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### Pre-Service Teachers' Uptake of Geogebra and its Impact on their Perception Toward the Teaching and Learning of Geometry

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#### Abstract

The purpose of this paper is to discuss the impact of GeoGebra on pre-service teachers' perceptions toward the teaching and learning of geometry. Pre-service teachers, according to research, struggle with geometric concepts. Geometry knowledge assists pre-service teachers in developing basic and higher-order mathematics skills. This research looked into pre-service teachers' perceptions and use of GeoGebra in geometry teaching and learning. In this study, a quasi-experimental design was used, with one group receiving post-intervention questionnaires. This paper presents a case study of 74 first-year pre-service mathematics teachers at the college level of education. Questionnaires and interviews were used to collect data. The

quantitative data were analyzed quantitatively with descriptive statistics, while the qualitative data were analyzed qualitatively. The statistical analysis of the questionnaire confirmed that pre-service teachers are willing and will frequently use GeoGebra in mathematics teaching and learning. According to the interview analysis, all the pre-service mathematics teachers believe GeoGebra is an effective ICT tool for teaching and learning geometry. It is possible to conclude that GeoGebra is useful for teaching and learning mathematics. The use of GeoGebra software in mathematics teaching and learning is recommended by this study.

**Keywords:** Technology, GeoGebra, Geometry, Perception, Pre-Service Teacher

#### Introduction

Currently, the entire world is moving toward technology in all sectors, including banking, communication, and education. However, technology adoption is low. Researchers who investigated in-service mathematics teachers' competencies in integrating technology into teaching and learning mathematics demonstrated this (Muhazir & Retnawati, 2020, in Indonesia; Amuko *et al.*, 2015, in Kenya; Agyemang & Mereku, 2015, in Ghana) <sup>[10, 3, 2]</sup>. It was discouraging to learn that some mathematics teachers do not incorporate technology into their mathematics teaching and learning. This could be due to a lack of training for mathematics teachers on how to integrate technology into mathematics teaching and learning, or to a general lack of interest in using technology to teach mathematics.

According to Ayamah *et al.* (2020) <sup>[4]</sup>, technology aids in the teaching and learning of mathematics. Both teachers and students value technology. There are a variety of mathematics technology tools available for teaching and learning mathematics. Calculators, sketchpads, Derive 6, and GeoGebra are just a few of the tools available. Because GeoGebra is free computer software that can be downloaded from the internet and installed on computers and smartphones, this study focused on integrating it into the teaching and learning of geometry.

GeoGebra was created in 2001 by Markus Hohenwarter as mathematical software for teaching and learning mathematics. Views for algebra, calculus, statistics, probability, and geometry are included in the software. GeoGebra is, in other words, mathematics software that can be used to effectively teach and learn algebra, calculus, statistics, probability, and geometry. Because studies including (Özerem, 2012 in Turkey; Bowie *et al.*, 2019 in South Africa; Zutaah *et al.*, 2023 in Ghana) <sup>[11, 6, 14]</sup> show that Pre-service Mathematics Teachers (PMTs) struggle with geometry concepts, this study gravitated toward integrating GeoGebra in geometry teaching and learning. Even though Zutaah *et al.* (2023) <sup>[14]</sup> conducted their research in Ghana and among PMTs at the college level, the study did not use GeoGebra software. To delve deeper, the current study investigated whether the use of GeoGebra can have an impact on PMTs' perceptions toward the teaching and learning of geometry.

In this study, PMTs are college students receiving four years of training in Ghanaian educational colleges to become

professional teachers. The purpose of this study was to investigate PMTs' attitudes toward incorporating GeoGebra into geometry teaching and learning. Theories and authors have defined perceptions from various perspectives. Bohner and Wanke (2002) <sup>[5]</sup> define perception as a summary evaluation of an object or thought. Horzum and Ünlü (2017) <sup>[8]</sup> investigated PMTs' attitudes toward GeoGebra and its use following exposure to GeoGebra activity design processes. Horzum and Ünlü (2017) <sup>[8]</sup> conducted their research in Turkey and focused on mathematics in general. Three open-ended questions were administered once after PMTs were exposed to the GeoGebra software in the study. According to the content analysis of the open-ended questions, all of the PMTs believe GeoGebra has a positive impact on their professional development. They also emphasized that GeoGebra can help students achieve academic success. Furthermore, all of the PMTs stated that they want to use GeoGebra in their professional careers. This positive outcome motivated the current study to investigate PMTs' uptake of GeoGebra and its impact on their perceptions toward incorporating the software into geometry teaching and learning because studies such as Zutaah *et al.* (2022) <sup>[13]</sup> show that PMTs in Ghanaian colleges of education have difficulty solving geometry concepts. For triangulation, the current study used questionnaires and interview schedules. In this investigation, perception describes the feelings or opinions of PMTs concerning the integration of GeoGebra into teaching and learning geometry.

### Statement of the Problem

GeoGebra is a computer program that helps with mathematics teaching and learning. GeoGebra is useful for both teachers and students. GeoGebra, when used correctly, can aid in the teaching and learning of mathematics. Inadequate knowledge of how to use GeoGebra in the mathematics classroom can be an impediment rather than a catalyst. According to a review of the literature, most studies on PMTs' perceptions of GeoGebra integration into teaching and learning geometry were conducted at all levels of education, but not at the college level. PMTs in Ghanaian education colleges have negative perceptions of geometry teaching and learning, according to an observation in a mathematics class. GeoGebra software can influence PMTs' perceptions toward geometry teaching and learning in particular, and mathematics in general. In these studies, GeoGebra was found to be effective in improving students' perceptions of geometry. The current study, on the other hand, seeks to learn about PMTs' perceptions toward incorporating GeoGebra software into geometry teaching and learning at the college level.

### Research Objective

The objective of this study was to look into PMTs' perceptions toward incorporating GeoGebra into geometry teaching and learning.

### Research Question

What are PMTs' perceptions toward incorporating GeoGebra into geometry teaching and learning?

### Methodology

The purpose of this study was to investigate the impact of incorporating GeoGebra, a dynamic mathematics software, into PMTs' training in Ghana, with a focus on geometry

instruction. This section describes the methodology used to achieve the research goal. The study used a mixed-method approach to data collection and analysis, which included both quantitative and qualitative data. In this study, a quasi-experimental design with one group post-intervention questionnaire was used. For eight weeks, PMTs were trained on how to integrate GeoGebra into the teaching and learning of geometry in this design. Because of academic advantages such as the availability of functional computers and internet connectivity, this investigation was carried out at the Presbyterian College of Education (PCE) in Ghana. The study's population includes 488 PMTs in their first year at PCE. Presbyterian College of Education is a public institution of higher learning. A simple random sampling technique was used in this study to select one intact class of 74 PMTs from the college for the study. This study's sample size is 74 PMTs. Because experimental methodologies necessitate at least 15 participants in each group, the sample size for this study is representative (Gall *et al.*, 2003) <sup>[7]</sup>. This study collected both quantitative and qualitative data. The quantitative data were gathered through the use of a questionnaire, while the qualitative data were gathered through the use of an unstructured interview schedule. As part of the intervention, GeoGebra was integrated into the geometry instruction component of the PMTs training program. Participants engaged in GeoGebra-based interactive activities, simulations, and explorations aimed at improving their geometric reasoning and visualization abilities. For eight weeks, PMTs were given an intervention in which they learned geometry using GeoGebra. This study gathered quantitative and qualitative data, which were then analyzed quantitatively and qualitatively. The quantitative data were analyzed using descriptive statistics, while the qualitative data were analyzed using narratives. For ethical approval, permission was granted by the institution. All participants were allowed to provide informed consent, ensuring their rights and privacy were protected.

### Results and Discussion

This study investigated PMTs' perceptions toward incorporating GeoGebra into geometry teaching and learning. Data were collected using questionnaires and interview schedules. The data were analyzed quantitatively and qualitatively. The quantitative data were analyzed using descriptive statistics such as frequencies and percentages. This is presented in Table 1 below.

**Table 1:** PMTs' Perceptions Toward Incorporating GeoGebra into Geometry Teaching and Learning

| PMTs Responses                                                                    | N  | Percent (%) |
|-----------------------------------------------------------------------------------|----|-------------|
| GeoGebra is effective in teaching and learning mathematics                        | 35 | 47.93       |
| GeoGebra improves students' interest in learning mathematics                      | 8  | 10.18       |
| GeoGebra contributes to promoting students' understanding of mathematics concepts | 16 | 21.62       |
| GeoGebra should be included in the college curriculum.                            | 15 | 20.27       |
| Total                                                                             | 74 | 100.00      |

From Table 1 above, it was found that 35 (47.93%) of PMTs said GeoGebra is effective in teaching and learning mathematics, 8 (10.18%) of them stated that GeoGebra improves students' interest in learning mathematics, 16

(21.62%) PMTs mentioned that GeoGebra contributes to promoting students understanding of mathematics concepts, while 15 (20.27%) of the PMTs suggested that GeoGebra should be included in the college curriculum. According to the interview instrument, all PMTs indicate that GeoGebra is effective. This means that the use of GeoGebra helps both teachers and learners to achieve better understanding and performance in geometry. The software provides a visual and interactive way to explore geometric concepts. Learners interacted among themselves to share ideas. The software helps learners to be active participants, which promotes conceptual understanding of geometric concepts. This implies that PMTs have shown interest and willingness to use GeoGebra. These findings are consistent with those of Horzum and Ünlü (2017) <sup>[8]</sup>, who investigated Turkish PMTs' attitudes toward GeoGebra and its use after exposing them to GeoGebra activities, design processes, and discovered that all PMTs stated that they want to use GeoGebra in their professional careers. Similarly, Mokotjo and Mokhele-Makgalwa (2021) <sup>[9]</sup> show that the GeoGebra tool improves conceptual comprehension, especially in geometry and algebra. According to Adelabu *et al.* (2019) <sup>[1]</sup>, PMTs like the software's visualization and exploratory features, which encourage its adoption in classrooms. Furthermore, Yorganci (2018) <sup>[12]</sup> discovered that PMTs had favorable views and were eager to include GeoGebra into their teaching, noting its ease of use and potential to increase learner involvement.

### Conclusion

Drawn from the findings of this study, GeoGebra can boost PMTs' attitudes toward integrating it into geometry teaching and learning.

### Recommendation

Based on the findings and conclusions of this study, mathematics educators should encourage PMTs to use GeoGebra software in teaching and learning mathematics. Also, further study should be conducted on PMTs' perspectives towards the use of technology in mathematics classrooms.

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