[45] further highlighted the role of usefulness, social presence, and legitimacy in shaping favorable attitudes toward ChatGPT. They found that students enjoy using ChatGPT and perceive it as motivating and legitimate in an educational context. However, perceived ease of use was not a significant factor in determining adoption, suggesting that even if students find ChatGPT slightly challenging to use, they still recognize its benefits.Pre-service mathematics teachers generally have a positive outlook on ChatGPT, recognizing its potential to enhance motivation, engagement, and confidence in learning mathematics. However, while AI tools like ChatGPT are increasingly accepted in education, their effectiveness depends on how they are integrated into teaching. Educators should structure AI use to complement traditional instruction, ensuring that students engage in interactive learning while maintaining critical thinking skills. Additionally, addressing concerns related to trust, ethical use, and social influence will be essential in fostering responsible and effective AI adoption in mathematics education.

Table 5: Respondents' Extent of Perception on the Impact of ChatGPT on Mathematics Learning (N = 69)

Perception on the Impact of ChatGPT on Mathematics Learning	$\bar{wx}$	VD	SD	5	4	3	2	1
Does it improve one's ability to solve mathematical problems? (Significantly, Somewhat, No change, Worse, Not at all)	3.783	Somewhat improved	0.745	3 (4%)	55 (80%)	7 (10%)	1 (2%)	3 (4%)
It is effective in helping one to understand complex mathematical concepts. (Very effective, Effective, Neutral, Ineffective, Very ineffective)	3.551	Effective in helping	0.697	4 (6%)	33 (48%)	30 (44%)	1 (1%)	1 (1%)
It provides alternative strategies or methods for solving problems that one hasn't considered yet. (Always, Oftentimes, Occasionally, Rarely, Never)	3.435	Oftentimes provides	0.813	5 (7%)	29 (42%)	26 (38%)	9 (13%)	0 (0%)
It helps one to study for exams or tests. (Always, Oftentimes, Occasionally, Rarely, Never)	3.101	Occasionally helps	1.113	5 (7%)	24 (35%)	20 (29%)	13 (19%)	7 (10%)
Average Extent of Perception (Very Positive, Positive, Neutral, Negative, Very Negative)	**3.565**	**Positive Perception**	**0.866**	**8 (12%)**	**31 (45%)**	**23 (33%)**	**6 (9%)**	**1 (1%)**

As shown in Table 5, pre-service mathematics teachers generally hold a positive perception of ChatGPT's impact on their learning. They agreed that ChatGPT somewhat improved their ability to solve mathematical problems, effectively aided in understanding complex mathematical concepts, often provided alternative problem-solving strategies, and occasionally helped with exam preparation. These findings suggest that pre-service mathematics teachers view ChatGPT as a useful, though not all-encompassing, tool for learning mathematics. ChatGPT functions as a supplementary instructional tool, reinforcing mathematical learning by breaking down complex concepts and guiding students through step-by-step solutions. AI-generated explanations can be particularly beneficial for students struggling with abstract ideas, yet traditional problem-solving techniques remain essential for deeper conceptual engagement. Furthermore, ChatGPT's ability to present alternative problem-solving strategies encourages flexible thinking and mathematical creativity, supporting students in exploring multiple approaches rather than relying on a single method.

Recent research highlights ChatGPT's transformative potential in education. Wilkinson et al. [47] found that academics recognize ChatGPT as a valuable tool for saving time, enhancing research processes, and improving student learning. They also noted its potential to increase equity among diverse student groups, provided it is used responsibly**.**Similarly, Mohebi [22] reported that 75% of

studies emphasized the relevance of ChatGPT and generative AI in higher education, identifying key challenges such as pedagogical integration (31.25%) and student engagement (15.63%). While ChatGPT's content generation was sometimes inefficient (25.00%), its ability to enhance personalized learning (21.88%) showed promise in reshaping educational experiences. Sallam et al. [39] examined the determinants of ChatGPT adoption among university students, identifying perceived usefulness, ease of use, and lower perceived risks as major factors. They concluded that attitude toward ChatGPT is influenced by lower anxiety and higher acceptance of technology**.** Additionally, Youssef et al. [52] found that ChatGPT positively affects student engagement, enhances critical thinking abilities, and contributes to academic achievement. Their study suggested that ChatGPT can be an effective tool for improving students' motivation and effort in academic tasks.Despite these benefits, ChatGPT has limitations that educators must consider. Almarashdi et al. [5] found that while ChatGPT enhances personalized learning and student engagement, it struggles to answer complex mathematical problems, particularly in areas such as spatial geometry and derivatives. This limitation underscores the importance of integrating AI tools strategically, ensuring that students develop independent problem-solving skills rather than relying entirely on AI-generated solutions. Gouia-Zarrad and Gunn [14] highlighted ChatGPT's impact beyond education, noting its role in job automation and labor market shifts. While ChatGPT has led to job displacement in areas like customer service and content generation, it has simultaneously created new opportunities in AI-related fields such as AI ethics, system management, and AI-driven entrepreneurship.Furthermore, National Research [27] emphasized that AI tools like ChatGPT can adapt to students' thinking and interests in ways traditional tools cannot. However, they cautioned that AI-generated responses should be critically examined, as they may be based on biased datasets. Teachers will continue to play a crucial role in bridging the gap between AI-generated knowledge and conceptual understanding, ensuring that students develop critical thinking skills rather than passively accepting AI outputs.The overall positive perception of ChatGPT among pre-service mathematics teachers suggests that AI has a significant role to play in mathematics education. Its ability to improve problem-solving skills, present alternative strategies, and enhance engagement makes it a valuable supplement to traditional learning methods. However, AI should not be viewed as a standalone study tool. Instead, educators should strategically integrate ChatGPT into lesson planning, homework assistance, and classroom discussions while addressing its limitations. Ensuring that students engage in critical reflection and independent problem-solving will be key to maximizing the benefits of AI in mathematics education.

Figure 6 highlights distinguishable mean differences in the extent of ChatGPT usage, attitude, and perception based on gender. Similarly, notable variations are observed across age and year level for all three variables. Attitude toward ChatGPT also varies significantly when categorized by factors such as available gadgets, weekly allowance, parental support, perceived mathematics proficiency, GPA, perceived digital competence, and the AI tools used. Additionally, ChatGPT usage shows a considerable mean difference when grouped by perceived mathematics proficiency and the specific AI tools students use. Finally, perception of ChatGPT differs notably based on perceived mathematics proficiency and GPA.

These findings align with previous research on demographic influences on ChatGPT adoption. Timilsena and Bhandari Ghimire [44] found that females generally exhibit more positive attitudes toward ChatGPT, whereas males demonstrate higher behavioral intentions to use the tool. Their study also revealed that younger students and those at lower education levels tend to show more favorable attitudes and stronger intentions to integrate AI into their learning. Given these disparities, educational institutions should focus on enhancing the use of ChatGPT by emphasizing its practical benefits, ease of use, and credibility while addressing social pressures. Tailoring AI integration strategies to different demographic groups could help foster a more supportive and inclusive environment for technology adoption.

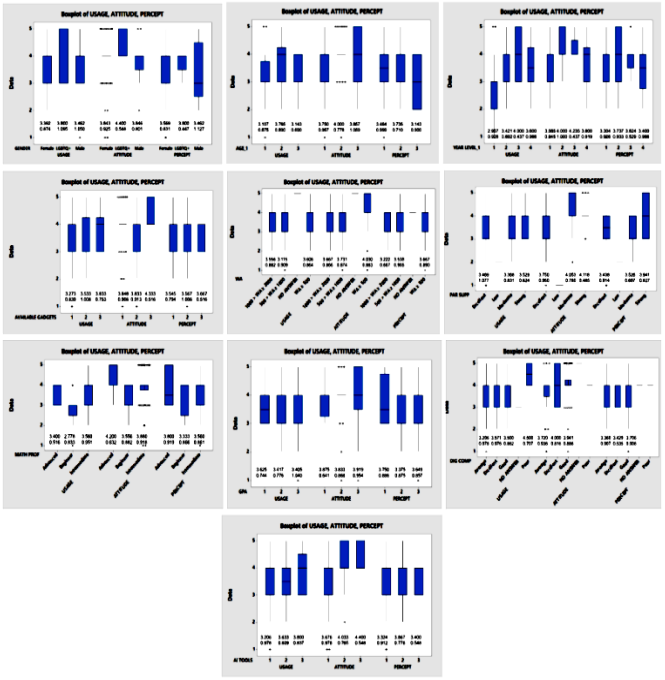

Figure 6: Difference Between Extent of Usage of Experience of ChatGPT, Extent of Attitude Towards the Use of ChatGPT, and Extent of Perception on the Impact of the Use of ChatGPT onMathematics LearningWhen Grouped According to Profile

Similarly, Sallam at al [39] found that positive attitudes toward ChatGPT were associated with being male, Arab in nationality, and having a lower GPA. Their study also identified key factors influencing ChatGPTusage, including higher perceived usefulness, lower perceived risks, higher behavioral and cognitive engagements scores, and greater perceived ease of use. These findings suggest that institutions should consider demographic variations when designing AI-based learning interventions to ensure equitable access and engagement across diverse student groups. Given the variations in attitudes, usage, and perceptions across demographic groups, it is crucial for educators and

policymakers to develop targeted strategies that cater to different student needs. Personalized AI learning experiences, digital literacy training, and structured support systems can help bridge gaps in AI adoption. Additionally, fostering an inclusive learning environment where students feel comfortable integrating AI tools like ChatGPT into their studies contribute to a more effective and equitable educational experience.

Table 6 and Figure 7 present correlation values between different profile factors of pre-service mathematics teachers and their experiences, attitudes, and perceptions regarding ChatGPT's use in learning mathematics. The correlation values indicate the degree to which these factors influence students' engagement with ChatGPT, their attitudes toward its use, and their perception of its impact on mathematics learning. *Profile and ChatGPT Usage* - The results suggest that gender has a notable influence on ChatGPT usage, with variations in engagement levels. Older students tend to use ChatGPT slightly more, and higher-level students may also use it more frequently. However, other factors such as the number of available gadgets, financial resources, and parental support show minimal impact. Students' confidence in mathematics and their grades do not strongly correlate with ChatGPT usage, while perceived digital competence also has little effect.The only significant correlation appears with the number of AI tools used—students who use more AI tools tend to engage more with ChatGPT.

Table 6: Relationship Between Profile and Extent of Usage of Experience of ChatGPT, Extent of Attitude Towards the Use of ChatGPT, and Extent of Perception on the Impact of the Use of ChatGPT on Mathematics Learning

Profile vs Extent of Usage of Experience of ChatGPT	Computed Value and Degree of Correlation	Profile vs Extent of Attitude Towards the Use of ChatGPT	Computed Value and Degree of Correlation	Profile vs Extent of Perception on the Impact of the Use of ChatGPT on Mathematics Learning	Computed Value and Degree of Correlation
In terms of Gender	0.371 (Moderate Association)	In terms of Gender	0.211 (Weak Association)	In terms of Gender	0.351 (Moderate Association)
In terms of Age	0.281 (Weak Correlation)	In terms of Age	0.185 (Very Weak Correlation)	In terms of Age	0.099 (Very Weak Correlation)
In terms of Year Level	0.385 (Weak Correlation)	In terms of Year Level	0.199 (Weak Correlation)	In terms of Year Level	0.125 (Very Weak Correlation)
In terms of Number of Available Gadgets	0.17 (Very Weak Correlation)	In terms of Number of Available Gadgets	0.073 (Very Weak Correlation)	In terms of Number of Available Gadgets	0.046 (Very Weak Correlation)
In terms of Weekly Allowance	-0.133 (Very Weak Correlation)	In terms of Weekly Allowance	-0.208 (Weak Correlation)	In terms of Weekly Allowance	-0.106 (Very Weak Correlation)
In terms of Parental Support	0.08 (Very Weak Correlation)	In terms of Parental Support	-0.11 (Very Weak Correlation)	In terms of Parental Support	-0.043 (Very Weak Correlation)
In terms of Perceived Math Proficiency	0.16 (Very Weak Correlation)	In terms of Perceived Math Proficiency	0.186 (Very Weak Correlation)	In terms of Perceived Math Proficiency	0.106 (Very Weak Correlation)
In terms of GPA in Mathematics	-0.057 (Very Weak Correlation)	In terms of GPA in Mathematics	0.072 (Very Weak Correlation)	In terms of GPA in Mathematics	0.103 (Very Weak Correlation)
In terms of Perceived Digital Competence	0.067 (Very Weak Correlation)	In terms of Perceived Digital Competence	0.100 (Very Weak Correlation)	In terms of Perceived Digital Competence	0.069 (Very Weak Correlation)
In terms of Number of AI Tools Used	0.252 (Weak Correlation)	In terms of Number of AI Tools Used	0.238 (Weak Correlation)	In terms of Number of AI Tools Used	0.209 (Very Weak Correlation)

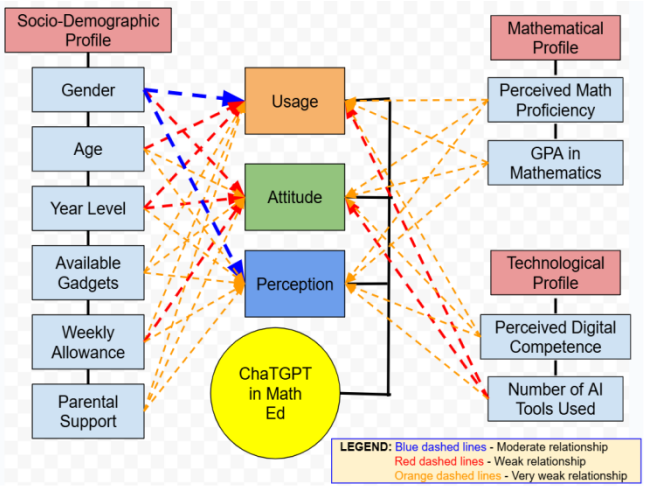

Figure 7: Conceptual Framework of the Correlational Analyses

These findings align with the study of Sidoti et al. [40], which found that students from higher-income households are more likely to be aware of and use ChatGPT. While 84% of teens from households with incomes above $75,000 had heard of ChatGPT, awareness was lower among those from middle-income (69%) and low-income (67%) households. However, awareness among lower-income students grew the most over the past year, suggesting an increasing adoption trend regardless of financial background. Despite rising familiarity, students remain divided on ChatGPT's role in mathematics learning, with only 29% believing it is acceptable to use it for solving math problems.Additionally, Ravselj et al. [37] disclosed that students' perceptions of ChatGPT usage vary across different socio-demographic and geographic factors, reinforcing the idea that individual circumstances influence AI adoption**.**Similarly, Mortensen [24,4] found that younger individuals (ages 18–29) are more likely to use or be aware of ChatGPT, whereas older individuals tend to have lower levels of engagement with the platform.Attitudes toward ChatGPT usage also vary slightly based on gender, with males generally having more positive behavioral intentions, as found in previous studies. However, other factors such as age and academic year level show only minimal influence. The number of available gadgets does not strongly correlate with attitude, while students with lower weekly allowances tend to have a slightly more favorable attitude toward ChatGPT. Parental support, perceived mathematical proficiency, GPA, and digital competence exhibit limited impact. Notably, students who use multiple AI tools tend to have a slightly more positive attitude toward ChatGPT, indicating that familiarity with AI can shape perceptions. These results resonate with findings from Asare et al. [6] who identified a positive correlation between student interest in mathematics and ChatGPT use. However, their study also noted that ChatGPT's direct impact on mathematics achievement was negative, though not statistically significant. The study emphasized that students with a higher interest in mathematics were more likely to engage with ChatGPT, potentially as a supplementary tool rather than a replacement for traditional problem-solving techniques.Perceptions of ChatGPT's impact on mathematics learning are influenced most notably by gender, with weaker correlations observed for age, academic year level, and

perceived digital competence. Other factors, including the number of available gadgets, weekly allowance, and perceived mathematical proficiency, show negligible influence. Interestingly, students who use more AI tools tend to have a slightly more positive perception of ChatGPT's role in learning mathematics. Perihan [34] supports the notion that Millennials and Gen-Z are early adopters and proficient users of AI-based tools, including ChatGPT. However, AI adoption is not limited to younger users; older students also participate, highlighting the broad appeal and growing importance of generative AI in education. Additionally, Al-Mamary et al. [4] emphasized that successful AI integration in education depends on achieving a strong Task-Technology Fit (TTF). Their study suggested that institutions should align AI tools with students' learning needs to encourage effective use and improve academic performance.

Overall, the findings indicate that while certain demographic and technological factors influence ChatGPT usage, attitudes, and perceptions, their effects are generally weak. Gender appears to have the most significant association with ChatGPT usage and perception, with males showing greater behavioral intention. Year level also exhibits weak correlations, suggesting that upper-year students may use and view ChatGPT more favorably. Meanwhile, students familiar with multiple AI tools tend to have a slightly better attitude toward ChatGPT. Other factors, such as age, weekly allowance, parental support, GPA, and perceived mathematical proficiency, show minimal correlations, implying that personal and technological factors have some influence but do not strongly dictate how students adopt or perceive ChatGPTin mathematics learning. These findings suggest that institutions should focus on improving AI literacy among students while considering individual differences in AI adoption. Strategic interventions, such as digital literacy programs and targeted AI training, can help bridge gaps in engagement and perception. Furthermore, as AI continues to evolve, educators must explore ways to integrate ChatGPT effectively while maintaining a balance between AI-assisted learning and traditional mathematical problem-solving techniques.

Table 7.1: Respondents' Suggestions on the Use of ChatGPT in terms of Enhancement of Features

Frequency Count	Suggestions on the Use of ChatGPT on Teachers- and-Students' Use for a Better Learning Experience
Most Frequently Suggested	**Multi-Resource Integration:** Used in Conjunction with Other Learning Resources
Frequently Suggested	**Simplifying Complex Topics:** Help clarify difficult concepts and simplify complex math topics for better understanding **Support for Learning and Teaching:** Assist with personalized lesson plans, practice problems, and immediate feedback for students. **Supplementary Resource:** Use ChatGPT before or after lessons to reinforce concepts and review key points. **Engagement and Classroom Use:** Use ChatGPT to generate examples, exercises, and engage students in interactive activities.
Less frequently suggested but notable	**Interactive Learning:** Create quizzes, debates, and simulations to make lessons more engaging. **Verification and Accuracy:** Use ChatGPT to verify answers and provide alternative solutions. **Guidance, Not Dependence:** Encourage independent learning with ChatGPT as a supplementary guide, not a replacement. **Personalized Learning:** Tailor responses to individual student needs and address specific knowledge gaps. **Ethical Use:** Set boundaries for responsible AI use, ensuring it supports, not replaces, critical thinking. **Improving Communication:** Aid teachers and students in articulating ideas and creating clear, formal content.

Table 7.1 presents suggestions for improving ChatGPT's mathematical capabilities, categorized by frequency. The Most Frequently Suggested is that it will be a Specialized AI. Instead of a general AI, users recommend a tool specifically designed for Mathematics. Next in rank are Clear explanations, Visual Aids, Comprehensive Proofs, and Improved Problem Solving.

ChatGPT should simplify language and provide more precise, easy-to-understand answers. It should include diagrams, graphs, and images, particularly for geometry and word problems. It should provide detailed, step-by-step proofs, especially in geometry, It should offer step-by-step solutions and multiple methods for solving complex problems. Next in Rank are Concise content,Better formatting, Reliable information, and Personalized learning. ChatGPT should keep its explanations focused and avoid unnecessary complexity. It should use proper mathematical symbols, formulas, and clearer text formatting. It should ensure that its responses are accurate, up-to-date, and include citations or sources. And it should adapt responses to match the user's level and learning needs. Finally, Interactive tools and Affordability and Access. ChatGPT should integrate graphing calculators or geometry software for hands-on learning, and provide affordable and accessible AI models with essential math features. In summary, the key recommendations emphasize better clarity, accuracy, and interactivity. Users suggest improvements like integrating visual aids, refining explanations, ensuring reliability, and even developing a specialized math-focused AI.

Table 7.2 outlines suggestions for using ChatGPT to enhance the learning experience for both teachers and students, categorized by frequency of mention. The Most Frequently Suggested is the Multi-resource integration. ChatGPT should be used alongside other learning resources rather than as a standalone tool. Next in rank are Simplifying complex topics, Support for learning and teaching, Supplementary resources, and Engagement and Classroom Use. ChatGPT can help clarify and simplify difficult math concepts. It can assist with personalized lesson plans, practice problems, and immediate student feedback. ChatGPT can be used before or after lessons to reinforce key concepts. Teachers can use ChatGPT to generate examples, exercises, and interactive activities for students. Next in rank are Interactive learning, Verification and accuracy, Guidance, not dependence, Personalized learning, Ethical use, and Improving communication. ChatGPT could help create quizzes, debates, and simulations for more engaging lessons.

Frequency Count	Suggestions on the Use of ChatGPT on Enhancement of Features
Most Frequently Suggested	**Specialized AI:** Use a more specialized AI tool instead that is focused specifically on Mathematics
Frequently Suggested	**Clear Explanations:** Simplify language and provide more precise, understandable answers. **Visual Aids:** Include accurate diagrams, graphs, and images, especially for geometry and word problems. **Comprehensive Proofs:** Provide full, detailed proofs and justifications, especially in geometry. **Improved Problem-Solving:** Offer step-by-step solutions and multiple methods for complex problems.
Less frequently suggested but notable	**Concise Content:** Provide focused, to-the-point explanations without unnecessary complexity. **Better Formatting:** Ensure correct use of symbols, formulas, and readable text for clarity. **Reliable Information:** Ensure accurate, up-to-date information with citations and reliable sources. **Personalized Learning:** Tailor explanations to the user's level and needs for better understanding.
Rarely suggested but present	**Interactive Tools:** Integrate tools like graphing calculators or geometry software for dynamic learning. **Affordability and Access:** Offer affordable, accessible models with key math features.

Table 7.2: Respondents' Suggestions on the Use of ChatGPT in terms of Enhancement of Features

Verification and Accuracy: It can be used to verify answers and provide alternative solutions. ChatGPT should be used as a supplementary guide to encourage independent learning rather than a replacement for traditional instruction. Responses should be tailored to individual student needs and knowledge gaps. Set responsible AI usage boundaries to ensure that it supports critical thinking rather than replacing it. ChatGPT can help both teachers and students articulate ideas clearly and formally. In summary, the key takeaway is that ChatGPT should be used as a supporting tool rather than a replacement for traditional learning. It can help simplify complex topics, provide additional learning resources, enhance classroom engagement, and assist with personalized learning. However, its accuracy should be verified, and ethical guidelines should be in place to encourage responsible use.

8. CONCLUSION

The study provides significant insights into the profile, experiences, attitudes, and perceptions of pre-service Mathematics teachers regarding the use of ChatGPT in learning mathematics. The findings indicate that the majority of respondents are female, aged between 20 to 22, with limited financial resources but strong parental support. These demographic factors may influence their engagement with AI tools, including ChatGPT. Additionally, first-year pre-service teachers comprise the largest group, while higher-level students face more challenges in mathematical learning, potentially impacting their usage experience and perception of ChatGPT. Regarding technological access, all respondents own smartphones, and over half possess multiple gadgets, indicating strong digital connectivity. While their self-perceived mathematical proficiency is generally intermediate, their actual GPAs are outstanding. Most respondents consider their digital competence as good and have interacted with at least one AI tool. Pre-service Mathematics teachers exhibit a moderate level of usage experience with ChatGPT, using it occasionally for problem-solving, clarification, and learning support. Their engagement varies across courses, with the highest usage seen in "Problem Solving in Mathematics," "Mathematical Investigation," and "Mathematical Modeling." More abstract subjects like "Logic, Set Theory, and Number Theory" see less engagement, indicating selective reliance on ChatGPT for specific topics. The study finds that ChatGPT is frequently used for requesting explanations, clarifying doubts, and obtaining step-by-step solutions. This suggests that pre-service Mathematics teachers integrate ChatGPT as a supplementary learning tool rather than a primary resource. They generally have a positive attitude toward ChatGPT, considering it helpful in maintaining motivation, engagement, and confidence in mathematics. This reflects growing acceptance of AI in education, with potential for future integration into teaching methodologies. Regarding perception, pre-service teachers recognize ChatGPT's positive impact on mathematical learning, particularly in problem-solving and conceptual understanding. The analysis of demographic factors reveals that gender significantly influences ChatGPT usage and perception. Year level and AI familiarity also play minor roles, while other factors like financial resources, parental support, and perceived mathematical proficiency exhibit weak correlations with ChatGPT engagement. Suggested improvements include integrating ChatGPT with other learning resources, enhancing interactivity, and ensuring ethical AI use in education. Overall, this study highlights the growing role of ChatGPT in Mathematics education while acknowledging its limitations. Educators should strategically incorporate AI tools to complement traditional instruction, ensuring that students develop both AI-assisted and independent problem-solving skills. Future research could explore AI's long-term effects on mathematical learning and its implications for teaching practices in higher education.

9. RECOMMENDATIONS

Based on the findings of this study and its limitations, the following are recommended.

1. **Integration into Curriculum:** Educational institutionsshould explore structured ways to incorporate ChatGPT as a supplementary learning tool in mathematics courses. This could include guided AI-assisted problem-solving activities and structured discussions on AI-generated responses.
2. **Training for Effective Use:** Faculty members and students should receive training on how to effectively use ChatGPT for learning, emphasizing verification of responses, proper questioning techniques, and critical evaluation of AI-generated content.
3. **Encouragement of Multi-Resource Learning:** ChatGPT should be used alongside other reliable learning resources, such as textbooks, teacher guidance, peer discussions, and traditional problem-solving exercises, to ensure a well-rounded learning experience.
4. **Enhancement of AI Literacy:** Institutions should foster AI literacy among pre-service Mathematics teachers, educating them about AI's capabilities, limitations, and ethical considerations to ensure responsible and informed usage.
5. **Promotion of Independent Problem-Solving:** While AI tools can assist in learning, students should be encouraged to develop independent problem-solving skills through hands-on mathematical practice without over-reliance on AI-generated solutions.
6. **Continuous Evaluation of AI Integration:** Educators should periodically assess the effectiveness of ChatGPT and other AI tools in mathematics education through feedback, surveys, and performance analysis, making necessary adjustments to maximize their benefits.
7. **Improvement of AI Accuracy and Accessibility:** Developers and educators should collaborate to improve AI tools' mathematical accuracy and clarity, ensuring they align with standard educational methods and cater to students' diverse learning needs.
8. **Encouragement of Ethical AI Use:** Students should be made aware of ethical considerations when using AI in learning, including academic honesty, responsible usage, and the need for human verification of AI-generated solutions.

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