INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VII, Issue III
February 2026
Available online at https://www.instabrightgazette.com

TEACHING AND LEARNING MATHEMATICS USING GEOGEBRA: BASIS FOR AN ENHANCEMENT PROGRAM

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ABSTRACT

This study examined the experiences of teachers and learners in using GeoGebra for teaching and learning Mathematics at Iloilo City National High School during SY 2024–2025, with the aim of developing an enhancement program. Through in-depth interviews, the study revealed that teachers found GeoGebra to be helpful, innovative, and user-friendly, though they encountered challenges such as limited access to devices, insufficient training, and issues with classroom management. Learners reported increased enjoyment, improved understanding, better collaboration, and more opportunities for exploration, but also faced challenges like limited access to technology, minimal integration into lessons, and lack of familiarity with the tool. The findings highlight the need for an enhancement program to better integrate GeoGebra into Mathematics instruction.

Keywords: *Teaching, Learning, Mathematics, GeoGebra, Enhancement Program*

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VII, Issue III
February 2026
Available online at https://www.instabrightgazette.com

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INTRODUCTION

Mathematics encourages student engagement, exploration, and independent learning, positioning students as active participants (Cabilan & Peteros, 2023). According to Yanuarto et al. (2025), math education is supposed to build up not only the conceptual knowledge but also the essential skills of the 21 st century, including critical thinking, problem solving and digital literacy, which is essential to students in the modern technological environment.

According to the OECD (2024), mathematics education must equip learners with essential skills for a data-driven, technologically advanced world, including problem-solving, critical thinking, and the effective use of digital tools. Nevertheless, although such guidelines have been put down, there is still a gap in comprehending how these skills can be effectively applied to the classroom by the teachers and learners.

The proposed study would fill this gap by discussing how these skills can be put into practice in teaching mathematics. Many students perceive mathematics as difficult, often due to challenges with problem-solving and visualization (An Evolution of Mathematics Curriculum, n.d). Nevertheless, these challenges are also to be considered as the opportunities to grow and develop mindset. Constructive struggle can be used to empower students and resonate with the research results that mathematics can help overcome problems to address issues in everyday life (Rahman et al., 2023).

The growing access to technology has increased its application in education (OECD Digital Education Outlook, 2023). Therefore, this problem gives sufficient opportunities to

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ISSN: 2704-3010
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mathematics teachers and students to be taught mathematics through the existing ICT tools, including mobile applications.

Besides, the incorporation of technological tools into mainstream mathematics classes facilitates the association between conceptual and procedural knowledge of mathematical concepts as well (Maharjan et al., 2022).

Teachers and learners can explore various sources and approaches to the instruction and education process. There are lessons in our current curriculum that need to leverage the power of technology to teach and learn abstract geometrical visualization and manipulation effectively and efficiently. Visualizing concepts and ideas correctly and effectively have been part of teachers' daily challenges, affecting the transition of learning to students. Such a strategy of the integration of technology is also likely to become the relevant and innovative approach to interactive learning and teaching (Agyei et al., 2021) because integrating technology is already the part and parcel of the daily routine of educators and students.

Additionally, integrating computational thinking and digital geometry enhances students' problem-solving abilities and prepares them for data-rich careers where real-world modeling is essential. Highlighting these advantages can help emphasize the importance of such skills in today's educational policies and practices.

GeoGebra is a widely used tool for teaching and learning math (Muslim et al., 2023). Recent updates include Augmented Reality (AR) tools that let students view 3D math objects in the real world. Iparraguirre-Villanueva et al. (2025) note that this hands-on approach helps students explore shapes from angles that aren’t visible in 2D drawings.

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ISSN: 2704-3010
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Available online at https://www.instabrightgazette.com

Padilla-Escorcia and García-Rodríguez (2025) point out that GeoGebra allows students to change values and see results immediately, which helps them understand abstract mathematical ideas. Using AR in GeoGebra also makes hard math problems easier to understand by following dual-coding and split-attention principles.

The researcher aimed to define the experiences of teachers and students in teaching and learning mathematics with the help of GeoGebra, which would be used in the development of an improvement program in this research.

This improvement program is projected to have a huge impact on the classroom practice by creating an interactive learning atmosphere that results to better understanding of complex mathematical concepts by students that would eventually translate to better performance of the students.

MATERIALS AND METHODS

Research Method

This study used a descriptive research method within a qualitative framework, employing in-depth interviews. The descriptive approach aims to systematically observe and describe a phenomenon in its natural context, without altering any variables. It is also intended to represent the precise account of the existing circumstances, activities, or associations within the educational environment to assist a researcher to comprehend the trends, patterns, and implications of the practice (Elliott, 2025). The method is applicable especially in educational research that aims at recording and examining real life events, actions, or observations

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without modifying the setting in which they take place (Elliott, 2025).

The interviewer sits with the interviewee at a comfortable distance, planning the sequence of questions on a specific issue. The goal was to gather the essential opinions of those involved by observing their reactions to the questions in a social context.

Research Design

The study employed a phenomenological research design, which focuses on understanding how individuals perceive the world and how their perceptions may differ from widely accepted views.

Phenomenology examines subjective experiences by interviewing participants to gather their impressions. This approach is commonly used in fields such as psychology, sociology, and social work.

Its primary goal is to explore and describe phenomena as experienced firsthand, without relying on theories or preconceptions about their causes (Biemel & Spiegelberg, 2024).

Participants of the Study

Ten (10) participants were utilized in the study, which included five (5) of the mathematics teachers and five (5) high school students who were selected using purposive sampling.

Purposive selection was done to these participants of the Iloilo City National High School in School Year 2024-2025. The selection criteria meant both teachers and students had previous experience of teaching and learning Mathematics using GeoGebra, which meant

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
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that they would be able to offer relevant and meaningful information depending on the purposes of the research.

The teacher-participants handled mathematics subjects in various grades i.e. Grades 7, 8, 9, 10, and 11 and one per grade. The distribution made it possible to have a variety of instructional practices and experiences involved in the implementation of GeoGebra at both junior and senior high school levels. In the same manner, the participants in the student sample were chosen at each grade level, namely Grade 7, Grade 8, Grade 9, Grade 10 and Grade 11, in order to have representation at each grade level. Their inclusion gave them a wider view on the experience and perception of GeoGebra in various subjects of Mathematics and classroom settings.

Sampling Design

The study used purposive sampling design. According to Nikolopoulou (2023), purposive sampling is a non-probability sampling method where participants are selected based on specific characteristics needed for the sample. That is to say, purposive sampling involves the selection of units intentionally.

This is also referred to as judgmental sampling, this type of sampling uses the judgment of the researcher in the selection as well as identification of the individuals, cases or events that will best give the study objectives of the information.

Research Instrument

The study used a researcher-developed interview schedule as its research instrument. An interview schedule in research methodology was a written list of pre-planned questions

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(either structured, semi-structured, or open-ended) prepared to guide an interviewer in collecting information consistently from participants. It is used as a consistency method of data set collection, and the same kinds of topics and questions are covered in all interviews to allow the systematic comparison and analysis.

The interviewer used a sequence in the face-to-face, telephone, or electronic interviews, and with every participant, he posed the previously planned items and took notes of their answers (Socio.health, 2024). There were four (3) broad questions in the interview schedule that tapped on their experiences in teaching and learning Mathematics using GeoGebra, the enabling factors that they have undergone in teaching and learning Mathematics using GeoGebra, and the inhibiting factors that they have undergone in teaching and learning Mathematics using GeoGebra. Voice and video recorders were used to obtain data and document them as per the consent of the respondents.

Validity of the Research Instrument

Before determining the validity of the interview schedule, the researcher sought validation from the adviser, the Dean of the Graduate School at the time, and a panel of experts in research, testing and assessment, and English. They were asked to review and revise each question. Validity is the degree to which the results, explanations, and conclusions reached out of a research are correct, significant, and suitable in portraying the concept under investigation. It ensures that the research instrument truly measures what it is intended to measure and that the results are credible reflections of reality. When determining the content validity, the questions and format of the instrument should be in line with the variables and

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ISSN: 2704-3010
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objectives of the study to ensure that every item works correctly to reflect the construction under study.

This is done by the expert reviewing to assess the relevance of the items in the process, their clarity and the representation of the concepts under study. In a manner that makes the content and structure of the instrument align with the framework of the study, researchers improve the precision and utility of the obtained data in regard to the purpose of the research (Creswell & Creswell, 2023).

The suitable form of Good and Scates (1972) was used as cited by Soquena (2021) to consider the comments, corrections, and suggestions of the panel of validators on the interview schedule.

Data Gathering Procedures

The adviser, Dean of the Graduate School, Office of the Schools Division Superintendent, Office of the District Supervisors, School Heads, and individual participants allowed the researcher to carry out the study.

The researcher visited the schools/community/place with the participants that are convenient and specific on their part. The researcher prompted the participants to make a signature of the waiver or permission relative to the study conduct.

A voice and video recorder were used during in-depth interviews to fully record the words of the interviewee. All the data were gathered by the researcher following a series of interviews.

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ISSN: 2704-3010
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Data Analysis

The data were gathered by the interview schedule that was studied with the help of the thematic analysis which is a qualitative design that helps to recognize, deconstruct, and present common patterns or themes in the narrative information.

This method helped the researcher to identify meaningful clues on the experience of the interviewees in their teaching and learning Mathematics using GeoGebra.

Thematic analysis, as described by Braun and Clarke (2023), involves connecting specific ideas and concepts to a dataset, often through predefined categories. This approach is particularly suitable for educational research that seeks to understand complex social and organizational dynamics. According to Nowell et al. (2021), thematic analysis enhances transparency and credibility in qualitative research by ensuring systematic coding and interpretation of data.

Thematic analysis was applied to the transcribed interview data to identify, analyze, and report patterns (themes) in qualitative data. The analysis followed a six-phase process: (1) Familiarization with the data: reading and re-reading transcripts in both the local language and English; (2) Generating initial codes: labeling meaningful parts of the data (e.g., shared phone, fear of judgment); (3) Searching for themes: grouping codes into potential themes and sub-themes; (4) Reviewing themes: refining themes to ensure they accurately reflect the dataset and the study's focus; (5) Defining and naming themes: creating clear and concise names for the final themes (to be presented in Chapter 4); (6) Producing the report:

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ISSN: 2704-3010
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integrating themes, supported by direct quotes, into the analysis and linking them to the theoretical framework.

RESULTS AND DISCUSSIONS

The study aimed to explore the experiences of teachers and learners in teaching and learning mathematics using GeoGebra, with the goal of developing an improvement program for the 2024-2025 school year at Iloilo City National High School.

A qualitative phenomenological approach was employed within a descriptive research design, involving 5 mathematics teachers and 5 high school students who utilized GeoGebra in their teaching and learning activities.

Data was collected through a researcher-created interview schedule, supplemented by voice and video recordings with participant consent.

The interview schedule was tested by a panel of experts, and their feedback was incorporated to enhance its effectiveness. With the participants' consent, face-to-face interviews were conducted in convenient locations, and online instructions were provided.

In-depth interviews were held, with voice and video recordings used to capture the participants' responses, which were then organized for analysis. Thematic analysis was applied to identify key patterns and insights from the data.

The study's findings revealed that teachers found GeoGebra to be helpful, innovative, and user-friendly, with its illustrative features enhancing their teaching experience.

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However, they also identified challenges such as limited access to devices, inadequate training or skills, and difficulties in managing the classroom. Enabling factors for effective teaching included the software's user-friendly interface, collaboration among teachers, students, and peers, and its facilitation of inquiry-based learning.

On the students' side, they enjoyed using GeoGebra, as it enhanced their conceptual understanding, encouraged collaboration, and allowed for exploration.

They also pointed out some obstacles, such as the limited application of GeoGebra in lessons, poor technology infrastructure, and a lack of knowledge on how to effectively use the tool.

The factors that facilitated student learning included the availability of learning tools, the expertise of their teachers, and their own interest in the subject.

Based on the findings, the following insight was drawn:

Teachers value GeoGebra's innovative features, stating that it increases their efficiency and promotes modern classroom practices by making complex ideas easier to illustrate and explain because it was perceived as a user-friendly tool that bridges the gap between abstract math and visual understanding.

Teachers identified limited access to devices as a major problem, making it difficult for students to use the software themselves. They also mentioned insufficient training and skills, which affect their confidence in using GeoGebra effectively. In addition, teachers experience difficulties with classroom management, especially when handling technical issues during lessons.

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Teachers found that GeoGebra's user-friendly interface makes it easier to use during lessons. They also highlighted the importance of collaboration among teachers, students, and peers, which supports effective classroom use. In addition, teachers noted that GeoGebra supports inquiry-based learning, enabling students to actively explore and understand mathematical concepts.

Learners reported that the lessons used with GeoGebra were enjoyable, increasing their interest and engagement. They also experienced improved conceptual understanding as GeoGebra helped them visualize and explore mathematical ideas. In addition, learners highlighted collaboration and exploration, as the software allowed them to work with classmates and actively investigate mathematical concepts.

Learners identified limited application of the software during lessons, which reduced their opportunities to practice and explore concepts. They also mentioned inadequate access to technology, such as devices, which made it difficult to use GeoGebra effectively. In addition, a lack of knowledge or familiarity with the software hindered their ability to benefit from GeoGebra-based activities fully.

Learners identified effective learning GeoGebra tools that helped them understand mathematical concepts more easily. They also emphasized the importance of teachers' knowledge and expertise in guiding and explaining lessons using the software. In addition, learners noted that their interest and motivation increased when GeoGebra was used, making learning more engaging and meaningful.

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Conclusion

Based on the findings and insights from this study, the following recommendations are proposed:

Teachers should be encouraged to regularly integrate GeoGebra into mathematics lessons, especially in topics that require visualization, to maximize its helpful and innovative features. School administrators may support this by recognizing and promoting best practices in technology-integrated teaching.

Schools should increase access to technological resources, such as laptops, tablets, and projectors to support students' use of GeoGebra. In addition, regular training and professional development programs should be conducted to enhance teachers' skills and confidence in using GeoGebra and managing technology-based classrooms.

Teachers should be encouraged to design collaborative, inquiry-based classroom activities using GeoGebra that allow students to explore concepts independently. Peer collaboration among teachers may also be strengthened through communities of practice to share strategies and resources.

Schools and stakeholders should ensure reliable internet connectivity and access to necessary devices for both teachers and learners. It will help minimize disruptions, enable smooth lesson delivery, and allow full utilization of GeoGebra's interactive features.

Learning activities using GeoGebra should be designed to actively involve students through exploration, experimentation, and group work. Allowing students to manipulate

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objects and discover mathematical concepts on their own can sustain enjoyment and deepen their conceptual understanding.

Students should be given more opportunities to use GeoGebra regularly during Mathematics lessons to strengthen their skills and confidence. Schools should support learners by providing adequate technological resources, while teachers may offer step-by-step guidance and practice activities to address students' lack of knowledge.

GeoGebra lessons should be tailored to students' interests and learning needs, incorporating interactive tools to enhance understanding.

Teachers should continue supporting learners to ensure effective use of GeoGebra and maintain motivation in mathematics.

The Schools Division Office, Regional Office, and Central Office should approve and implement the enhancement programs. If not accepted, school heads may implement them locally.

Future studies could explore additional variables not covered in this research.

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ISSN: 2704-3010
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