Teachers' Perspective of AI Chatbots on Students' Mathematical Solving Capabilities: A Grounded Theory

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ABSTRACT

AI chatbots are computer-powered technology that answers questions asked of them in a human-like manner. On the other hand, Mathematical solving capability is the ability to solve mathematical problems, equations, and formulas accurately and efficiently. This study generated a theory on the teacher's perspective on AI chatbots on students' mathematical solving capabilities. The study utilized a grounded theory design under a qualitative approach. This inquiry tapped 7 Mathematics teachers in junior and senior high school and was conducted at in one of the public schools in West 1, Mandaue. The researchers utilized semi-structured interview questions. Five emerging themes and a category emerged from the in-depth interviews with the participants. Teacher's Perspective on AI's Proficiency, Collaboration, Access, Risks, And Ethics has emerged as the core category and entailed five themes: (1) AI's Impact on Math in its Evolution, Efficiency, and Accessibility, (2) Motivated Learning for Mathematical Proficiency, (3) Empowering Teachers and Guiding Intelligence through Collaboration with AI, (4) Challenges of AI in Education, and (5) Overreliance on AI and its Risks in Education and Society. Overall, this theory states that the collaboration of AI Chatbots and teachers in teaching mathematics to students provides various benefits such as access to numerous resources online, detailed pieces of information, and answers to students' mathematical queries. But with AI's capabilities to provide answers to the student's questions can ultimately lead to the student's over-reliance on the technology. Additionally, all of AI's responses can be accessed leading to possible biased answers. However, this can be prevented by the teacher's guidance on the use of AI chatbots in their mathematical solving capabilities and as a validator of the generated answers from the AIs.

Keywords: ai chatbots, mathematical solving capabilities, math teachers, grounded theory, theory generation

INTRODUCTION

AI chatbots are computer-powered technology that answers questions asked of them in a human-like manner. According to Kooli (2023), "chatbots are automated conversational agents that use natural language processing and machine learning algorithms to interact with users in a human-like manner." They are programmed to understand and respond to user queries quickly and efficiently, making them a valuable tool for service and support. With advancements in Al technology, chatbots are becoming more sophisticated and capable of handling complex conversations and tasks.

Mathematical solving capability is the ability to solve mathematical problems, equations, and formulas accurately and efficiently. According to Osman et al. (2024), "problem-solving in mathematics helps students to experience how to solve daily life problems by applying their mathematical knowledge and skill. Word problem solving is one of the important components of mathematical problem-solving that incorporates real-life problems and applications." Mathematical solving capability is crucial in various fields such as engineering, finance, and science. It is also essential for everyday tasks such as budgeting, shopping, and cooking. Developing strong mathematical problem-solving capabilities can help individuals think critically, analyze data, and make informed decisions.

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The researchers have empirically observed that the use of AI chatbots in mathematics education, such as ChatGPT in mathematics education influences students' mathematical solving capabilities, as evidenced by improved problem-solving skills and mathematical reasoning. The statement *"As a math teacher, the use of AI chatbots to generate* ideas and gain inspiration for helping students in solving mathematical problems" has the highest mean of 2.50 in the pre-survey in West 1 district. The use of AI chatbots in education provides personalized feedback and guidance, allowing students to practice and refine their skills through interactive problem-solving experiences and some people always rely on AI chatbots primarily because of having no confidence in their answers. These empirical observations suggest that AI chatbots can greatly influence some students' mathematical problem-solving capabilities.

Internationally, a study in the United States by Cheng et al. (2024), entitled “Facilitating Student Learning with a Chatbot in an Online Math Learning Platform”, implies that while Al chatbots can be beneficial in providing immediate assistance to students, they may also have unintended consequences for students’ confidence and problem- solving abilities. Furthermore, a study in Switzerland by Sánchez-Ruiz et al. (2023), entitled “ChatGPT Challenges Blended Learning Methodologies in Engineering Education: A Case Study in Mathematics”, supports that while ChatGPT may be effective in improving confidence and general usage in the learning process, there may be some drawbacks in terms of developing lateral competencies in students. However, a study in China by Liu et al. (2022), entitled “Al Intelligence Chatbot to Improve Students Learning in the Higher Education Platform”, states that by incorporating Al intelligence into education, students can receive personalized feedback and guidance, ultimately enhancing their overall learning experience.

This inquiry primarily focused on developing a new theory demonstrating the possible connection between Al chatbots and students’ arithmetic-solving abilities by getting the teacher's perspective on this matter. Additionally, this study seeks to address the gap in the existing literature by offering a theoretical framework that elucidates the mechanisms through which Al chatbots can influence students’ problem-solving skills in mathematics among high school students.

Thus, this study aimed to generate a theory based on the teacher’s perspective on the influence of the utilization of Al chatbots and students’ mathematical solving capabilities. The data obtained will serve as a foundation to construct a new theory of the relationship between AI chatbots on students’ mathematical solving capacities.

Philosophical Stance

This study is anchored on technological determinism as a philosophical stance. Technological determinism is a theory that suggests that technology drives social change. It was first introduced by Thorstein Veblen, an American economist, and sociologist, in his 1904 book "The Theory of the Leisure Class”. It is a reductionist theory that seeks to establish a causal relationship between technology and society. It attempts to explain who or what could wield governing authority in human affairs. The hypothesis raises questions about how much technology influences human thought or conduct.

As students are exposed to various technological tools and resources, such as Al chatbots, it is important to consider how these advancements may impact their cognitive development and problem-solving skills. Technological determinism explores the potential causal relationship between Al chatbots and their influence on students. While Al chatbots can provide personalized support and immediate feedback, there is a concern that students may become overly reliant on these tools and neglect critical thinking skills.

Additionally, technological determinism refers to technology as a possible influence on human thoughts, and technology could affect students' mathematical problem-solving capabilities. Students' over-reliance on technology could lead to some effects on their mathematical solving capabilities. Students who use technology in their activities and assignments could affect their skills such as their mathematical solving capabilities. This can affect students' ability to think creatively and independently if they rely too heavily on technology for problem-solving mathematically.

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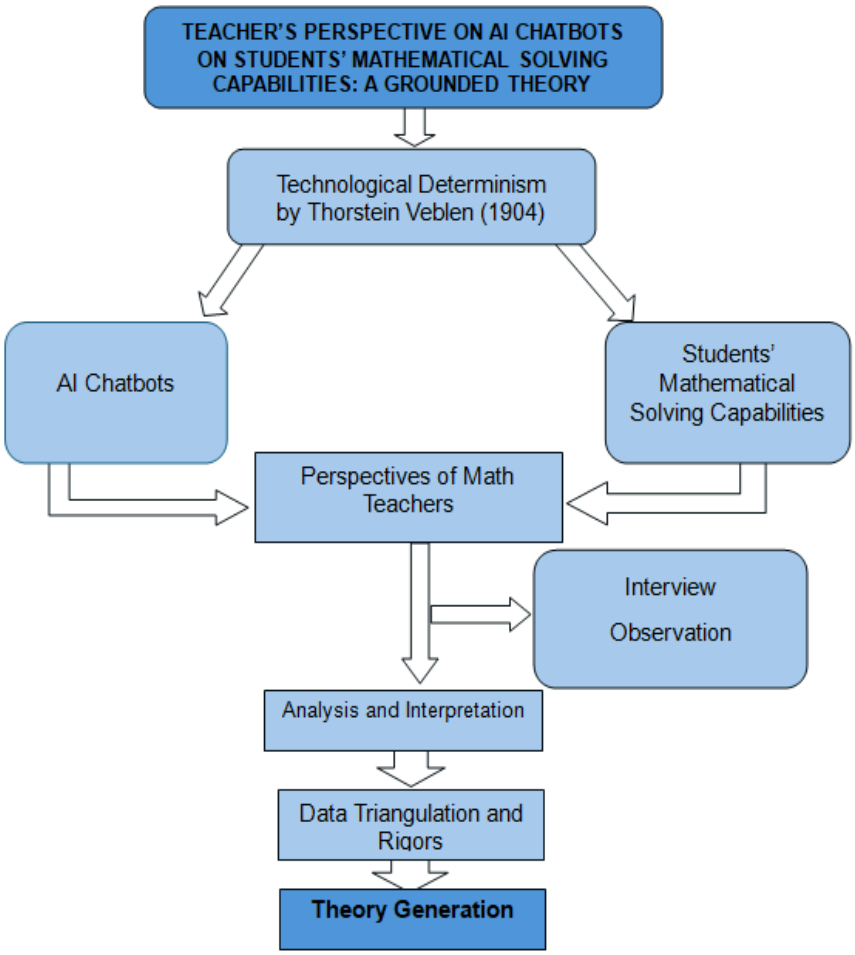

Figure 1. Schematic Presentation on Teacher's Perspective on AI Chatbots on Students' Mathematical Solving Capabilities: A Grounded Theory

Technological determinism is the philosophical stance on which the researchers based their theory. Technological determinism is a theory that seeks to establish a causal relationship on how technology drives changes in how individuals think, feel, and act in society.

LITERATURE REVIEW

Realm of Artificial Intelligence (AI)

AI chatbots are artificial intelligence-generated messages that respond to user queries. They are computer-programmed feedback systems that will automatically generate responses based on the input they receive from users. These chatbots can provide information, answer questions, and even engage in conversations with users in a way that simulates human interaction.

According to Bryant (2023), entitled "AI Chatbots: Threat or Opportunity?" the paper suggests that AI chatbots have the potential to be both a threat and opportunity, and it calls for insightful and stimulating submissions to explore this topic further. Additionally, according to Chaka (2023), entitled "Generative AI Chatbots ChatGPT vs YouChat vs Chatsonic: Use Cases of Selected Areas of Applied English language Studies" the study used prompts related to decolonial applied linguistics, critical southern decoloniality, and translanguaging, multilanguaging, and languaging as inputs in the chatbots. YouChat was found to be technically unstable and unreliable, with inconsistent responses. Both ChatGPT and Chatsonic tended to plagiarize responses from the internet information without acknowledging the sources. The responses generated by the chatbots often lack credibility, accuracy, and quality with some generating similar responses for different and unrelated prompts. The chatbot also failed to detect critical nuances in the sources, resulting in superficial and fluffy knowledge communication.

Furthermore, according to Helga and Tawil-Souri (2023), entitled "Chatbots in Education: The impact of Artificial Intelligence based Chat GPT on Teachers and Students", "The results showed that inevitability of integrating artificial Intelligence, particularly ChatGPT into education. It highlights the potential benefits such as personalized instruction and automated assessment, but also acknowledges the examines the impact on students and teachers, discusses both positive and negative aspects, and concludes with suggestions for effective implementation in educational settings".

On the other hand, according to Gugagayanan (2022), entitled "The Effects of a Chatbot Solving Mathematical Equations using NLP", "The experiment result confirms that NLP chatbot has better accuracy for answering the selected topics than math library. This is based on the number of questions each chatbot got correct when answering the questions. Trigonometry was the sole topic to have more than one question answered from both chatbots". In addition, according to Betrand et al. (2023), entitled "Artificial Intelligence Chatbot Advisory System" the study developed an AI chatbot system that effectively responds to queries and provides easy access to information. The study concluded that the developed AI chatbot system provides a more direct and automatic way of getting information, overcoming the limitations of manual book searching and physical meetings.

Additionally, according to Saengrith, Viriyavejakul and Pimdee (2022), entitled " Problem-Based Blended Training via Chatbot to Enhance the Problem-Solving Skill in the Workplace ".In the study result, the developed model is highly appropriate for implementation, particularly because the chatbot platform is involved in almost every step of this training model to accommodate learners who can easily access the training platform, repeat the training content, and feel motivated to explore new information to improve their problem-solving skills. On top of that, according to Parsakia (2023), entitled "The Effect of Chatbots and AI on The Self-Efficacy, Self-Esteem, Problem-Solving and Critical Thinking of Students ". The article concludes that while AI and chatbots offer transformative potential for enhancing student learning and engagement, their impact is complex and multifaceted. Future advancements in chatbot technology should aim to enhance their positive impact on users' psychological well-being and cognitive development, balancing the need for independent thinking and adaptability to complex problems.

Moreover, according to Paliwal, Bharti, and Mishra (2019), entitled "Ai Chatbots: Transforming the Digital World", Artificial Intelligence has been adopted continuously at a rapid scale by organizations and businesses for the automation of their process. And chatbots have brought a revolution in the business communication process as well as helped attain customer satisfaction at a large scale.

AI chatbots have the potential to be both a threat and an opportunity. It was discovered to be technically unstable and unreliable, with inconsistent responses, but it can also benefit education by providing personalized instruction and automated assessment, as well as accommodating learners who can easily access the training platform, repeat the training content, and feel motivated to explore new information to improve their problem-solving skills.

Mathematical Solving Capabilities

Mathematical solving capabilities refer to the ability to understand and solve mathematical problems. This involves understanding the principles and theories that underlie mathematics. It includes understanding mathematical operations, formulas, and theorems. Mathematical solving capabilities are not only essential for academic success in mathematics but also for everyday life and many professions.

According to Wardat et al. (2023), entitled "ChatGPT: A revolutionary tool for teaching and learning mathematics". The result of this investigation proposes several avenues for research that ought to be explored in order to guarantee the secure and conscientious integration of chatbots, especially ChatGPT, into mathematics education and learning. More so, according to a study entitled "Mathematics word problem solving for deaf Students: A survey of practices in grade 6-12 by Kelly, Lang, and Pagliaro (2003), "Based on results of this study, it appears that in two of the three types of education settings, the majority of instructors teaching mathematics and word -problem solving to deaf students lack adequate preparation and certification in mathematics to teach these skills."

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Moreover, according to Azizah and Fadlikah (2023), entitled "Analysis of Mathematics Problem-Solving Ability In View of Mathematics Disposition" students with high disposition fulfilled more problem-solving indicators while students with low disposable struggled to fulfill the indicators. Students' Mathematical problem-solving abilities are influenced by their mathematical dispositions, with the highest dispositions correlating with better problem-solving skills. In addition, according to Parsakia (2023) in the study entitled "The Effect of Chatbots and AI on The Self-Efficacy, Self-Esteem, Problem-Solving and Critical Thinking of Students". The article concludes that while AI and chatbots offer transformative potential for enhancing student learning and engagement, their impact is complex and multifaceted. Future advancements in chatbot technology should aim to enhance their positive impact on users' psychological well-being and cognitive development, balancing the need for independent thinking and adaptability to complex problems.

While AI chatbots have the potential to enhance student learning and engagement, their influence is multidimensional. A study also advocates the incorporation of chatbots, particularly ChatGPT, into mathematics instruction and learning.

Domain of Inquiry

This study generated a theory on the teacher's perspective on AI chatbots on students' mathematical solving capabilities in Mandaue West 1 District Schools, second semester, S.Y. 2023-2024. The results were the basis for the theory generation.

Specifically, this answered the following questions:

1. What are the participants' views on AI chatbots?
2. What are the participants' thoughts on the advantages and disadvantages of using AI chatbots?
3. What do participants perceive as the influence of AI chatbots on students' capacity to solve mathematical problems?
4. Based on the findings, what recommendations may be proposed?

METHODOLOGY

Research Design

To develop a theory on the teacher's perspective on AI chatbots on students' mathematical solving capabilities, this study used a qualitative method to research with an emphasis on the Glaser grounded theory approach.

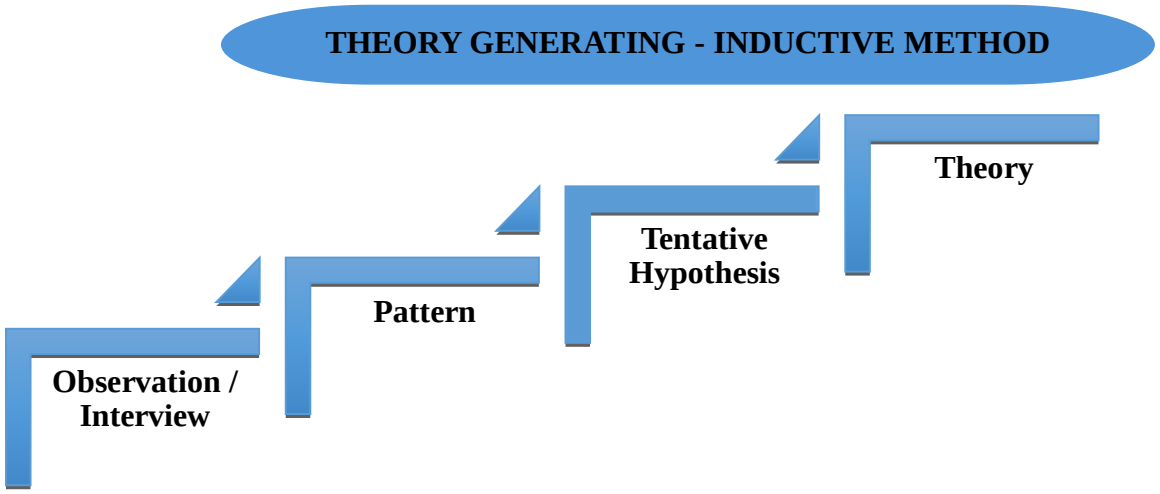

Figure 2. The research process on the Teacher's Perspective on AI Chatbots on Students' Mathematical Solving Capabilities

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The essence of Glaser and Strauss' (1967) grounded theory is that the adequacy of the theory developed depends on the research process used to derive it. The theory derives concepts from the data and develops them by collecting, coding, and analysing data concurrently (Cullen & Brennan, 2021).

According to Abadiano (2014), inductive reasoning is used, moving from detailed observations to more generalizations and ideas. It starts with measurements and observations, moves on to looking for patterns and regularities, develops some flimsy hypotheses that we can test, and then comes to some broad conclusions or theories.

Research Participants

The research participants were 7 Mathematics teachers at in one of the West I School in Mandaue City. The inclusion criteria for this research are: (1) a Math teacher teaching in in one of the public schools in Mandaue; (2) has heard about artificial intelligence (AI); (3) has an idea and tried using one of the AI Chatbots.

Depending on the topic you are studying and the diversity you are attempting to capture, Creswell (2013) suggests that a reasonable sample size may range from 3 -25 participants for a qualitative study. Regardless of which sample size you choose, you will want a clear rationale that supports why you chose it. According to Bryant and Charmaz (2019), "an excellent participant for grounded theory has been through or observed the experience under investigation. Participants must therefore be experts in the experience of the phenomenon under investigation, they must be willing to participate, and have the time to share the necessary information; and they must be reflective, willing, and able to speak articulately about the experience. Not all those people who volunteer to participate in your study will have all of the characteristics of an excellent participant."

With this, this study utilized a purposive sampling technique. According to Birks and Mills (2015), a purposive sampling is chosen deliberately to illustrate various aspects of the methodology, making the text more accessible and practical for readers. In doing so, there will be repeated data gathering and analysis in which the researcher will employ data saturation to produce a theory that will answer the developed and revised questions.

Locale

This study took place in one of the public secondary schools in West 1 District, Mandaue City. The researchers chose this high school because they can easily tap all the participants in a short time frame.

Research Instruments

To gather the necessary data for the study, a semi-structured interview questionnaire was employed by the researchers. The semi-structured interview is more powerful than other types of interviews for qualitative research because it allows for researchers to acquire in-depth information and evidence from interviewees while considering the focus of the study. In addition, the semi-structured interview could potentially enable qualitative researchers to amend their research questions throughout their studies while maintaining their track (Ruslin et al., 2022).

The first part will focus on the views of the participants about the AI chatbots. The second part will focus on the thoughts of the participants on the advantages and disadvantages of utilizing AI chatbots. Lastly, the third part will focus on the participant's perception as the influence of AI chatbots on students' capacity to solve mathematical problems.

The interview questions were validated by an English teacher who has educational attainment of Doctor of Education major in English Language Teaching – Completed Academic Requirements and in Dissertation writing phase.

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Research Procedures

A systematic procedure of acquiring observations or measurements is known as data collection (Bhandari, 2020). Hence, the data collection methods employed by the researchers should be appropriate to secure legitimacy of the study. The gathering of data will be conducted at three high schools in West 1 District of Mandaue with twenty math teachers as the participants.

The data will be gathered through the following procedure:

Phase 1: Approval of the Transmittal Letters and Semi-Structured Interview Questionnaires

After getting a letter of transmittal, the researchers scholarly reviewed their research work. The researchers prepared the required paperwork, which included the consent form, letter for semi-structured interview questions and pre-survey questionnaires, and transmittal letter, before beginning the research. The transmittal letter, survey interview, and consent final papers were signed by the research adviser, coordinator, and school administrator.

Phase 2: Identification of the Locale and Participants

The researchers chose Mandaue City as the general setting and three high schools in West 1 District of Mandaue as the specific locale for pre-survey and one school for the conduct of semi-structure interview. Finally, the researchers had a total of twenty participants for the pre-survey and 7 in the interview. Moreover, the participants were chosen through purposive sampling to gather sufficient data.

Phase 3: Data collection

The interview questionnaire that was supplied to the participants were presented by the researchers once they had been given permission to carry out the study. The researcher went through over the details of consent and assist the participants in responding to the presurvey and the interview questions. The researchers started tallying, recording, and evaluating data after the participants had done answering both the presurvey and interview questions.

Interview Phase

The researchers began the interview to the seven participants following that, the researchers went through over the content of consent and guided the participants throughout the interview.

Retrieval Phase

If the participants got through with filling out and imparting answers to the pre-survey, informed consent, the researchers showed up at and accumulated every document in the data collection.

Data Analysis

Like qualitative research in general, grounded theory methods use an inductive rather than a logical approach to the field. During data collection activities, the GTM approach necessitates that the researcher be present and cognizant of the dynamic nature of the data, its thematic connectivity, intersectionality, and development toward theory formation (e.g. interview, observation, and artifact assessment). This focus on strict data coding techniques may be traced back to pioneering qualitative research, which said that "joint data collection, coding, and analysis is the fundamental operation [toward] the production of theory" (Glaser & Strauss, 1967). Moreover, "The essential notion of coding is to portray the interaction of participants' and researchers' views of the type and dimensions of events understudy" (Douglas, 2003)

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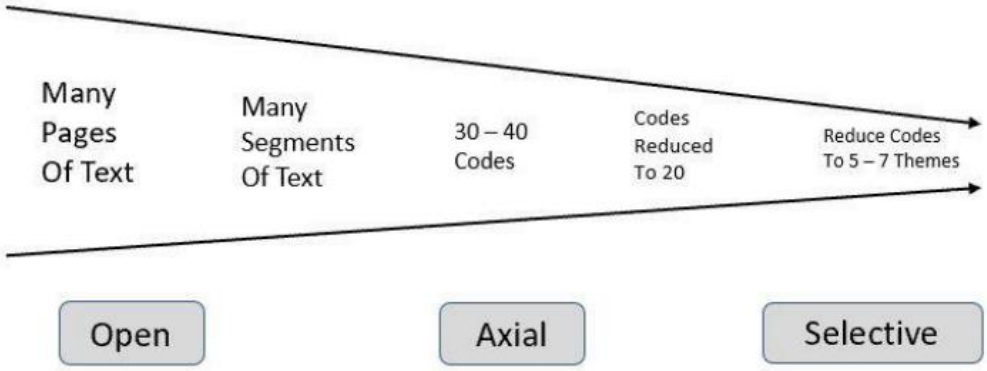

Open Coding

Open coding is the basic level of coding. Open coding is used by the researcher to identify distinct concepts and topics for categorization. Establishing a broad topic domain for data collecting establishes the first level of data organization. Expressions (single words, short sequences of words) are categorized into units of meaning to attention and "concepts" (Flick, 2009). Using the "5W-1H" (who, what, where, when, why, and how) inquiries as a basis for researching and analyzing data to characteristic codes and categories related to the text (Flick, 2009). This method allows the researcher to sift and arrange thematically comparable material to apply unique codes. To discover core theme substance and directionality, code selection can be employed in open, axial, and selective coding (Flick, 2009). There are several operational techniques for showing data in open-source coding as a result, researchers may be creative and original when building data open coding tools to support their study.

Table 1. Open Coding on the Teacher's Perspective on AI Chatbots on Students' Mathematical Solving Capabilities

Open Codes				
AI on Teacher's Class	Complex and higher math	Enrichment	Natural Intelligence	Teacher's Guidance
AI's limited exploration	Confidence Influencer	Extension of learning	Passive Learning	Teacher's Limited use of IA
AI's procedural discussion	Convenient	Flexible learning	Premium access's costs	Tendency of manipulation
AI's reliability	Dependent on AI	Guidance from teacher's use of AI	Student's engagement	Youngsters' exposure
Before and now of AI	Dependent on web-based resources	Impaired Critical Skills	Student's Practice	Teacher's Guidance
Bridging the gaps	Easy Access and Guide	Increased motivation	Student's solving problem	Teacher's Limited use of

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				IA
Clarification of Math Skills	Efficient	Lack of self-trust	Student's validator	
Collaborative Learning Process	Emotional Intelligence	Laziness in solving	Teacher's Doubt	

Axial Coding

Axial coding is the second level of coding. In contrast, to open coding, which focuses on identifying emergent themes and then clarifies, aligns, and categorizes the topics, axial coding focuses on doing the same. "Major (core) codes arise as aggregations of the most closely linked (or overlapping) open codes for which there is considerable supporting evidence," according to the statement that "Axial coding builds links between open codes to generate core codes (Strauss, 1998). The "Six C's Model," which supports classification utilizing specified key views, is another definition of axial coding "causes, contexts, contingencies, consequences, covariance, and conditions" are used to better organize and categorize data (Larossa, 2005). While these coding tasks are typically linked with qualitative research, examining applicable deductive techniques to testing theory is a crucial data comparison strategy that allows for continual evaluation, reconsideration, and reflection. The second strategy is the continual comparison strategy. A approach for organizing and improving data is continual comparison. Line-by-line coding is the third method. Line-by-line coding is used to examine each textual line in an interview or document to retain the researcher's focus on the text.

Table 2. Selective Coding on the Teacher's Perspective on AI Chatbots on Students' Mathematical Solving Capabilities

Axial Codes	
Before and Now of AI Complex and Higher Math Convenient Easy Access and Guide Efficient	**AI's Impact on Math in its Evolution, Efficiency, Accessibility**
Clarification of Math Skills Confidence Influencer Enrichment Extension of Learning Increased Motivation Student Practice Student Validator	**Motivated Learning for Mathematical Proficiency**

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Student's Engagement Student's solving problem Youngster's exposure	
AI on Teacher's class AI's Procedural discussion Bridging the Gaps Collaborative Learning Process Flexible Learning Guidance from teacher's use of AI Natural Intelligence Teacher's Guidance	**Empowering Teachers and Guiding Intelligence through Collaboration with AI**
AI's Limited Exploration AI's reliability Emotional Intelligence Premium Access's Cost Teacher's Limited use of AI Tendency of manipulation	**Challenges of AI in Education**
Dependent on AI Dependent on Web-based resources Impaired Critical skills Lack of Self-trust Laziness in Solving Passive Learning Teacher's Doubt	**Overreliance on AI and its Risks in Education and Society**

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Selective Coding

Selective coding is the third level of coding. It enables the researcher to choose and combine groups of ordered data from axial coding into sentences that make sense. "At a higher level of abstraction, selective coding continues axial coding [via] behaviors that lead to an expansion or formulation of the case story" (Flick, 2009). "The notion of a 'case' or 'story' for the yield from selective coding is crucial since it gives researchers flexible and multi-type vehicles for codifying and presenting study data" (Strauss, 1998). The researcher can work toward topic specificity and, as a result, theory-building with this type of data framing. The results of selective coding may be used by researchers to develop case studies that accurately and effectively explain the entire progressive coding process. Selective coding promotes expressiveness and facilitates the construction of meaning.

RESULTS AND DISCUSSION

The main theme that emerged from the investigation was **"Teacher's Perspective on AI's Proficiency, Collaboration, Access, Risks, And Ethics"**. This category contains five fundamental themes:

Theme 1: AI's Impact on Math in its Evolution, Efficiency, Accessibility

Theme 2: Motivated Learning for Mathematical Proficiency

Theme 3: Empowering Teachers and Guiding Intelligence through Collaboration with AI

Theme 4: Challenges of AI in Education

Theme 5: Overreliance on AI and its Risks in Education and Society

These topics are used to build propositions. Based on these principles, hypotheses are created and assessed. A thorough examination of each theme is provided.

Theme 1: AI's Impact on Math in its Evolution, Efficiency, Accessibility

Artificial Intelligence (AI) has revolutionized the landscape of mathematics, playing a pivotal role in its evolution by enhancing problem-solving techniques and mathematical modeling. Below are some of the participants' statements on how the Math teachers perceive the impact of AI in the field of Mathematics:

"...kay labi na for gitawag nato ug conveniency kay sa kana na paagi kay dili na maglisod ug construct dili na maglisod ug kana bitaw solve..." **(T1)**

"...for a guide no kung mogamit silag AI dapat naa jud silay teacher na mo Guide sad gyud kung sakto ba na na answer..."

*"...diman ko istudyante gud nya during may katong istudyente pako wla pa man gud ning AI so ang ako lang ma sulti no kung POV isip usa ka maestro kay masabtan man nako siya..."***(T2)**

"... kani siya guide ra guide siya pero dapat mo math mani so mag compute pero guide rani niya AI chatbots..."

*"... mogamit jud mo ana ha basin guro sa higher level na kanang mga calculus unsa pana inyoha differential calculus integral kana siguro mogamit akong student ana niya ..."***(T3)**

"For personal nga tabang mapadali ang pag answer sa student it can give the students an easy life diba especially sa ilang assignment..." **(T4)**

The above statements showcase how the math teachers perceived the impact of AI in their mathematics classes. AI has democratized mathematical exploration and empowered researchers and enthusiasts alike to delve

deeper into complex mathematical concepts. These premises are by the study by Pursnani et al. (2023) in their study entitled, “Performance of ChatGPT on the US fundamentals of engineering exam: Comprehensive assessment of proficiency and potential implications for professional environmental engineering practice" shows a significant improvement in the model's accuracy when answering FE exam questions through noninvasive prompt modifications, substantiating the utility of prompt modification as a viable approach to enhance AI performance in educational contexts. Furthermore, the findings reflect remarkable improvements in mathematical capabilities across successive iterations of ChatGPT models, showcasing their potential to solve complex engineering problems.

In addition, a study entitled, "Enhancing Mathematical Capabilities through ChatGPT and Similar Generative Artificial Intelligence: Roles and Challenges in Solving Mathematical Problems" by Rane (2023), illuminates the promising potential of incorporating generative AI, notably ChatGPT, into the realm of mathematics education. By addressing the associated challenges and adopting a nuanced approach, educators can harness the power of AI to craft enriching and efficient learning environments, nurturing a generation of individuals adept at mathematics and well-equipped to tackle the intricacies of the modern world.

Hypothesis 1: AI chatbots help make complex and hard math concepts easier to understand.

Proposition 1: AI chatbots provide step-by-step examples and definitions of complex math concepts by accessing different resources.

Theme 2: Motivated Learning for Mathematical Proficiency

Motivated learning lies at the core of achieving mathematical proficiency, driving students to engage deeply with mathematical concepts and problem-solving strategies that are contextualized and practical. Below are the snippets of the teachers’ views on how AI correlates with students’ proficiency:

“…then kung mo consult ug AI so it would be validate they answer and by that point motaas ilang confidence gyud bahin ana kay murag naa may assurance na sakto ilang answer”

“ … kana bitaw Im sure ma engage sad sila sa kana bitaw daghan ang mahatag sa AI compared sa ilang kanang sa ilang lang gyud ba can give us such many kanang information…”

“…aware na sila sa solution or makahibaw sila ug gi unsa pag arrive na kuan ba kay ang kasagaran man gud uban sa labi na sa books…”

*“… I would say na mas mo monindot ang ang motivation ug engagement sa students kung with the help of AI kay in this way students will be encourage to share …”****(*****T1)**

“…katong usa ka istudyante nga gimat ang AI in a good way where in iyang gigamit ba gi analyse niya ang answer gi tan aw niya ang step by step details morag bali gigamit niya para mas maka sabot siya so kung pangutan on sya maka solve ra pud sya.”

“…i analyse niya ang problem step by step details so i think mao ng usa ka advantage na syay confidence nga mo solve ouh.” **(T2)**

“…we should understand gyud diba pero using the AI nowadays I understand because even elementary students use AI to answer their homeworks because I saw that from my daughter…” **(T4)**

The statements above show how the role of AI motivates the learning process. By cultivating intrinsic and extrinsic motivation, learners can harness their full potential and develop a strong foundation in mathematics essential for success in various academic and professional endeavors. The observations are supported by Chiu et al. (2023) on their study, “"Teacher Support and Student Motivation to Learn with Artificial Intelligence (AI)-Based Chatbot” which revealed that intrinsic motivation and competence to learn with the chatbot depended on both teacher support and student expertise, and the teacher better satisfied the need for relatedness, and it less satisfied the need for autonomy. More so, a study entitled, “"Effects of artificial

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Intelligence–Enabled personalized recommendations on learners' learning engagement, motivation, and outcomes in a flipped classroom" revealed that the AI-enabled personalized video recommendations could significantly improve the learning performance and engagement of students with a moderate motivation level (Huang et al., 2023).

Hypothesis 2: AI chatbots assist the students in determining their math skills and develop and enhance their learning experience.

Proposition 2: AI chatbots provide answers and information to students' queries enhancing their math skills.

Theme 3: Empowering Teachers and Guiding Intelligence through Collaboration with AI

Collaboration between teachers and Artificial Intelligence (AI) technologies has the potential to revolutionize education by empowering educators with innovative tools and insights. Below are the snippets of the teacher's view on how the AIs can be part of collaboration:

"...AI chatbots,chatbots,can leverage that one or kanang makawa siya sa gap…"

"...mas ma share nila sa ubang taw have kuan na collaborative na ilang involvement kay kanang mag kuan naman sila kung naay mo hisgot ug AI mao na siya"

*"… so sa akoa lang gyud mogamit ug AI ang students naa sad juy mo guide ug magpasabot sa iyaha nganong na unsa na siya na answer dapat ang kana na students ug kang teacher na magpagamit sa students ug AI mo guide gyud ang teacher para makasabot siya ug sa gihatag sa AI kay ang AI …"***(T1)**

"...dli gyud ko educ nga graduate I am a engineer so wla pakay koy experience unsa on pag teach unsay mga strategys unsay mga tekniks to teach the students so akong gina buhat gi gamit nako ang AI…"

"...ig type nimo sa mga complicated na mga problems ig type nimo ana mo pop up with in a seconds mo pop up na dayun iyang solution detailed solution so mao ning naka nindot sa AI no mao naka, naka nindot sa iyaha detailed na ang solution ba na iyang gi na hatag…" **(T2)**

"….oy oh ma palambo ang AI chatbots or interactive quizzes aw kani noung interactive quizes oh kung mogamit sila aning kuan AI"

"...aning AI chatbots mogamit mas grabe gyud baya ang kuan kanang brain sa inyuha human brain supplier pa jud nang ilang brain oh mosalig gyud mo kuan inyong cells…" **(T3)**

The statements above how the use of AI can be beneficial in the teaching and learning process. Through collaboration and right practice, learning will be meaningful. Through this partnership, AI can guide and augment human intelligence, enhancing teaching methodologies and personalized learning experiences for students. These premises posit a relationship to the study of eSchool News (2024), entitled, "Impact of Artificial Intelligence in Education. ESchool News" AI helps instructors by personalizing learning experiences, automating administrative work, delivering real-time feedback, aiding professional development, improving teaching tactics, and fostering diversity in education. Furthermore, Poth (2023) in his study, "AI Tools That Help Teachers Work More Efficiently" , AI can aid with content creation and supplementation. Teachers can curate a variety of instructional resources using AI-powered platforms. Teachers, in example, can use generative AI to construct lessons, activities, exams, discussion prompts, and presentations by merely supplying a short keyword suggestion.

Hypothesis 3: AI helps teachers create effective teaching processes and guidance through collaboration.

Proposition 3: AI supports teachers in creating effective teaching processes and guidance through collaboration, improving overall educational quality.

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Theme 4: Challenges of AI in Education

The integration of Artificial Intelligence (AI) in mathematics education presents challenges that affect student's mathematical learning experiences. The perspectives of the teacher's side posit two sides of view. Below are the excerpts of their answers:

" ... naay mga apps nga mo provide jud ug solution pero some apps need ug payment or bayad bitaw para maka subscribe kato bitaw na solution pero actually some apps nag answer pud ana kay ang kuan ra sad mga experts…

"…AI can be manipulative pud sad baya." **(T1)**

"… kung emotional intelligence lang para nako ha, para nako wla ramn kay ang math dli man mag involve og kuan sad about emotions diba you just solve the problem and then there's solution…" **(T2)**

"…Grade 8 man ko nu wala pa jud ko na introduced AI Chatbots…"

"…dili lang sa ko mag introduced nila gawas na kung lisod na problem mohatag…" **(T3)**

"…di gyud siya ingon nga maka solve og complex nga problem pero kani siya mga simple siya nga mga problem ang kaya niyang solvon so wala koy walakoy kay kaun nga murag kay unsa ni oi…" **(T5)**

The statements above showcase some of the challenges of the teachers in the integration of Ais in their mathematics classes. However, understanding these complexities can pave the way for leveraging AI's capabilities to enhance teaching methods, address learning gaps, and foster a deeper understanding of mathematical concepts among students. These are supported by Sharma (2023) in his study, "Potential Harms of AI Chat Models like GPT" AI conversation models may be susceptible to manipulation and exploitation by malicious actors. These models have the capacity to generate convincing and realistic content that might be exploited to promote misinformation, frauds, or even impersonation. In addition, on teacher's limitation in the use of AI is supported by the study of Melo (2023), "Incorporating Artificial Intelligence Into The Classroom: An Examination Of Benefits, Challenges, and Best Practices" , one of the most difficult difficulties is the necessity for technical skills. Teachers who are unfamiliar with AI may struggle to incorporate this technology into their teaching practices, and they may require assistance and training to get started. It also presents a number of issues, including data privacy and ethics, and the possibility of unequal access to technology and digital skills.

Hypothesis 4: AI chatbots are susceptible to limited access to resources and data.

Proposition 4: AI chatbots can be vulnerable to bias and the limited resources it can access.

Theme 5: Overreliance on AI and its Risks in Education and Society

As Artificial Intelligence (AI) becomes increasingly prevalent in education and society, the risk of overreliance on these technologies looms large. Below are the snippets of the teacher's view on this pressing concern:

"Sa akoa kay kanang naa jud siyay disadvantage kay it would the students become dependent niya maglisod na siyag kana bitaw salig sa iyang kaugalingon like di na siya mo solve ug iyaha lang kay ganahan siya na maka depend siya sa AI…" **(T1)**

"…so ang buhaton sa mga estudyante igo nalang sila mo kopya dili na nila i analyse nganong na come up ni siya nga answer ba…"

"… what if pa ansiron walay AI unsay iyang matubag unsay iyang ma answer wla kay nag salig man sya sa AI …" **(T2)**

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"For me maybe, some of the students kay magsalig namn sila sa unsay tawag ani AI chatbots dili na sila mo gamit sa ilang brain kay magsalig nalang sila sa AI chatbots for me lang..." **(T3)**

" ... it teaches the student to be lazy gani dili na maghunahuna thats why gani atoang mga estudyante karon are not critcal thinkers..no? do you agree with me? oh yah"

"...so they are just teaching the students how to become a secretary or mag suwat lang, take note pero the students are not thinking anymore."

" ... ah long term effect kuan nag kabugo ang mga estudyante nag salig nag ka lazy ang mga estudyante..yeah actually and then like for example karon im handling grade 10 even basics sus malooy ko grabi ang 1+1 mogamit pag calculator come to think of it nya nowadays AI is very common na no?

"...No, for me AI is not really that kuan effect ah effective in such a way nga maka answer siya directly maka help answer directly sa bata..." **(T4)**

"...disila palabii og rely kay at the end of the day ilaha man gihapon ang answer ang mag matter dili man sa AI" **(T5)**

The snippets of the teacher's view show how might students be over-reliant on the use of AI in solving math problems. While AI offers immense potential for automation and optimization, its unchecked usage poses significant risks, including exacerbating inequality, diminishing critical thinking skills, and fostering dependence on algorithmic decision-making processes. The statements above are supported by Yasar (2023) entitled, "7 ways AI could bring more harm than good. WhatIs" As individuals become overly reliant on AI systems for issue solving, and data collection, their critical thinking abilities may suffer. Overreliance on AI can result in a lack of knowledge of complex systems and processes. More so, a study entitled, "The Pros and Cons of AI in Education and How It Will Impact Teachers" As schools rely more on AI-powered solutions, there is a risk that students and educators could become overly reliant on technology. In the long run, this dependence may lead to the neglect of crucial traditional teaching approaches as well as the development of critical thinking and problem-solving skills (Adlawan, 2024).

Hypothesis 5: AI chatbots hinder students' critical thinking skills and promote laziness by fostering reliance on AI for problem-solving tasks.

Proposition 5: Overdependence on AI chatbots in Math problems may hinder critical thinking skills and encourage laziness among students.

Theory Generation Process

The presence of AI chatbots in the student's mathematical solving capabilities paves the way as an extension and challenge of its integration in math classes in basic education. By providing instant feedback and personalized assistance, AI chatbots extend the learning experience beyond traditional classroom boundaries, fostering greater engagement and comprehension. However, their presence also challenges educators to adapt teaching methodologies to effectively leverage AI technology while ensuring that students develop fundamental problem-solving skills independently.

Artificial Intelligence (AI) has revolutionized the landscape of mathematics, playing a pivotal role in its evolution by enhancing problem-solving techniques and mathematical modeling ***(Theme 1)***. Motivated learning lies at the core of achieving mathematical proficiency, driving students to engage deeply with mathematical concepts and problem-solving strategies that are contextualized and practical ***(Theme 2)***. Collaboration between teachers and Artificial Intelligence (AI) technologies has the potential to revolutionize education by empowering educators with innovative tools and insights ***(Theme 3)***. The integration of Artificial Intelligence (AI) in mathematics education presents challenges that affect student's mathematical learning experiences ***(Theme 4)***. As Artificial Intelligence (AI) becomes increasingly prevalent in education and society, the risk of overreliance on these technologies looms large ***(Theme 5)***.

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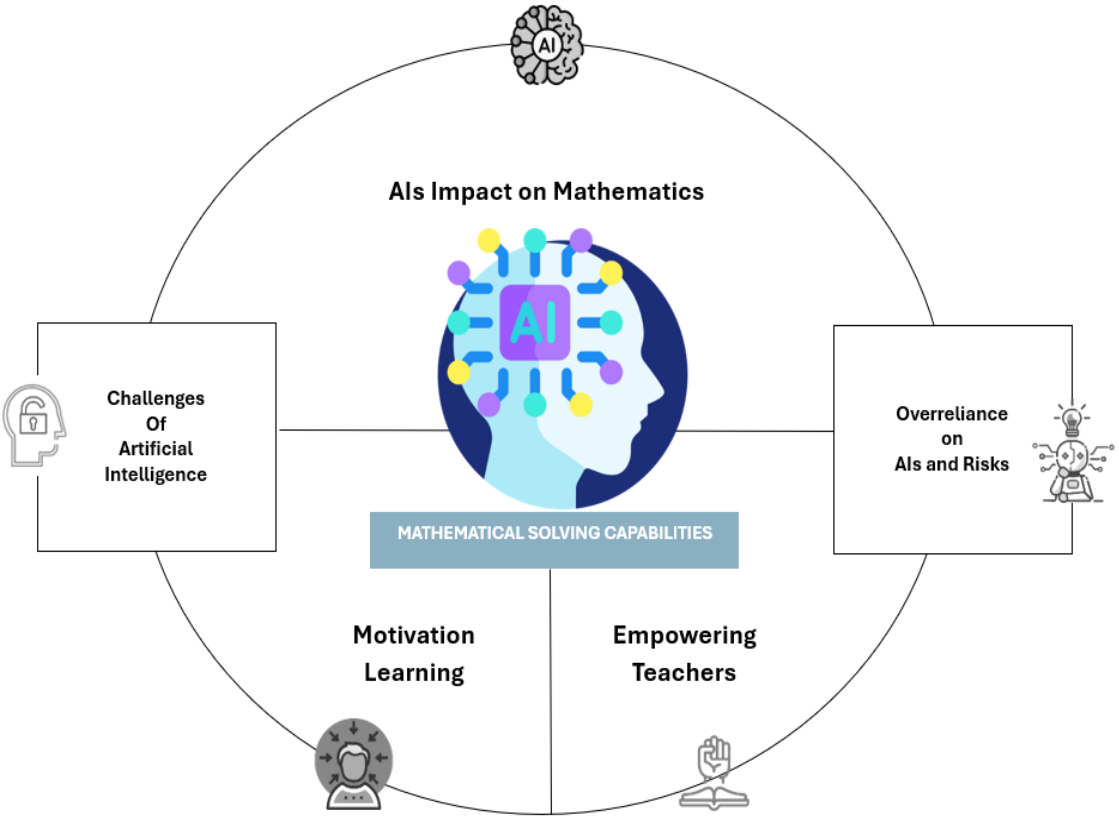
Mathematical A.I. Powered Theory



Mathematical A.I. Powered Theory by Monterde et al. (2024) states that the collaboration of AI Chatbots and teachers in teaching mathematics to students provides various benefits such as access to numerous resources online, detailed pieces of information, and answers to students' mathematical queries. But with AI's capabilities to provide answers to the student's questions can ultimately lead to the student's over-reliance on the technology. Additionally, all of AI's responses can be accessed leading to possible biased answers. However, this can be prevented by the teacher's guidance on the use of AI chatbots in their mathematical solving capabilities and as a validator of the generated answers from the AIs.

Future Direction: Theory Validation

The following tools and techniques will be used as part of the general methodology for validating Mathematical A.I. Powered Theory: survey questionnaire (to determine the theory's relevance to the student's mathematical solving capabilities), interview, and focus group discussion (presented propositions). Basic education students, Math teachers, and school administrators from the different schools in West I district, Maguikay, Tabok, and Tingub. Validated instruments such as the survey questionnaire and interview guide questions will be used to collect data. The information gathered will be examined using statistical software. Ethics, trustworthiness, and data reliability will all be considered. Each proposition's results and discussion will be presented in the next chapter.

CONCLUSION

The benefits of integrating AI chatbots alongside teachers to enrich mathematics education, providing students with access to a plethora of online resources and comprehensive explanations. However, the theory of technological determinism suggests that technology like AI chatbots may influence social change, potentially leading to over-reliance and hindering students' problem-solving abilities. Therefore, as students are exposed to these technological advancements, educators must adopt a collaborative approach, guiding students in utilizing AI chatbots as supplementary tools while validating responses, thus ensuring balanced cognitive development, and fostering effective problem-solving skills amidst evolving technological landscapes.

RECOMMENDATIONS

Students. It is recommended to use AI chatbots as supplementary tools under teacher guidance to enhance understanding while fostering independent problem-solving skills.

Math teachers. They should incorporate AI chatbots into their teaching methodologies, guiding students in leveraging them effectively while maintaining a focus on critical thinking and problem-solving strategies.

School administrators. Admin should encourage the integration of AI chatbots in mathematics education, providing resources and support for teachers to implement them responsibly and effectively within the curriculum.

Researchers. Student researchers should further explore the impact of AI chatbots in mathematics education, focusing on best practices for integration, potential biases, and long-term effects on student learning outcomes.

Future researchers. Researchers are encouraged to investigate evolving trends and advancements in AI chatbots, exploring their potential applications and refining strategies for seamless integration into mathematics education.

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