The International Review of Multidisciplinary Research
Volume 1, Issue 6, May 2026, pp. 131-145
https://doi.org/10.5281/zenodo.20399264

Knowledge and Challenges in Using Graphing Calculators: Insights from Pre-Calculus Teachers

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Article Details:

Received: 6 April 2026
Revised: 14 April 2026
Accepted: 21 April 2026
Published: 27 May 2026
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Recommended Citation:

Duran J. M. E., Piñero B. A., Futalan M. C. Z. (2026). Knowledge and Challenges in Using Graphing Calculators:Insights from Pre-Calculus Teachers. The International Review of Multidisciplinary Research. 1 (6), 131-145.
https://doi.org/10.5281/zenodo.20399264

Index Terms:

graphing calculators, instructional challenges, mathematics education, Pre-Calculus

Abstract. This study examined the level of Pre-Calculus teachers' knowledge and the challenges they encountered in using graphing calculators as instructional tools. Using a descriptive correlational design, the study involved 30 Pre-Calculus teachers from selected public schools in the Schools Divisions of Negros Oriental, Dumaguete City, Tanjay City, and Bais City. A validated questionnaire was administered, and data were analyzed using the mean and Spearman's Rank Order Correlation. The findings revealed that teachers demonstrate an excellent level of knowledge in teaching conic sections, a very good level in systems of nonlinear equations, and a good to very good level in the polar coordinate system. In terms of challenges, the teachers experience a high extent of technical difficulties, particularly due to limited access to graphing calculators, an insufficient number of devices, and a lack of technical training. Student-related, curriculum and instructional, and assessment and evaluation challenges were also evident at varying levels. The results further showed that teachers' knowledge in using graphing calculators is inversely related to the challenges they encounter, specifically in teaching conic sections and systems of nonlinear equations. Higher levels of knowledge significantly reduce technical, student-related, instructional, and assessment-related difficulties. However, in teaching polar coordinate systems, knowledge does not significantly lessen most challenges and even shows a positive relationship with student-related difficulties. This result suggests that learners' unfamiliarity with the technology remains a key barrier despite teacher expertise. Moreover, higher educational attainment is associated with lower levels of knowledge in using graphing calculators for conic sections, which indicates that practical experience and exposure may be more influential than academic qualifications.

Introduction

In an increasingly digital and interconnected world, the integration of technology into education has become a global priority, particularly in mathematics instruction, where computational thinking and problem-solving are essential 21st-century skills (Ran et al., 2021). However, despite its recognized importance, the effective integration of technology in mathematics education continues to face widespread global challenges, including unreliable internet connectivity, complex access procedures, and insufficient hardware infrastructure, which limit the meaningful use of digital tools (Viberg et al., 2020). Other persistent barriers include the lack of adequate financial support (Nguyen & Van Nguyen, 2023), limited computer literacy among educators (Ghory & Ghafory, 2021), and a misalignment between technological tools and curricular objectives (Ortiz et al.,2020). These issues hinder the effective use of educational technologies that promote algorithmic thinking, pattern generalization, and understanding of abstract mathematical concepts, while also limiting student engagement and exploration (Meylani, 2025).

In 2018, the Programme for International Student Assessment (PISA) ranked the Philippines as the second lowest among 79 participating countries, highlighting the country's persistent struggles in mathematics education (Padrones et al., 2024). One of the critical factors contributing to this low performance is the limited integration of Information and Communication Technology (ICT) in the classroom. In the Philippine context, the lack of adequate ICT facilities, unstable internet connectivity, and insufficient teacher training in technology use significantly hamper the effective delivery of mathematics instruction (Alcantara et al., 2020). These challenges not only affect student learning outcomes but also widen the digital divide, particularly in underserved regions.

A review of related literature reveals a notable research gap. Existing studies primarily focus on the general challenges and perceptions of mathematics teachers regarding ICT integration (Thurm & Barzel, 2022). However, there is a lack of specific inquiry into the use of particular digital tools, such as graphing calculators and graphing software, in the teaching of Pre-Calculus. Alcantara et al. (2020) examined ICT use among mathematics teachers in Tanauan City and found that although ICT was commonly used for lesson planning and presentations, teachers faced significant limitations due to inadequate access to resources, funding, and confidence in using ICT. This is a crucial omission, considering that many key Pre-Calculus topics, such as conic sections, polar coordinates, and systems of nonlinear equations, are best understood through visual and dynamic representations provided by graphing technologies. To date, only a few studies in the Philippine context have examined Pre-Calculus teachers' knowledge and the challenges they face in effectively using digital tools such as graphing calculators and graphing software in classroom instruction.

This study is driven by the urgent need to understand and address the real-world challenges encountered by Pre-Calculus teachers in integrating technology into their teaching. It aims to offer evidence-based insights and practical strategies that can enhance both teaching practices and student learning outcomes. Moreover, the study aligns closely with Sustainable Development Goal (SDG) 4, which seeks to ensure inclusive, equitable, and quality education for all. As education systems worldwide strive to bridge digital gaps and foster 21st-century skills, the integration of affordable and accessible tools emerges as a key strategy for promoting equity and excellence. In the Philippine context, where disparities in access to educational technology persist, this research seeks to support teacher professional development, encourage inclusive pedagogy, and advance the national agenda toward achieving SDG 4's vision (Alcantara et al., 2020; Padrones et al., 2024).

Statement of the Problem

This study aims to examine the level of Pre-Calculus teachers' knowledge and the challenges they encountered in the use of graphing calculators as instructional tools.

Specifically, the study seeks to answer the following questions:

1. What is the level of Pre-Calculus teachers' knowledge in using graphing calculators to teach the following topics:

    1.1 conic sections;
    1.2 systems of nonlinear equations; and
    1.3 polar coordinate system?

2. To what extent do Pre-Calculus teachers face challenges in using graphing calculators in classroom instruction, in terms of:

    2.1 technical difficulties;
    2.2 student-related challenges;
    2.3 curriculum and instructional constraints; and
    2.4 assessment and evaluation issues?

3. Is there a significant relationship between the level of teachers' knowledge and the extent of challenges they face in using graphing calculators?

4. Is there a significant relationship between the teachers' profile based on the highest educational attainment and the following:

    4.1. level of knowledge; and
    4.2. extent of challenges encountered?

Methodology

Research Design

This study is a quantitative type of research that employed a descriptive-correlational research design. It seeks to systematically describe the level of knowledge of Pre-Calculus teachers in using graphing calculators and the challenges they encounter, while also examining the relationships among these variables. The descriptive component is appropriate since the study aimed to determine the knowledge of the teachers in using graphing calculators to teach across specific topics (i.e., conic sections, systems of nonlinear equations, and polar coordinate systems) and the extent of challenges they experienced in terms of technical, student-related, curricular, and assessment factors. The correlational component is justified because the study further investigated whether significant relationships exist between variables. Specifically, it examined the relationship between the level of teachers' knowledge and the extent of challenges they encounter, as well as the relationship between teachers' profile (e.g., number of related trainings and highest educational attainment) and both their level of knowledge and challenges. Since the study did not aim to establish causation but rather to determine the degree and direction of association among variables, correlational analysis is most suitable.

Research environment

The study was conducted in selected schools within the province of Negros Oriental. Specifically, the study covered the Schools Division of Negros Oriental, the Schools Division of Dumaguete City, the Schools Division of Tanjay City, and the Schools Division of Bais City. The respondents of the study comprised STEM/STEAM teachers handling Pre-Calculus from various public senior high schools within these divisions. Dumaguete City, the capital of Negros Oriental, is located along the southeastern coast of the island. It is approximately 5 kilometers from Sibulan Airport and is considered the educational center of the province, being home to several universities and colleges. The city also has a number of secondary schools, including 8 public high schools and 6 private high schools, distributed across its urban and suburban barangays. Tanjay City is a component city located approximately 31 kilometers north of Dumaguete City. It has a total of 12 public and 4 private high schools distributed across its districts, with some situated in rural barangays and others in the urban center. Like Dumaguete, Tanjay is divided into several school districts for efficient supervision and management of its schools. Meanwhile, Bais City is situated approximately 45 kilometers north of Dumaguete City. It has a total of 18 public secondary schools and 1 private high school located in various barangays, including coastal areas, as well as mountainous and inland regions. The city is also divided into multiple school districts to ensure the effective implementation of educational programs and support services.

Research respondents

The respondents in this study were secondary school teachers teaching Pre-Calculus for the School Year 2025-2026. The study employed a one-stage cluster sampling technique. Among the seven divisions in Negros Oriental, four were randomly selected as clusters: the Division of Dumaguete City, the Division of Negros Oriental, the Division of Bais City, and the Division of Tanjay City. All thirty (30) secondary school teachers handling Pre-Calculus in these selected divisions during the SY 2025–2026 were included as respondents in the study.

Research instruments

This study utilized a validated questionnaire to gather data. The questionnaire used the 7-point Likert scale, which offers seven response options related to agreement. These were sufficiently distinct for the respondents and included a moderate or neutral midpoint. The questionnaire consists of four parts. Part I contains the purpose of the study and the disclosure statement, which serves as evidence of the respondent's informed consent. The second part is designed to collect data on the teachers' profile, while the third part is meant to gauge the level of teachers' knowledge on utilizing graphing calculators. The fourth part examines the challenges that the teachers encountered in utilizing graphing calculators. The questionnaire was presented to three experts in the field of Mathematics education for content validity and cross-checking if the items were aligned with the specific problems of the study. These experts were secondary school teachers or college professors handling Mathematics subjects. The suggestions from the experts were applied to further refine the items in the questionnaire. On the other hand, to ensure item reliability, a dry run was conducted. The researcher sought to include at least 30 Pre-Calculus teachers from the Schools Division of Dumaguete City, Tanjay City, and Bais City as dry run respondents. After the dry run, the questionnaire items were tested for reliability using Cronbach's alpha, a method commonly used to measure internal consistency in the social and organizational sciences. This was done to verify the consistency and reliability of the self-constructed questionnaire. The results of the reliability testing indicate that all values are greater than 0.70, confirming that the items are statistically reliable.

Ethical considerations

The researcher made sure that all necessary ethical standards were observed to ensure that the respondents' dignity and overall well-being were protected throughout the conduct of the study. Additionally, anonymity and confidentiality of data were strictly upheld. The researcher also adhered to the ethical protocols established by the Foundation University Research Office and the Schools Divisions of Negros Oriental, Dumaguete City, Tanjay City, and Bais City, as well as those of Foundation University and Silliman University. Additionally, the researcher declared that OpenAI's GPT-4, ChatPDF, and Google AI's NotebookLM were used as tools to enhance readability, analyze and summarize sources, clarify complex ideas, and transform the content of this manuscript, by utilizing structured prompts for drafting and refinement, uploading and querying PDF documents for targeted summarization and extraction of key ideas, and organizing research materials for synthesis and comparison of concepts. After utilizing these tools, the author thoroughly reviewed and edited the manuscript and took full responsibility for its content.

Research procedure

A letter of request stating the intent to conduct the study was then submitted to the Schools Superintendents of the Divisions of Negros Oriental, Dumaguete City, Tanjay City, and Bais City, upon endorsement by the Dean of the College of Education and Graduate School of Foundation University. Approval was also secured from the Schools Divisions of Bais and Tanjay City to conduct a dry run in selected schools. Subsequently, a dry run was carried out in selected schools in Bais City and Tanjay City to assess the clarity and reliability of the questionnaire. Based on the results, the instrument was reviewed and refined further through pilot testing to ensure its effectiveness for the actual data collection. For the data collection phase, the questionnaires were printed and personally administered by the researcher to the selected respondents. Each participant was approached individually, and the purpose of the study was clearly explained, along with proper instructions on how to answer the questionnaire. The respondents were given sufficient time to complete the survey, and all completed questionnaires were retrieved on the same day, including those from participants who initially could not finish immediately.

Statistical Treatment of the Data

The data gathered in this study were analyzed using appropriate statistical tools. The mean was employed to determine the extent of the challenges experienced by the teachers as well as the level of utilization of different strategies. To examine the relationships among variables, Spearman's Rank-Order Correlation was utilized. Specifically, it was used to identify the relationship between (a) the level of teachers' knowledge and the extent of challenges they encounter in using graphing calculators, and (b) teachers' profile particularly in terms of the number of related trainings attended and highest educational attainment and their level of knowledge and challenges encountered. Spearman's Rank-Order Correlation was deemed appropriate for this analysis due to the ordinal nature of the Likert scale data and its non-requirement of normal distribution assumptions.

The following scales were used to describe the level of teachers' knowledge and the extent of the challenges they encounter in using graphing calculators.

Range	Level of Knowledge (LoK)	Extent of Challenge (EoC)
6.15 – 7.00	Excellent (E)	Very High (VH)
5.29 – 6.14	Very Good (VG)	High (H)
4.43 – 5.28	Good (G)	Somewhat High (SH)
3.57 – 4.42	Satisfactory (S)	Moderate (M)
2.71 – 3.56	Fair (F)	Somewhat Low (SL)
1.85 – 2.70	Poor (P)	Low (L)
1.00 – 1.84	Very Poor (VP)	Very Low (VL)

Results and Discussion

This section presents, analyzes, and interprets the data gathered from the respondents. The results are organized in a logical sequence based on the stated research problems, with the findings displayed in both tabular and narrative forms. This structure ensures a clear and coherent presentation of the evidence needed to address each objective of the study.

	I know how to use graphing calculator/software when…	$\bar{x}$	LoK	SD
1.	graphing a circle given its standard equation	6.60	E	0.56
2.	identifying the general form of a conic equation using a graphing calculator	6.23	E	0.82
3.	graphing a hyperbola and identifying its asymptotes	6.57	E	0.63
4.	graphing an ellipse and interpreting its key features (center, vertices, foci)	6.53	E	0.63
5.	converting a conic from general form to standard form using a calculator	6.23	E	0.97
6.	finding the intersection points of a conic with the x- and y-axes	6.47	E	0.63
7.	identifying the type of conic based on its graph	6.30	E	0.53
8.	adjusting the window settings to appropriately display different conics.	6.17	E	0.59

9.	using tables and trace features to interpret values of conic equations	6.20	E	0.55
10.	solving real-world problems involving conics using graphing calculators	6.17	E	0.65
	Composite	6.35	E	0.66

Table 1. Level of Knowledge of the Pre-Calculus Teachers in Using Graphing Calculators for Conic Sections

Table 1 presents the level of knowledge of Pre-Calculus teachers in using graphing calculators in teaching conic sections, yielding a composite mean of 6.35, which is interpreted as Excellent. Beginning with the highest-rated competency, graphing a circle given its standard equation ($\bar{x}$ = 6.60) reflects that teachers demonstrate excellent proficiency in representing conic sections using graphing technology. This indicates strong foundational knowledge in connecting algebraic equations to their graphical forms. The effectiveness of visualization tools in enhancing understanding of mathematical representations is supported by Foku et al. (2023), who emphasized the role of graphical tools in promoting conceptual clarity.

Closely following is graphing a hyperbola and identifying its asymptotes ($\bar{x}$ = 6.57), which also falls within the excellent level. This competency requires both procedural knowledge and conceptual understanding of asymptotic behavior. Interpreting graphical features such as asymptotes requires strategic visual analysis, which is strengthened through the use of graphing technologies, according to Becker et al. (2023). Similarly, graphing an ellipse and interpreting its key features (center, vertices, foci) ($\bar{x}$ = 6.53) indicates that teachers are highly capable of analyzing the essential characteristics of conic sections. Interpreting and evaluating graphical representations, as noted by Gardner et al. (2024), is a critical skill in mathematics, particularly in understanding complex structures such as conics.

Teachers also demonstrate strong competence in finding the intersection points of a conic with the x- and y-axes ($\bar{x}$ = 6.47). This suggests that they are proficient in linking graphical and algebraic solutions, as graphing calculators support the accurate identification of key points and enhance problem-solving efficiency. In addition, identifying the type of conic based on its graph ($\bar{x}$ = 6.30) further reflects teachers' strong analytical skills, as this competency requires recognition of distinct graphical patterns. This is supported by studies showing that graphing technologies enhance users' ability to visualize functions, analyze their properties, and interpret key features of graphs effectively (Efimov & Efimov, 2025).

Meanwhile, identifying the general form of a conic equation using a graphing calculator ($\bar{x}$ = 6.23) and converting a conic from general form to standard form using a calculator ($\bar{x}$ = 6.23) also fall within the excellent level. These tasks involve algebraic manipulation supported by technological tools, as graphing software facilitates the transformation and analysis of equations, making complex processes more accessible (Efimov & Efimov, 2025).

Slightly lower, yet still excellent, are using tables and trace features to interpret values of conic equations ($\bar{x}$ = 6.20) and adjusting the window settings to appropriately display different conics ($\bar{x}$ = 6.17). These results suggest that while teachers are proficient in using graphing calculator features, maximizing their functionality may require further refinement. Users often experience challenges when utilizing more advanced features of graphing tools, which can affect efficiency and accuracy (Mitchelmore & Cavanagh, 2000).

Similarly, solving real-world problems involving conics using graphing calculators ($\bar{x}$ = 6.17) received one of the lowest mean scores, although still within the excellent level. This indicates that applying mathematical concepts to real-life contexts may present slight challenges. Meaningful learning occurs when mathematical concepts are linked to real-world situations (den Heuvel-Panhuizen, 2020).

The findings above reveal that teachers demonstrate exceptionally strong competence in graphing and analyzing conic sections using graphing calculators, particularly in foundational and procedural tasks. However, relatively lower performance in applying these skills to real-world contexts and in maximizing advanced calculator features suggests an opportunity to further enhance higher-order thinking and application skills. Effective integration of technology should promote deeper conceptual understanding rather than mere procedural use (Mdhlalose, 2023). Technology should also be used to support meaningful learning experiences and conceptual development (Thurm & Barzel, 2022).

	I know how to use graphing calculator/software when…	$\bar{x}$	**LoK**	**SD**
1.	entering nonlinear equations into a graphing calculator	5.60	VG	0.81
2.	graphing two or more nonlinear functions simultaneously	5.83	VG	0.91
3.	finding the point(s) of intersection of nonlinear graphs	5.77	VG	0.82
4.	identifying the nature of the solutions (real, extraneous, etc.)	5.77	VG	0.77
5.	solving systems involving quadratic and linear equations	5.73	VG	0.91
6.	solving systems involving circles and lines	5.67	VG	0.88
7.	solving systems involving two quadratic equations	5.57	VG	0.77

8.	approximate irrational solutions	5.73	VG	0.83
9.	utilizing "zoom" and "trace" features to verify solutions	5.60	VG	0.81
10.	interpreting the graphical solution of a system contextually	5.63	VG	0.85
	Composite	5.69	VG	0.84

Table 2. Level of Knowledge of the Pre-Calculus Teachers in Using Graphing Calculators for Systems of Nonlinear Equations

Table 2 presents the level of knowledge of Pre-Calculus teachers in using graphing calculators in teaching systems of nonlinear equations, yielding a composite mean of 5.69, which is interpreted as Very Good. Beginning with the highest-rated competency, graphing two or more nonlinear functions simultaneously ($\bar{x}$ = 5.83) reflects that the teachers are highly capable of using graphing technology to visualize multiple relationships at once. This skill is essential in analyzing systems, as it allows for direct comparison of functions and supports conceptual understanding of their interactions. The importance of visualization in enhancing mathematical understanding is supported by Foku et al. (2023), who emphasized that graphical tools improve comprehension through the dynamic representation of concepts.

Similarly, finding the point(s) of intersection of nonlinear graphs ($\bar{x}$ = 5.77) is rated very good, indicating that teachers are proficient in identifying solutions using graphical methods. This aligns with Becker et al. (2023), who found that students' ability to interpret graphs improves when visual strategies are effectively utilized. In addition, identifying the nature of the solutions, whether real or extraneous ($\bar{x}$ = 5.77), further demonstrates teachers' competence in analyzing solution behavior. Gardner et al. (2024) highlighted that interpreting and evaluating graphical information is a key competency in mathematics learning.

Teachers also show strong knowledge in solving systems involving quadratic and linear equations ($\bar{x}$ = 5.73). This suggests that they can effectively integrate algebraic and graphical approaches in problem-solving noted that graphing calculators support students and teachers in understanding relationships between different types of functions. Likewise, approximating irrational solutions ($\bar{x}$ = 5.73) requires analytical thinking and the ability to interpret non-exact values, which Efimov & Efimov (2025) identified as a key advantage of using graphical methods in solving complex mathematical problems. Slightly lower ratings are observed in solving systems involving circles and lines ($\bar{x}$ = 5.67). This may indicate some difficulty in handling geometrically complex relationships, particularly when multiple representations are involved.

Similarly, interpreting graphical solutions contextually ($\bar{x}$ = 5.63) suggests that while teachers can determine solutions, connecting these to real-life contexts or meaningful interpretations may require further development. This supports the view of den Heuvel-Panhuizen (2020), who emphasized that meaningful learning occurs when mathematical concepts are linked to real-world situations. Further, entering nonlinear equations into a graphing calculator ($\bar{x}$ = 5.60) and utilizing "zoom" and "trace" features to verify solutions ($\bar{x}$ = 5.60) both fall within the very good level. These competencies reflect teachers' familiarity with technological tools; however, the slightly lower means suggest that full mastery of advanced features may still need improvement.

Mitchelmore and Cavanagh (2000) found that users often encounter difficulties when operating more advanced calculator functions, which can affect efficiency and accuracy. The lowest-rated competency, solving systems involving two quadratic equations ($\bar{x}$ = 5.57), although still very good, indicates that more complex nonlinear systems pose relatively greater challenges. This finding is consistent with Ran et al. (2021), who reported that increased task complexity requires deeper conceptual understanding and more effective use of technology.

To synthesize, the findings reveal a pattern in which teachers demonstrate stronger competence in graphing and identifying solutions than in interpreting, verifying, and applying these solutions in more complex or contextualized scenarios. While teachers possess strong procedural and technological skills, there remains an opportunity to enhance higher-order thinking skills. Mdhlalose (2023) emphasized that technology integration should go beyond basic usage to promote critical thinking and deeper understanding. Similarly, Thurm and Barzel (2022) highlighted the importance of using technology to support conceptual learning rather than solely procedural tasks. Strengthening these areas may lead to a more comprehensive and meaningful approach to teaching systems of nonlinear equations using graphing calculators.

	I know how to use graphing calculator/software when…	$\bar{x}$	LoK	SD
1.	switching the calculator mode from rectangular to polar	5.17	VG	0.95
2.	graphing basic polar functions (e.g., r = a, r = aθ, r = a + bcosθ)	5.03	VG	0.81
3.	interpreting polar graphs (spirals, limacons, rose curves, etc.)	5.17	VG	0.99
4.	analyzing symmetry of polar graphs using gc	5.13	VG	0.86
5.	identifying maximum r-values from a polar graph	5.17	G	0.87
6.	using table and trace features in polar mode	5.17	G	0.83

7.	graphing multiple polar equations simultaneously	5.50	VG	0.86
8.	visualizing complex polar equations	5.50	VG	0.83
9.	finding the point(s) of intersection of polar graphs	5.47	VG	0.82
10.	determining key features of a polar graph (petals, loops, intercepts)	5.53	VG	0.82
	Composite	5.28	VG	0.86

Table 3. Level of Knowledge of the Pre-Calculus Teachers in Using Graphing Calculators for Polar Coordinate System

Table 3 presents the level of knowledge of Pre-Calculus teachers in using graphing calculators in teaching the polar coordinate system, yielding a composite mean of 5.28, which is interpreted as very good. Beginning with the highest-rated competency, determining key features of a polar graph (petals, loops, intercepts) ($\bar{x}$ = 5.53) reflects that teachers demonstrate a good level of understanding in identifying essential characteristics of polar graphs. This indicates that teachers are capable of recognizing patterns unique to polar coordinate systems. The use of visualization tools has been shown to enhance understanding of such mathematical representations, particularly in non-Cartesian systems (Meylani, 2025; Owusu et al., 2023).

Closely following are graphing multiple polar equations simultaneously ($\bar{x}$ = 5.50) and visualizing complex polar equations ($\bar{x}$ = 5.50), both interpreted as very good. These competencies suggest that teachers can effectively utilize graphing technology to explore relationships among multiple equations. The integration of graphing technologies has been found to improve learners' ability to analyze and compare mathematical functions dynamically (Owusu et al., 2023).

Similarly, finding the point(s) of intersection of polar graphs ($\bar{x}$ = 5.47) indicates that teachers possess the ability to analyze relationships between equations in polar form. Such skills require both graphical interpretation and analytical reasoning, which are strengthened through consistent use of technological tools, as postulated by Nguyen and Van Nguyen (2023). However, a noticeable decline in mean scores is observed in the remaining competencies, all of which fall under the Good level. Switching the calculator mode from rectangular to polar ($\bar{x}$ = 5.17) suggests that some teachers experience difficulty in navigating between coordinate systems. This may be linked to challenges in effectively using calculator functionalities, as emphasized in studies on teachers' technological competence (Taley & Adusei, 2020). In addition, interpreting polar graphs (spirals, limacons, rose curves, etc.) ($\bar{x}$ = 5.17) and identifying maximum r-values from a polar graph ($\bar{x}$ = 5.17) indicate moderate proficiency in analyzing more complex polar forms. These tasks require deeper conceptual understanding and higher-order thinking skills. More complex mathematical concepts demand advanced reasoning and the ability to interpret graphical representations, which may still pose challenges even when technological tools are available to support learning (Efimov & Efimov, 2025).

Furthermore, using table and trace features in polar mode ($\bar{x}$ = 5.17) and analyzing symmetry of polar graphs using a graphing calculator ($\bar{x}$ = 5.13) also fall within the good level. These findings suggest that while teachers are familiar with basic technological operations, maximizing advanced features for deeper analysis remains a developing skill. Difficulties in integrating technology effectively into teaching practices have been documented in prior studies. The lowest-rated competency, graphing basic polar functions (e.g., $r = a\theta$, $r = a + b\cos\theta$) ($\bar{x}$ = 5.03), although still within the good level, indicates that even fundamental polar equations present challenges. This may be due to the abstract nature of polar coordinates compared to Cartesian systems. Research suggests that increased task complexity requires stronger conceptual understanding and effective use of technology (Ran et al., 2021). The findings generally reveal that teachers demonstrate stronger competence in identifying and graphing polar features than in interpreting, analyzing, and fully utilizing graphing calculator functionalities within the polar coordinate system. While a very good level of knowledge is observed in foundational tasks, more complex applications result in lower performance. This suggests a need to strengthen both conceptual understanding and technological proficiency in polar coordinates to support more effective teaching and learning.

	The following challenges were experienced:	$\bar{x}$	**EoC**	**SD**
1.	Lack of available graphing calculators in the school	6.03	H	1.19
2.	Insufficient number of calculators for all students	5.97	H	1.25
3.	Frequent technical malfunctions of graphing calculators	5.03	SH	0.89
4.	Difficulty updating or maintaining calculator software	5.50	H	0.86
5.	Compatibility issues between calculator models and instructional materials	5.47	H	1.07
6.	Inadequate training on the technical functions of graphing calculators	5.33	H	1.18
7.	Power or battery issues during instructional use	5.13	SH	1.25
8.	Difficulty connecting graphing calculators to projection or display tools	5.07	SH	1.14
9.	Inaccessibility of technical support in case of malfunction	5.23	SH	1.04
10.	Limited knowledge of advanced calculator features	5.23	SH	1.07
	Composite	5.40	H	1.10

Table 4. Extent of Teachers' Challenges in Using Graphing Calculators in terms of Technical Difficulties

Table 4 presents the extent of challenges faced by Pre-Calculus teachers in using graphing calculators in classroom instruction in terms of technical difficulties, yielding a composite mean of 5.40, which is interpreted as High.

Beginning with the highest-rated challenge, the lack of available graphing calculators in the school ($\bar{x}$ = 6.03) signifies that teachers experience a high level of difficulty due to limited access to essential technological tools. This finding strongly supports the claim that unequal distribution of devices and insufficient financial support hinder the widespread use of graphing calculators in classrooms (Nguyen & Van Nguyen, 2023). Even when shared resources are available, inconsistent access limits both classroom engagement and independent student practice.

Closely following is the insufficient number of calculators for all students ($\bar{x}$ = 5.97), which further reinforces the issue of inequitable access. When students cannot individually use graphing calculators, opportunities for hands-on learning are restricted. This aligns with findings by Nguyen and Van Nguyen (2023) that the limited availability of devices reduces the effectiveness of technology integration in mathematics instruction.

Another major challenge is difficulty updating or maintaining calculator software ($\bar{x}$ = 5.50). This reflects issues related to technical maintenance, including outdated programs and software incompatibility. Such barriers complicate the integration of graphing technology, particularly when different versions are used across home and school environments (Mdhlalose, 2023). These technical concerns are further supported by evidence that maintenance and software-related issues can significantly affect instructional continuity. Similarly, compatibility issues between calculator models and instructional materials ($\bar{x}$ = 5.47) highlight the difficulties teachers face when technological tools do not align with available resources. Variations in device specifications and software versions can disrupt lesson implementation and reduce instructional effectiveness (Mdhlalose, 2023).

Teachers also reported inadequate training on the technical functions of graphing calculators ($\bar{x}$ = 5.33), indicating that limited computer literacy can hinder their effective use in instruction. Without proper training and guidance, teachers may struggle to maximize the potential of these technologies in the classroom. This challenge is further reflected in the inaccessibility of technical support in case of malfunction ($\bar{x}$ = 5.23) and limited knowledge of advanced calculator features ($\bar{x}$ = 5.23), both interpreted as somewhat high, suggesting difficulties in troubleshooting and utilizing more complex functionalities. The absence of clear instructional guides and support materials further complicates effective implementation. Additionally, practical and logistical barriers such as power or battery issues during instructional use ($\bar{x}$ = 5.13) and difficulty connecting graphing calculators to projection or display tools ($\bar{x}$ = 5.07) can disrupt lesson flow and reduce the efficiency of technology integration, particularly in contexts with limited infrastructure. Although frequent technical malfunctions of graphing calculators ($\bar{x}$ = 5.03) received the lowest mean, it is still considered somewhat high, indicating that while such issues are less prominent compared to training and access concerns, they can still negatively impact teaching and learning processes when they occur. Overall, these findings highlight the critical role of teacher competence and infrastructural support in the successful integration of graphing calculators in mathematics instruction (Ghory & Ghafory, 2021; Mdhlalose, 2023).

Collectively, the findings reveal that Pre-Calculus teachers face a high level of technical challenges (composite $\bar{x}$ = 5.40) in using graphing calculators in classroom instruction. The most significant issues are related to limited access to devices, technical maintenance, and insufficient training, which are consistent with existing literature. As emphasized by Mdhlalose (2023), simply providing technological tools is not enough; effective use depends on adequate training, support, and opportunities for meaningful engagement.

The following challenges were experienced:	$\bar{x}$	EoC	SD
1. Students' lack of basic skills in operating graphing calculators	5.63	H	1.00
2. Limited exposure of students to graphing calculators in previous grades	5.47	H	0.86
3. Textbooks or modules do not align with calculator use	5.40	H	0.97
4. Difficulty in managing calculator use in large classes	5.37	H	0.96
5. Students find calculator menus confusing or hard to navigate	5.30	H	0.88
6. Students lose focus when working with calculators in groups	5.30	H	0.88
7. Students misuse or play with the calculator during class	5.23	SH	0.90
8. Students prefer manual computation over using the calculator	5.20	SH	1.00
9. Some students lack motivation to learn calculator-based methods	5.13	SH	1.01
10. Time spent re-teaching students how to use graphing calculators	5.13	SH	0.90
Composite	5.32	H	0.93

Table 5. Extent of Teachers' Challenges in Using Graphing Calculators in terms of Student-Related Challenges

Table 5 presents the extent of challenges faced by Pre-Calculus teachers in using graphing calculators in classroom instruction in terms of student-related challenges. Beginning with the highest-rated challenge, students' lack of basic skills in operating graphing calculators ($\bar{x}$ = 5.63) indicates that teachers experience a high level of difficulty due to students' limited technical competence. This finding supports the observation that students often struggle with key sequences, menu navigation, and proper input of mathematical expressions, especially when they have little prior exposure to graphing calculators (Nguyen & Van Nguyen, 2023). Such difficulties can lead to errors and reduced confidence in using the technology.

Closely following is the limited exposure of students to graphing calculators in previous grades ($\bar{x}$ = 5.47), which further emphasizes their lack of familiarity with these tools. When students are not introduced to graphing technology early, they often struggle with its technical use and develop only a superficial understanding of its functions and capabilities (Nguyen & Van Nguyen, 2023). This limited exposure restricts their ability to effectively utilize graphing calculators in more advanced mathematical tasks.

Another notable challenge is that textbooks or modules do not align with calculator use ($\bar{x}$ = 5.40), suggesting that instructional materials may not adequately support the integration of graphing calculators. When learning resources are not designed to incorporate technology, students may struggle to connect theoretical concepts with practical applications, resulting in a fragmented understanding.

Similarly, difficulty in managing calculator use in large classes ($\bar{x}$ = 5.37) reflects classroom management concerns that arise when students have varying levels of proficiency. Differences in skill levels can make it challenging for teachers to ensure that all students are engaged and effectively using the technology. Students also report challenges in navigating calculator menus ($\bar{x}$ = 5.30), indicating confusion in using the device interface. This supports findings that students often lack familiarity with the full functionality of graphing calculators, leading to inefficient or incorrect usage (Nguyen & Van Nguyen, 2023). In addition, students lose focus when working with calculators in groups ($\bar{x}$ = 5.30), suggesting that collaborative settings may sometimes reduce engagement rather than enhance it. This may be linked to overdependence on peers or a lack of structured guidance during group activities. "Somewhat High" challenges are observed in students misusing or playing with the calculator during class ($\bar{x}$ = 5.23) and students preferring manual computation over using the calculator ($\bar{x}$ = 5.20). These findings may reflect students' discomfort or lack of confidence in using the technology, as well as a tendency to rely on familiar traditional methods. Overdependence on or avoidance of calculators can both hinder balanced mathematical development (Meylani, 2025).

Additionally, lack of motivation to learn calculator-based methods ($\bar{x}$ = 5.13) and time spent re-teaching students how to use graphing calculators ($\bar{x}$ = 5.13) indicate that students may struggle not only with skills but also with engagement and retention. This aligns with findings that students often fail to critically interpret graphical outputs and instead rely on surface-level understanding (Dahland, 2024). Moreover, difficulties in connecting graphical, symbolic, and contextual representations can contribute to confusion and reduced motivation (Becker et al., 2023). Access-related issues may also influence these challenges, as students without consistent exposure to graphing tools have fewer opportunities to practice and develop fluency. From the foregoing discussion, the findings reveal that Pre-Calculus teachers face a high level of student-related challenges (composite $\bar{x}$ = 5.32) in using graphing calculators in classroom instruction. The most prominent issues are related to students' lack of technical skills, limited prior exposure, and difficulties in navigation and interpretation. These challenges highlight the need for structured instruction, consistent practice, and improved alignment between instructional materials and technology use, as supported by Nguyen and Van Nguyen (2023). Addressing these concerns can help students develop deeper conceptual understanding and a more effective use of graphing calculators in mathematics learning.

	The following challenges were experienced:	$\bar{x}$	EoC	SD
1.	Curriculum does not emphasize the use of graphing calculators	5.67	H	0.92
2.	Lack of time to incorporate calculator-based activities	5.59	H	0.89
3.	Difficulty balancing calculator and traditional (manual) instruction	5.57	H	0.77
4.	Pressure to cover many topics limits the use of technology	5.53	H	0.97
5.	Students skip graph analysis and rely only on visual results	5.50	H	0.86
6.	Insufficient instructional guides for calculator integration	5.50	H	0.94
7.	Lesson plans must be adjusted significantly to integrate calculators	5.43	H	0.94
8.	No official policy or expectation for using calculators in instruction	5.43	H	0.94
9.	Teaching with calculators extends lesson duration	5.40	H	0.86
10.	Limited sample problems in materials that use graphing calculators	5.40	H	0.93
	Composite	5.50	H	0.90

Table 6. Extent of Teachers' Challenges in Using Graphing Calculators in terms of Curriculum and Instructional Constraints

Table 6 presents the extent of challenges faced by Pre-Calculus teachers in using graphing calculators in classroom instruction in terms of curriculum and instructional constraints. Beginning with the highest-rated challenge, "curriculum does not emphasize the use of graphing calculators" ($\bar{x}$ = 5.67) indicates that teachers experience a high level of difficulty due to the lack of curricular support for technology integration. This suggests that when graphing calculators are not explicitly embedded in the curriculum, their use becomes optional rather than essential. Misalignment between curriculum goals and technological tools has been identified as a major barrier to effective integration (Ortiz et al., 2020).

Closely following is the lack of time to incorporate calculator-based activities ($\bar{x}$ = 5.59), reflecting teachers' time constraints and the added preparation required for technology-integrated lessons (Thurm & Barzel, 2022). Another notable challenge is balancing calculator use with traditional (manual) instruction ($\bar{x}$ = 5.57), indicating difficulty in maintaining students' foundational skills alongside technology use.

Similarly, pressure to cover many topics limits the use of technology ($\bar{x}$ = 5.53), suggesting that curriculum demands restrict meaningful integration. Teachers also observed that students tend to skip graph analysis and rely mainly on visual outputs ($\bar{x}$ = 5.50), indicating a tendency toward superficial learning. Insufficient instructional guides for calculator integration ($\bar{x}$ = 5.50) further highlight the lack of structured support for effective implementation (Ortiz et al., 2020). The need to significantly adjust lesson plans ($\bar{x}$ = 5.43) and the absence of official policies or expectations for calculator use ($\bar{x}$ = 5.43) suggest that teachers must exert extra effort to integrate graphing calculators, often without institutional support.

Furthermore, "teaching with calculators extends lesson duration" received a rating of $\bar{x}$ = 5.40, indicating that integrating technology can slow down instructional pacing. This result reinforces the perception that technology use requires more time, which may discourage its regular application (Thurm & Barzel, 2022). The lowest-rated challenge, limited sample problems in materials that use graphing calculators ($\bar{x}$ = 5.40), although still high, suggests that existing learning materials may not sufficiently support calculator-based instruction. This limits students' opportunities to practice and apply concepts using technology, further affecting integration.

The findings collectively reveal that Pre-Calculus teachers face a high level of curriculum and instructional challenges (composite $\bar{x}$ = 5.50) in using graphing calculators in classroom instruction. The most significant issues are related to curriculum alignment, time constraints, instructional balance, and lack of support materials, which are consistent with existing literature. These results stress the need for improved curriculum design, clearer policies, and enhanced professional development to support effective integration.

The following challenges were experienced:	$\bar{x}$	**EoC**	**SD**
1. Difficulty designing assessments that incorporate graphing calculator use	5.57	H	1.17
2. Students share answers generated by the calculator without showing the process	5.50	H	0.97
3. Challenges in checking students' calculator inputs during tests	5.47	H	0.82
4. Uncertainty about how to score calculator-based solutions	5.43	H	0.94
5. Restrictions on calculator use during standardized tests	5.40	H	1.07
6. Limited test items that align with calculator-based instruction	5.35	H	0.98
7. Lack of a rubric or guidelines for evaluating calculator-generated graphs	5.33	H	0.96
8. Time constraints in evaluating calculator-supported tasks	5.27	SH	1.08
9. Calculator use may mask students' actual level of understanding	5.20	SH	1.06
10. Assessments often do not reflect real use of calculators in instruction	5.17	SH	0.95
Composite	5.35	H	1.00

Table 7. Extent of Teachers' Challenges in Using Graphing Calculators in terms of Assessment and Evaluation Issues

Table 7 presents the extent of challenges faced by Pre-Calculus teachers in using graphing calculators in terms of Assessment and evaluation issues. Beginning with the highest-rated challenge, difficulty designing assessments that incorporate graphing calculator use ($\bar{x}$ = 5.57) indicates that teachers experience a high level of difficulty in aligning assessment practices with technology-integrated instruction. This suggests that creating meaningful evaluation tools that reflect calculator-based learning remains a challenge. Standardized assessments often fail to capture the benefits of technology-enhanced instruction, resulting in misalignment between teaching and evaluation (Alam, 2020).

Closely following is that students share answers generated by the calculator without showing the process ($\bar{x}$ = 5.50), which highlights concerns related to academic integrity and transparency. When students rely solely on final answers without demonstrating their solution process, it becomes difficult for teachers to assess true understanding. Research indicates that students may skip analytical procedures and focus only on results (Becker et al., 2023) and students often accept calculator-generated outputs uncritically without verifying or interpreting them (Dahland, 2024).

Another notable challenge is in checking students' calculator inputs during tests ($\bar{x}$ = 5.47). This reflects the difficulty teachers face in verifying how students arrive at their answers. Without access to students' step-by-step processes, it becomes challenging to identify errors or misconceptions. Monitoring students' actual use of graphing calculators during assessments is complex and often limited (Dahland, 2024).

Similarly, uncertainty about how to score calculator-based solutions ($\bar{x}$ = 5.43) indicates a lack of clear evaluation standards. The absence of consistent rubrics for assessing graphing calculator outputs leads to subjective grading practices. This aligns with findings that emphasize the need for standardized criteria to improve the reliability and clarity of assessment (Gardner et al., 2024). Teachers also reported restrictions on calculator use during standardized tests ($\bar{x}$ = 5.40), which creates inconsistencies between classroom instruction and formal evaluation. When students are trained using graphing calculators but are restricted from using them in assessments, their ability to demonstrate learned skills may be affected. This misalignment can disadvantage students and distort assessment results.

Pre-Calculus teachers experience a high level of assessment and evaluation challenges in integrating graphing calculators, particularly in terms of limited test items aligned with calculator-based instruction ($\bar{x}$ = 5.35) and the lack of a rubric or guidelines for evaluating calculator-generated graphs ($\bar{x}$ = 5.33). These issues suggest that assessment practices have not kept pace with technological integration, resulting in inconsistencies in measuring student competencies, as supported by Gardner et al. (2024), who highlighted the absence of standardized evaluation criteria. Furthermore, the misalignment between instruction and testing practices reflects a broader issue, wherein traditional assessments fail to capture the benefits of technology-enhanced learning (Alam, 2020). The challenge is compounded by time constraints in evaluating calculator-supported tasks ($\bar{x}$ = 5.27) and concerns that calculator use may mask students' actual level of understanding ($\bar{x}$ = 5.20), making it difficult for teachers to verify students' solution processes and conceptual grasp (Dahland, 2024).

The lowest-rated challenge, assessments often do not reflect real use of calculators in instruction ($\bar{x}$ = 5.17), although still somewhat high, indicates a disconnect between teaching practices and evaluation methods. This reinforces the broader issue that assessment systems may not fully capture the skills developed through technology-integrated learning.

The findings in general reveal that Pre-Calculus teachers face a high level of assessment and evaluation challenges (composite $\bar{x}$ = 5.35) in using graphing calculators in classroom instruction. The most significant issues are related to assessment design, academic integrity, lack of evaluation standards, and misalignment between instruction and testing practices. These findings are consistent with existing literature, which highlights those standardized assessments often fail to reflect the benefits of technology-enhanced instruction (Alam, 2020). The absence of clear and standardized evaluation criteria further contributes to inconsistencies in grading and assessment practices (Gardner et al., 2024).

Level of knowledge in using graphing calculators in teaching…	**Extent of Challenges in Using Graphing Calculators**			
	Technical Difficulties	Student-Related Challenges	Curriculum & Instructional Constraints	Assessment & Evaluation Issues
Conic Sections	r_s = -.426 p = .019 (significant)	r_s = -.520 p = .003 (significant)	r_s = -.351 p = .057 (not significant)	r_s = -.463 p = .010 (significant)
Sys. of Nonlinear Eqns.	r_s = -.496 p = .005 (significant)	r_s = -.479 p = .007 (significant)	r_s = -.512 p = .004 (significant)	r_s = -0.625 p <. 001 (significant)
Polar Coordinate Sys.	r_s = .358 p = .052 (not significant)	r_s = .513 p = .004 (significant)	r_s = .127 p = .503 (not significant)	r_s = .349 p = .059 (not significant)

Table 8. Relationship between the Level of Teachers' Knowledge and the Extent of Challenges They Face (n=30)

Table 8 presents the relationship between the level of teachers' knowledge in using graphing calculators in teaching selected Pre-Calculus topics and the extent of challenges they encounter in their use. The results show several significant negative correlations, particularly in the areas of conic sections and systems of nonlinear equations. This indicates that as teachers' knowledge of using graphing calculators increases, the challenges they experience tend to decrease. Specifically, teachers' knowledge in teaching conic sections is significantly related to technical difficulties (r_s = -.426, p = .019), student-related challenges (r_s = -.520, p = .003), and assessment and evaluation issues (r_s = -.463, p = .010).

These findings signify that teachers who are more knowledgeable in operating graphing calculators are better able to manage technical issues, guide students effectively in using the tool, and incorporate it appropriately in assessment practices. This finding supports the literature indicating that insufficient teacher knowledge often limits the effective integration of graphing calculators in mathematics instruction (den Heuvel-Panhuizen, 2020). When teachers possess greater familiarity with graphing technologies, they can use these tools more confidently to visualize mathematical relationships and enhance students' conceptual understanding (Meylani, 2025).

Similarly, the results show that teachers' knowledge in teaching systems of nonlinear equations has significant negative relationships with all four types of challenges: technical difficulties (r_s = -.496, p = .005), student-related challenges (r_s = -.479, p = .007), curriculum and instructional constraints (r_s = -.512, p = .004), and assessment and evaluation issues (r_s = -.625, p < .001). These findings indicate that teachers who have higher levels of knowledge in using graphing calculators for nonlinear systems tend to encounter fewer barriers in integrating the technology into instruction. This result aligns with studies emphasizing that teachers who are proficient in graphing technologies can design more interactive and meaningful lessons, enabling students to visualize and explore nonlinear functions effectively (Efimov & Efimov, 2025). The strong negative relationship between knowledge and challenges stresses the importance of teacher competence in technology integration, as greater expertise allows them to overcome instructional, technical, and assessment-related barriers.

In contrast, the results for the polar coordinate system reveal mostly non-significant relationships between teachers' knowledge and the challenges they face, except for student-related challenges (r_s = .513, p = .004), which shows a significant positive relationship. This suggests that even when teachers have greater knowledge of graphing calculators in teaching polar coordinates, they may still encounter student-related difficulties, such as students' lack of familiarity with the technology or challenges in interpreting graphical outputs. This finding is consistent with previous research showing that students often struggle with the technical operation and interpretation of graphing calculators despite teachers' guidance (Nguyen & Van Nguyen, 2023; Dahland, 2024). Students may also rely heavily on calculator outputs without fully understanding the mathematical concepts involved, which can create additional instructional challenges for teachers (Meylani, 2025).

Variables	r_s	*p*	**Remark**
Educational attainment and level of knowledge in using graphing calculators in…			
• conic sections	-.547	.002	Significant
• systems of nonlinear eqns.	.048	.802	Not significant
• polar coordinate system	.272	.146	Not significant
Educ. attainment and extent of challenges in using graphing calculator in terms of…			
• technical difficulties	.036	.852	Not significant
• student-related challenges	.110	.563	Not significant
• curriculum & instl. constraints	.003	.988	Not significant
• assessment & evaluation issues	.072	.707	Not significant

Table 9. Relationship between Educational Attainment, the Level of Knowledge, and the Extent of Challenges (n=30)

Table 9 presents the relationship between teachers' educational attainment and both their level of knowledge in using graphing calculators and the extent of challenges they encounter. The results reveal a significant relationship between educational attainment and the level of teachers' knowledge in teaching conic sections (r_s=-.547, p = .002). The negative correlation indicates an inverse relationship.

The result signifies that as teachers' educational attainment increases, their level of knowledge in using graphing calculators for conic sections tends to decrease. This may imply that teachers with lower educational attainment may have greater practical exposure or familiarity with graphing calculator tools compared to those with higher academic qualifications. This finding supports the claim that higher academic attainment does not necessarily guarantee proficiency in using technological tools in instruction, as technological competence may depend more on training, exposure, and practical experience (Taley & Adusei, 2020).
However, the results show no significant relationships between educational attainment and teachers' knowledge in teaching systems of nonlinear equations (r_s = .048, p = .802) and the polar coordinate system (r_s = .272, p = .146). This proposes that having a higher academic degree does not necessarily translate into greater expertise in using graphing calculators for all mathematical topics. This finding is consistent with studies indicating that educational attainment alone does not guarantee technological proficiency, as other factors such as training, exposure, and practical experience play

more critical roles in technology integration (Taley & Adusei, 2020). Teachers may possess advanced academic knowledge but still lack sufficient hands-on experience with graphing calculators or dynamic mathematical software.

Furthermore, the results show that educational attainment has no significant relationship with the extent of challenges encountered by teachers in terms of technical difficulties (r_s = .036, p = .852), student-related challenges (r_s = .110, p = .563), curriculum and instructional constraints (r_s = .003, p = .988), and assessment and evaluation issues (r_s = .072, p = .707). This implies that the challenges teachers face when using graphing calculators are not primarily determined by their academic qualifications. Instead, these challenges may be influenced by other factors such as access to resources, availability of technology, professional development opportunities, and institutional support.

Conclusion and Recommendations

The teachers demonstrate strong knowledge in using graphing calculators, particularly in conic sections, but show relatively lower proficiency in systems of nonlinear equations and polar coordinates. This points to a gap in deeper conceptual understanding and the application of more complex or less familiar topics. A broader challenge is also evident in mathematics instruction, where competence in fundamental concepts does not necessarily lead to mastery of advanced or specialized areas. Despite their high level of knowledge, teachers encounter notable challenges in integrating graphing calculators into classroom instruction, especially curriculum constraints, technical difficulties, and assessment-related issues. These challenges suggest that effective technology integration depends not only on individual competence but also on structural and instructional factors within the educational environment.

The existence of significant relationships between the level of teachers' knowledge and the challenges they face indicates that greater competence may help in managing some difficulties. However, the inconsistency of these relationships across different domains shows that knowledge alone is not enough to overcome all barriers, particularly in more complex topics such as polar coordinates. These findings point to the need for instructional support that not only strengthens teachers' conceptual understanding of advanced topics but also enhances their ability to integrate graphing calculators effectively in teaching.

Based on the findings and conclusions drawn, it is hereby recommended that:

1. Schools and teachers implement structured training and orientation programs to address students' lack of basic skills in operating graphing calculators. These programs should focus on fundamental operations such as navigating menus, entering equations correctly, adjusting window settings, and interpreting graphical outputs.
2. Teachers design instructional activities that effectively integrate graphing calculators into lessons, including exploratory tasks, visual demonstrations, and problem-solving activities that enhance students' understanding of mathematical concepts. Providing guided practice in using calculator features such as graphing, zoom, and trace functions can improve both teaching and learning outcomes.
3. Teachers adopt strategies to address classroom challenges related to technology use, such as establishing clear guidelines for calculator use, providing step-by-step instructions, and ensuring students develop basic operational skills to minimize confusion and misuse.
4. Schools provide adequate resources and technical support, including sufficient graphing calculators, maintenance of devices, and access to updated software. Schools should also offer regular training programs and workshops to enhance teachers' confidence and competence in integrating technology into instruction.
5. Curriculum planners and administrators may consider strengthening the alignment between curriculum, instruction, and assessment by integrating graphing calculator-based activities and related evaluations. It is also suggested that clear guidelines on the use of graphing calculators in teaching and assessment be developed to support more consistent and effective implementation.

Acknowledgements

The authors would like to thank the colleagues and institutions who provided guidance, feedback, and support throughout the conduct of this research and the preparation of this manuscript. Any remaining errors or omissions are the sole responsibility of the authors.

Funding

This research received no external funding from any public, commercial, or not-for-profit funding agency, and no organization provided financial support for the conduct of the study, authorship, or publication of this article.

Competing Interests Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study; all data used were obtained from previously published sources as cited in the reference list.

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Appendices

No appendices are attached to this study.