

Investigating the Nexus Between Prior Knowledge in Plane Geometry (I) and Senior High School Students' Performance in Circle Theorem in Sefwi Wiawso Municipality



Suglo Kabinaa Enoch¹, Issah Mohammed²,
Thomas Asante³, Abubakari Mejira⁴

¹Department of Education, Regentropfen University College, Bolgatanga Upper East Region Ghana.

²Department of Business Education, Faculty of Education, University for Development Studies.

³Department of Educational Management and Policy Studies, Faculty of Education, University for Development Studies, Tamale, Ghana.

⁴Kpandai Senior High School, Kpandai, Ghana.

Corresponding Author's Email:
enochsuglo85@gmail.com

Article's History

Submitted: 24th January 2025

Revised: 9th February 2025

Published: 13th February 2025

Abstract

Aim: This study aimed to reveal the powerful role played by students' background knowledge of Plane Geometry (I) in their learning of the circle theorem (Plane Geometry II).

Methods: The study employed a correlational design with a sample of 210 students selected from a population of 440. The sample members were chosen for the study using a systematic random sampling technique. The study measured students' confidence levels in their prior knowledge of Plane Geometry (I) using descriptive statistics (mean and standard deviation). The study analyzed the relationship between students' Plane Geometry (I) background knowledge and their circle theorem test performance using a simple linear regression model.

Results: The descriptive statistics showed that students had the least confidence in their understanding of properties and theorems in Plane Geometry (I), ($M = 1.88$, $SD = 1.05$). This revealed a gap in foundational knowledge that may impact their learning of the Circle Theorem. The linear regression model summary revealed that background knowledge in Plane Geometry (I) as the predictor variable has a significant relationship with students' test performance in circle theorem $r^2 = .111$, $F(10,199) = 2.475$, $P = .008$.

Conclusion: Students are more likely to perform better in circle theorem if they have solid and better background knowledge in Plane Geometry (I).

Recommendation: Teachers should employ inquiry-based and hands-on learning strategies to reinforce students' understanding of Plane Geometry (I) concepts to provide a foundation for learning success in circle.

Keywords: *Prior knowledge, circle theorem, circle geometry, geometric thinking model, student performance, circle properties, plane geometry*

INTRODUCTION

There is evidence that students normally struggle with basic mathematical concepts and skills, and several theories have been put forth to explain why these declines in mathematical competency levels have occurred over time (Faulkner *et al.*, 2013). The Ministry of Education (MoE) in Ghana holds that significant advancement in nearly every area of life is impossible without a solid understanding of mathematics and science, which serve as the basis for development (MoE, 2010). Additionally, the ministry expresses the view that the study of mathematics is heavily emphasized in the educational systems of nations that are concerned with their growth. It is therefore indispensable that enabling all Ghanaian youth to acquire mathematical knowledge, abilities, attitudes, and values necessary for success in their chosen professions and everyday lives is a primary goal of the Ghanaian mathematics curriculum (MoE, 2010). Our study examined the pertinent background knowledge that students had gained in Plane Geometry I during their time in SHS I and how that knowledge affected their subsequent learning of circle theorems (Plane Geometry II), which they encountered in SHS 2.

What is the scope of plane geometry (I) as captured in the core mathematics syllabus? Concerning the 2010 teaching syllabus for Ghana's senior high schools, the Ministry of Education included several specific content areas related to teaching and learning Plane Geometry (I) as part of the core mathematics curriculum. These content areas included: corresponding angles, vertically opposing angles, alternate, and adjacent angles, supplementary angles, exterior angle theorem, isosceles, equilateral triangles, right-angled triangles, quadrilaterals, and polygons. The expectation is that, before transitioning to plane geometry (II), which covers circle theorems, students must complete these content areas in plane geometry (I) according to the core mathematics syllabus (Ministry of Education, 2010). This implies that for students to properly master the concept of circle theorems (plane geometry II) in their second year, they need to undertake Plane Geometry (I) in year one to help them have a solid foundational understanding and good prior knowledge of plane geometry (I). Acquiring good prior knowledge in Plane Geometry (I) catalyzes students' learning success in circle theorems. This is because the literature shows that students' success in subsequent Mathematics learning is dependent on their existing knowledge (Derr *et al.*, 2018). Therefore at every point in time, the student must carry a certain amount of background knowledge, which serves as a foundation upon which new learning is constructed.

Learning new mathematical concepts: the role of students' background (prior/previous) knowledge. Literature indicates that prior mathematical expertise influenced mathematics performance in postsecondary education (Faulkner *et al.*, 2013). Prior knowledge is a powerful predictive factor for students' learning of new learning content (Lipson, 1982). Zakariya *et al.* (2023), Derr *et al.* (2018), Hailikari *et al.* (2008), and Sidney and Alibali (2014) express support that prior knowledge plays an impact on students' acquisition of new knowledge in a variety of fields. Research literature demonstrated that first-year engineering students' performance in mathematics was correlated with their prior mathematical knowledge and their learning strategies (Zakariya *et al.*, 2023). This suggests that while students with limited background knowledge may do poorly, those with a positive and strong background in mathematics are more likely to perform well academically in other mathematical topics or areas. Derr *et al.* (2018) highlighted that domain-related prior knowledge and secondary school achievement are important factors in engineering study success. This suggests that when examining instructional support difficulties, both prior

knowledge and self-beliefs should be considered as they might offer important insights into the students' future performance (Hailikari *et al.* 2008).

Fyfe *et al.* (2012) in their study to determine whether prior knowledge counts, the authors highlighted that learning theories should consider how past knowledge can help in learning new content. Akinsola and Odeyemi (2014) looked into how students' performance in mathematics was impacted by prior knowledge and mnemonic teaching techniques. The authors discovered that prior knowledge instructional strategies improved students' mathematical achievement, emphasizing the need for teachers to devise mnemonics that help students retain both new and old information. In their study to determine the impact of prior learning on secondary school mathematics performance, Appavoo *et al.* (2013) discovered that past knowledge influences future learning success. In their study to identify the precise impacts of past mathematical knowledge and learning strategies on first-year engineering students' mathematical performance Zakariya *et al.* (2023), highlighted that prior mathematical knowledge improved performance.

To ascertain whether students' past knowledge affected how their motivation compositions affected their ability to retain and transfer knowledge when watching lecture videos, Pi *et al.* (2023) found that prior knowledge moderates students' interaction during learning. Rajagukguk *et al.* (2022) conducted a rigorous analysis of the impact of prior knowledge on mathematical communication while controlling for other variables. The authors discovered that previous knowledge had the greatest impact and significant influence on mathematical learning. Based on their findings, the researchers advised teachers to constantly focus on the three independent variables when continuing their mathematics education.

What does the circle theorem entail in the Ghanaian senior high school core mathematics syllabus? The concept of circle theorem is an integration of both Plane geometry (I) (angles, exterior angle theorem, special triangles, quadrilaterals, and polygons) and Plane Geometry (II) (circle theorems, tangents, diameter, chords, radius, sector, etc). Geometric theorem according to Contreras (2011) serves as a building block for understanding key geometric principles. This implies that the circle theorem provides insight into the relationships between angles, chords, tangents, secants, and other elements associated with circles. It requires students to analyze geometric configurations, make conjectures, and construct logical arguments to prove theorems and solve problems (Sinclair *et al.*, 2017). Understanding the circle theorem allows students to connect between mathematical concepts and their real-world applications, highlighting the relevance and practicality of mathematics in everyday life (Fetters, 2017).

About the learning circle of theorems, Ahasan and Ahasan (2013) presented key properties for students when learning the concept. These properties include: 1) angles subtended by a chord at the center of a circle are twice as large as those subtended by the same chord at the circumference; 2) angles subtended by the same chord at the circumference are equal; 3) the circle's diameter subtends a 90-degree angle at the circumference of the circle; 4) the angle subtended by a minor arc and its corresponding major arc adds up to 180 5) Equal angles at a circle's circumference are subtended by equal arcs or chords; 6) A tangent is said to be perpendicular to a circle's radius at the point of contact; 7) two tangents to a circle of alleged equal length that are drawn from an exterior point; 8) The angle in the alternate segment is equal to the angle formed by a chord across the point of contact and a tangent to a circle.

The literature acknowledged in this study highlights the significant role prior knowledge plays in support of students' acquisition of new information and mathematical concepts in regions other than the research topic. The relationship between third-year senior high school student's academic achievement in the circle theorems and their prior knowledge in plane geometry (I) is nonexistent in the current research location. To fill this research gap in the Sefwi-Wiawso municipality, this study was conducted against this backdrop.

Statement of the Problem

Senior high school students within the Sefwi-Wiawso municipality frequently struggle with academic performance, particularly circle geometry (Suglo *et al.*, 2023). Various reports from West African Examination Council (WAEC,) Chief Examiners have revealed the abysmal academic performance of students on WASSCE circle theorem questions. For instance, the 2012 candidates demonstrated poor factual knowledge and poor performance in questions involving the circle theorem (WAEC, 2012). Again, the Chief Examiner for Mathematics for May/June 2011 reported that candidates had trouble answering circle theorem questions because of the inability to recall the relevant circle theorem relations (WAEC, 2011). Also, the Chief Examiner's report indicated that many students chose not to tackle circle theorem questions as those questions required geometrical concepts (WAEC, 2013, 2016).

The reports revealed that the few students who attempted these questions only demonstrated inadequate content knowledge and a lack of understanding of the application of geometric theorems. The 2017 edition of WASSCE revealed a similar outlook where candidates could not sufficiently use applicable geometrical theorems and properties to calculate the values of required angle problems (WAEC, 2017). In 2020 WASSCE, the chief examiner report indicated that the majority of students incorrectly solved circle theorem question 3a of the core mathematics paper, affirming their low knowledge and understanding of the circle theorem (WAEC, 2020).

The report indicated that part (b) of question 11 was poorly answered by most candidates, which confirms students' dislike for the circle theorem. The 2020 WAEC Chief Examiner reported a downward trend in the academic performance of students in mathematics over that of the preceding year's WASSCE. From 2010 to 2022, WAEC Chief Examiner reports have consistently highlighted students' poor performance in circle theorem-related questions. While a few students demonstrate adequate knowledge, the majority continue to struggle with the fundamental concepts of circle theorems (Suglo *et al.*, 2023). This study aimed to look at the potential role students' background knowledge in plane geometry (I) could play in their learning success in the circle theorem.

Objectives of the Study

This study aimed to:

1. Measure the confidence level of senior high school students regarding their prior knowledge in Plane Geometry (I), which serves as a baseline level for learning the Circle Theorem.
2. Ascertain whether there is a significant relationship between students' prior knowledge in Plane Geometry (I) and their test performance in circle theorem (Plane Geometry II).

Null Hypotheses

The study tested the following hypotheses using a simple linear regression model:

H₀: There is no significant relationship between students' prior knowledge in Plane Geometry (I) and their test performance in circle theorem (Plane Geometry II).

H₁: There is a significant relationship between students' prior knowledge in Plane Geometry (I) and their test performance in circle theorem (Plane Geometry II).

EMPIRICAL LITERATURE REVIEW

Zakariya *et al.* (2021) aimed to study the precise impacts of prior mathematical knowledge and learning strategies on first-year engineering students' mathematical performance. The authors employed a cross-sectional design, and structural equation modeling techniques were used to analyze the data. The results demonstrated that prior mathematical knowledge improved performance. While Zakariya *et al.* (2021) used structural equation modeling techniques for their data analysis, the current study employed simple linear regression models to ascertain the relationship between prior knowledge confidence level and circle theorem test performance.

Hailikari *et al.* (2007) aimed to determine how 139 students' performance in a university mathematics course was predicted by their prior knowledge and prior study success among other variables. The authors examined how these variables interact to predict student achievement using structural equation modeling. The findings showed that domain-specific prior knowledge was the best predictor of student achievement among the factors in the model, accounting for 55% of the variance.

Fyfe *et al.* (2012) investigated how children with different levels of prior domain knowledge responded to one type of assistance, feedback when they were doing exploratory mathematics problems. After presenting 12 new mathematical equivalency problems to children in the second and third grades, the authors gave them a quick conceptual education. They were given either (a) no feedback, (b) outcome feedback, or (c) strategy feedback after completing each issue. The findings demonstrated that the influence of feedback on kids' learning was mitigated by prior knowledge. While children who had some knowledge of a correct solution approach gained more from investigating without feedback, children who had less knowledge of correct solution strategies benefited more from feedback during exploration.

The impact of prior knowledge and mnemonics instructional strategies on students' mathematical achievement was examined by (Akinsola & Odeyemi, 2014). The authors used a 3x2x3 factorial matrix in a quasi-experimental pretest-posttest control group approach. Participants in the study included 288 pupils from six public schools chosen from three local government districts in Ibadan, Oyo State, Nigeria. The authors discovered that teaching methods based on prior knowledge improved students' mathematical performance.

Performance on a precourse diagnostic exam of mathematical skills was linked to the final grade of 1403 students enrolled in the first semester of the introductory, pre-professional physics course (Hudson & Rottmann, 1981). Based on their research, the authors noted that past mathematical proficiency has a major impact on course performance and a secondary impact on the likelihood of dropping out.

The activation of students' prior knowledge for the growth of language, concepts, and mathematics was examined by (Oyinloye and Popoola, 2013). Two hundred and sixty students were chosen using a random sample procedure for this quasi-experimental investigation. The experimental groups worked cooperatively in smaller groups, applying their past expertise to debate problems about the new subjects. A pre-test was administered to the experimental and control groups before the start of the study, and an achievement test was administered following the trial. T-test statistics were used for the obtained data, and the study's conclusions demonstrate that the experimental group's students outperformed the control group.

Xhomara (2020) examined how students' foundational learning abilities in mathematics at the university level are influenced by past knowledge and other factors. A structured questionnaire and a quasi-experimental research design were used in the study. The study discovered a favorable link between prior knowledge and the comprehensive learning strategy, but a minimal correlation between prior knowledge and fundamental learning skills.

Bringula *et al.* (2016) ascertained how learner-interface interactions in an intelligent tutoring system that uses learning-by-teaching were impacted by students' prior mathematical knowledge. A pretest measuring the students' prior knowledge of mathematics and a posttest were completed by 139 high school students. The researchers partially rejected the null hypothesis, which held that students' interactions with a simulated student are not significantly influenced by their prior mathematical expertise. They concluded that students' demonstration or omission of a skill depends on their past understanding of equation terminology and the subsequent step in solving equations.

Hailikari (2010) evaluated university students' past knowledge and its consequences for theory and practice and how various prior knowledge categories affect student performance. The study examined the relationship between students' performance in the target course and their prior knowledge from earlier courses. The findings suggested that students who passed the more difficult target course with higher grades also had higher levels of prior knowledge, or procedural knowledge, from earlier courses.

The purpose of Zambrano *et al.* (2019) study was to ascertain how task-specific prior knowledge affected both individual students and cooperative groups that were given instructions to work together. A sample of 228 students was chosen for the experiment. The study discovered that in complex tasks, group learning was more beneficial than individual learning; nevertheless, performance was contingent upon the learner's existing knowledge relevant to the task at hand.

The impact of past knowledge on memory and its consequences for schooling were examined by (Shing & Brod, 2016). The authors stressed that having prior knowledge can significantly improve those memory processes and facilitate new information acquisition. However, existing knowledge can also impede the learning of new information, especially if the information is at odds with the learner's preconceptions. The authors also mentioned that to maximize students' learning, it is critical to consider students' prior knowledge and understand how it influences memory processes.

Academic aptitude and prior knowledge were investigated by Thompson and Zamboanga (2004) as potential predictors of student achievement in an introductory psychology course. Early in an introductory psychology course, the authors gave two pretests to 353,00 students. From there, they collected data on exam performance, participation in following courses, and general student

ability. Even when course participation and ACT scores were considered, the pretest of psychological knowledge was found to be a unique predictor of significant variance in exam scores in regression models. Thus, prior knowledge relevant to an area helps students understand introductory psychology beyond generic aptitude.

Byrne and Flood's (2008) study investigated the relationships between first-year accounting program academic performance at an Irish university and past academic accomplishment, prior accounting knowledge, gender, reasons, expectations, and preparedness for higher education. Exam scores were utilized as indicators of academic achievement, and information about the background variables was acquired through a questionnaire. The findings show a strong correlation between students' academic success and their earlier academic accomplishments and accounting expertise.

RESEARCH METHOD

This study employed a correlational design allowing both descriptive statistics (mean and standard deviation) and inferential statistics (simple linear regression model) to analyze the quantitative data collected from the respondents. The accessible population of this study included 440 senior high school students in Sefwi-Wiawso municipality who were in their final year at the time of the data collection. The population comprised 53% of female and 47% of male students. The sample size of 210 students was determined using Krejcie and Morgan's (1970) sample determination table. Systematic sampling was employed by selecting every 2nd student from the list of 440 students, where 2 was determined by dividing the accessible population size (440) by the sample size (210).

Data collection instruments included the Circle Theorem Performance Test (CTPT) and a self-developed closed-ended questionnaire. The (CTPT) instrument consisted of carefully selected fifty (50) multiple-choice West Africa Secondary School Certificate Examination past questions relating to both circle theorem and Plane Geometry (I) questions. The questionnaire comprised a list of itemized statements that measured the student's geometry prior knowledge confidence level. The questionnaire was structured using a Likert 4-point rating scale (1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree). The study ensured the reliability and validity of the instrument by conducting a Cronbach's Alpha reliability test, which yielded a score of .848, exceeding the acceptability threshold of .71. This indicated high internal consistency and stability in the measuring instrument.

The data collection procedure started with an introduction and ethical evaluation clearance letters presented to the managers of the school who participated in the study. The management, after reviewing these letters, granted permission for the data collection. The study's goal was explicitly communicated to the participants. The participants verbally agreed after receiving assurance that the information they provided would be treated with complete confidentiality. Participants before the start of data collection provided an opportunity for any of the students to withdraw from the study if he or she wanted to do so. To analyze the data gathered for the study, two (2) different techniques were used. Simple linear regression model to test the null hypothesis and descriptive statistics for objective one, measuring students' confidence level.

RESULTS AND DISCUSSIONS

Objective one: To measure the confidence level of senior high school students regarding their prior knowledge in Plane Geometry (I), which serves as a baseline level for learning the Circle Theorem

The objective of the study aimed to measure the confidence level of students on a scale of 1-4 regarding their prior knowledge in Plane Geometry (I) which serves as a baseline level for learning the circle theorem. Refer to Table 1 for the descriptive statistics of objective one.

Table 1: Showing Descriptive Statistics for Students' Prior Knowledge Confidence Levels in Plane Geometry (I)

Statement	Mean	Std. Deviation
I am confident in my ability to define and explain key concepts in plane geometry	2.42	1.10
I have reviewed and understood the key concepts in plane geometry before learning Circle Theorem	2.47	1.12
I am comfortable using plane geometry to solve real-world problems	2.17	1.07
I can recognize and explain the relationships between different plane geometry concepts	2.75	1.04
I have a strong foundation in plane geometry, which will help me learn Circle Theorem	2.72	1.03
I can visualize and work with geometric shapes, such as points, lines, and planes	2.50	1.05
I am familiar with the formulas used in plane geometry	2.46	1.09
I can easily apply plane geometry concepts to solve problems	2.54	1.06
I have a good understanding of the properties and theorems in plane geometry	1.88	1.05
I feel prepared to build on my prior knowledge of plane geometry to learn Circle Theorem	2.07	1.12

Source: Researcher, 2023

The descriptive statistics results in Table 1 showed that students generally have moderate confidence levels regarding their prior knowledge in Plane Geometry (I) with mean values ranging from 1.88 (lowest) to 2.75 (highest). The lowest mean score ($M = 1.88$, $SD = 1.05$) suggests that students have the least confidence in their understanding of properties and theorems in Plane Geometry (I), which could indicate a gap in foundational knowledge that may impact the learning of the Circle Theorem. The moderate mean score ($M = 2.54$, $SD = 1.06$) suggests that students may need some remediation in their confidence level with applying plane geometry to solve real-world problems. The students rated their review and understanding of key concepts before learning

the Circle Theorem ($M = 2.47$, $SD = 1.12$), and ability to define and explain key concepts in plane geometry ($M = 2.42$, $SD = 1.10$) as moderately confident which imply that teachers must make efforts to implement some remediation about these areas to help the students succeed in the circle theorem classroom. On the other hand, students demonstrated greater confidence in their capacity to identify and elucidate connections among various plane geometry ideas ($M = 2.75$, $SD = 1.04$) and in their solid plane geometry background to acquire the Circle Theorem ($M = 2.72$, $SD = 1.03$).

The findings also revealed that students have confidence in understanding the properties and theorems in plane geometry ($M = 1.88$, $SD = 1.05$). Overall, the findings imply that students' confidence in their prior knowledge of plane geometry varies and could affect their capacity to understand the concept of the Circle Theorem. Kwasi *et al.* (2022) and Yalley *et al.* (2021) highlighted that prior knowledge serves as a foundation for new learning, as it is found to have an influencing effect on how well students learn. Torto (2020) pointed out that prior knowledge is an essential tool for successful mathematics.

Objective two: To ascertain whether there is a significant relationship between students' prior knowledge of Plane Geometry (I) and their test performance in the circle theorem (Plane Geometry II).

Objective two of this study was formulated on the assumption that students' Plane Geometry (I) prior knowledge (in other words, students' performance in Plane Geometry (I)) has a certain relationship with their learning success and academic performance in the circle theorem. A significance test was performed on data collected concerning this objective using a simple linear regression model and the results are displayed in Table 2.

Table 2: Showing the relationship between students' prior knowledge in Plane Geometry (I) and Their Test Performance in Circle Theorem (Plane Geometry II)

r	r^2	Adjusted R Square	Std. Error of the Estimate	F Change	df1	df2	Sig. F Change
.333a	0.111	0.066	6.325	2.475	10	199	.008

Source: Researcher, 2023

Table 2 presents the linear regression model summary which revealed that the predictor variable, background knowledge has a significant relationship with the dependent variable, students' test performance in circle theorem $r^2 = .111$, $F(10,199) = 2.475$, $P = .008$. Although the relationship is statistically significant ($p = .008$), the Adjusted r^2 value of 0.066 suggests that prior knowledge in Plane Geometry (I) explains only 6.6% of the variance in the student's circle theorem test performance, indicating that other factors also played a role. The standard error of the estimate (6.33) shows the average distance that the observed values fall from the regression line. The F Change statistic of 2.475 with 10 and 199 degrees of freedom yielded a significance level ($p = .008$), which is less than the threshold of (.05), confirming a statistically significant relationship. Therefore, educators should consider implementing instructional strategies to address the student's knowledge gap in Plane Geometry (I) to potentially improve their performance in the circle theorem (Plane Geometry II).

This study affirms that students' background knowledge plays a significant role in learning new content as espoused by other researchers (Haj-Yahya *et al.* 2023; Zakariya *et al.* 2021; Hailikari *et al.* 2007; Fyfe *et al.* 2012; Akinsola & Odeyemi, 2014). For instance, Zakariya *et al.* (2021) study was to identify the precise impacts of prior mathematical knowledge and learning strategies on first-year engineering students' mathematical performance. The results demonstrated that prior mathematical knowledge improved performance.

Also, Hailikari *et al.* (2007) determined how 139 students' performance in a university mathematics course was predicted by their prior knowledge, academic self-beliefs, and prior study success. The authors' findings showed that prior knowledge was the best predictor of student achievement among the factors in the model. Additionally, Hailikari *et al.* (2007) conducted a study to examine how various forms of prior knowledge impact student accomplishment. The findings showed that prior knowledge type matters and that the best indicator of student achievement was prior study success.

Moreover, Fyfe *et al.* (2012) investigated how children with different levels of prior domain knowledge responded to one type of assistance, feedback when they were doing exploratory mathematics problems. The findings demonstrated that the influence of feedback on kids' learning was mitigated by prior knowledge. While children who had some prior knowledge of a correct solution approach gained more from investigating without feedback, children who had less prior knowledge of correct solution strategies benefited more from feedback during exploration.

This finding correlates with Kwasi *et al.* (2022) and Yalley *et al.* (2021) view that prior knowledge is a foundation for new learning as it influences how well students learn. This finding also fits into Kwasi *et al.* (2022) view that students blessed with a high prior knowledge of a content area are likely to demonstrate good understanding and remembrance of the content and achieve improved performance in examinations.

CONCLUSION

This study found that students' prior knowledge in Plane Geometry (I) explains approximately 11.1% of the variance in their Circle Theorem test performance ($r^2 = 0.111$, $p = .008$), highlighting a statistically significant but moderate relationship. We therefore concluded that students with better Plane Geometry (I) background knowledge are more likely to learn well and achieve higher scores in circle theorem assessments. A strong foundational understanding of Plane Geometry (I) enables students to grasp and apply Circle Theorem concepts more effectively. Conversely, students with poor prior knowledge of Plane Geometry (I) are at a greater risk of underperforming in circle theorem-related tests. Low confidence may reduce students' motivation and persistence in solving complex problems, negatively impacting their learning outcomes. Therefore, fostering a strong foundation in Plane Geometry (I) and building students' confidence in their mathematical abilities are crucial for improving their overall performance in the concept of circle theorems. This highlights the importance of targeted instructional strategies that not only teach geometric concepts but also nurture students' self-efficacy and motivation in mathematics.

RECOMMENDATIONS

Students should actively participate in Plane Geometry (I) related activities, such as group discussions, hands-on projects, and practice exercises. Active participation in these activities can

enhance students' Plane Geometry (I) background knowledge and improve their performance in Circle Theorem topics.

Teachers should use inquiry-based learning and hands-on strategies to reinforce students' understanding of geometric concepts, as well as implement confidence-building techniques.

Policymakers should prioritize the development of a comprehensive geometry curriculum that emphasizes foundational knowledge and its application to advanced topics like circle theorems. This curriculum should include professional development for teachers on effective pedagogical strategies that foster student confidence and engagement in mathematics. Additionally, resources should be allocated to support enrichment programs that help students struggling with geometry concepts.

Further research should explore additional factors, such as problem-solving strategies and spatial reasoning skills, that may influence students' performance in geometry beyond their background knowledge.

Funding Declaration

The authors received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest

The authors declares no conflict of interest.

Ethical Approvals

The study was given ethical clearance by the School Ethical Review Board, Academic Headmaster/Board and the research was carried out following relevant guidelines and regulations. All respondents granted consent before they were allowed to participate in the data collection process

Data Availability

The raw data collected from respondents and analyzed to produce the findings of this study are available in a Microsoft Excel document. The data can be made available from the Author upon request and with permission from the participants' School Academic Board.

REFERENCES

- Akinsola, M. K., & Odeyemi, E. O. (2014). Effects of Mnemonic and Prior Knowledge Instructional Strategies on Students Achievement in Mathematics. *International Journal of Education and Research*, 2(7), 675-688.
<https://www.tojdel.net/journals/tojdel/articles/v11i02/v11i02-48.pdf>
- Appavoo, P., Soyjaudah, K. S., & Armoogum, V. (2013, September). Effects of prior learning on mathematics performance at secondary level. In 2013 Africon (pp. 1-5). IEEE.
<https://doi.org/10.1109/AFRCON.2013.6757693>
- Ahassan, E. A., & Ahassan, E. (2013). Core Mathematics Made Simple For Senior High Schools in West Africa Part 2. <http://eprints.lmu.edu.ng/1373/1/Maths%20Book2.pdf>

- Byrne, M., & Flood, B. (2008). Examining the relationships among background variables and academic performance of first-year accounting students at an Irish University. *Journal of Accounting Education*, 26(4), 202-212. <https://doi.org/10.1016/j.jaccedu.2009.02.001>
- Bringula, R. P., Basa, R. S., Dela Cruz, C., & Rodrigo, Ma. M. T. (2016). Effects of Prior Knowledge in Mathematics on Learner-Interface Interactions in a Learning-by-Teaching Intelligent Tutoring System. *Journal of Educational Computing Research*, 54(4), 462-482. <https://doi.org/10.1177/0735633115622213>
- Contreras, J.N. (2011). Using Technology to Unify Geometric Theorems about the Power of a Point. *Mathematics Educator*, 21(1), 11-21. Retrieved February 9, 2025 from <https://www.learntechlib.org/p/55504/>.
- Derr, K., Hübl, R., & Ahmed, M. Z. (2018). Prior knowledge in mathematics and study success in engineering: informational value of learner data collected from a web-based pre-course. *European Journal of Engineering Education*, 43(6), 911–926. <https://doi.org/10.1080/03043797.2018.1462765>
- Faulkner, F., Hannigan, A., & Fitzmaurice, O. (2013). The role of prior mathematical experience in predicting mathematics performance in higher education. *International Journal of Mathematical Education in Science and Technology*, 45(5), 648–667. <https://doi.org/10.1080/0020739X.2013.868539>
- Fyfe, E. R., Rittle-Johnson, B., & DeCaro, M. S. (2012). The effects of feedback during exploratory mathematics problem solving: Prior knowledge matters. *Journal of Educational Psychology*, 104(4), 1094–1108. <https://doi.org/10.1037/a0028389>
- Fetters, M. D., & Molina-Azorin, J. F. (2017). The journal of mixed methods research starts a new decade: The mixed methods research integration trilogy and its dimensions. *Journal of Mixed Methods Research*, 11 291-307. doi: <https://doi.org/10.1177/1558689817714066>
- Haj-Yahya, A., Hershkowitz, R., & Dreyfus, T. (2023). Investigating students' geometrical proofs through the lens of students' definitions. *Mathematics Education Research Journal*, 35(3), 607-633. Retrieved on 23/01/2025 from <https://link.springer.com/article/10.1007/s13394-021-00406-6#citeas>
- Hudson, H. T., & Rottmann, R. M. (1981). Correlation between performance in physics and prior mathematics knowledge. *Journal of Research in Science Teaching*, 18(4), 291-294. <https://doi.org/10.1002/tea.3660180403>
- Hailikari, T. (2010). Assessing university students' prior knowledge: Implications for theory and practice. <https://helda.helsinki.fi/items/36686776-c407-41c0-9f7f-4f7d46eb7f81>
- Hailikari, T., Nevgi, A., & Lindblom-Ylänne, S. (2007). Exploring alternative ways of assessing prior knowledge, its components and their relation to student achievement: A mathematics based case study. *Studies in educational evaluation*, 33(3-4), 320-337. <https://doi.org/10.1016/j.stueduc.2007.07.007>

- Hailikari, T., Nevgi, A., & Komulainen, E. (2008). Academic self-beliefs and prior knowledge as predictors of student achievement in Mathematics: A structural model. *Educational psychology*, 28(1), 59-71. <https://doi.org/10.1080/01443410701413753>
- Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, 30(3), 607-610
- Kwasi, S. F., Lassong, B. S., & Fokuo, M. O. (2022). Students' Poor Mathematics Performance in Ghana: Are There Contributing Factors? *Asian Journal of Education and Social Studies*, 16-21. <https://doi.org/10.9734/ajess/2022/v30i430729>
- Lipson, M. Y. (1982). Learning New Information from Text: The Role of Prior Knowledge and Reading Ability. *Journal of Reading Behavior*, 14(3), 243-261. <https://doi.org/10.1080/10862968209547453>
- Ministry of Education (2010). Teaching Syllabus for Core Mathematics: Senior High School 1 – 3. Accra: Ministry of Education, Science and Sports. Accessed on 07/02/2025 from <https://mingycomputersgh.wordpress.com/wp-content/uploads/2015/03/core-maths-syllabus2.pdf>
- Oyinloye, O., & Popoola, A. A. (2013). Activating junior secondary school students' prior knowledge for the development of vocabulary, concepts and mathematics through instructional strategies. *International Journal of Education and Literacy Studies*, 1(2), 1-7. Retrieved on the 22nd January, 2025 from <https://journals.aiac.org.au/index.php/IJELS/article/view/163>
- Pi, Z., Zhang, X., Zhang, X., Gao, M., & Li, X. (2023). Students' prior knowledge moderates the effects of group motivation compositions on learning from video lectures. *British Journal of Educational Technology*, 54(6), 1814-1836.
- Rajagukguk, W., Bina, N. S., & Samosir, K. (2022). The Effect of Prior Knowledge, Emotional Intelligence and Motivation on Mathematical Communication. *Education Quarterly Reviews*, 5(4).
- Suglo, E. K., Bornaa, C. S., Iddrisu, A. B., Atepor, S., Adams, F. X., & Owuba, L. A. (2023). Teacher's Pedagogical Content Knowledge and Students' Academic Performance in Circle Theorem. *Online Submission*, 2(3), 29-41. <https://doi.org/10.58425/jetm.v2i3.195>. Accessed on 07/02/2025 from <https://files.eric.ed.gov/fulltext/ED630167.pdf>
- Sinclair, N., Bartolini Bussi, M. G., de Villiers, M., Jones, K., Kortenkamp, U., Leung, A., & Owens, K. (2017). Geometry Education, Including the Use of New Technologies: A Survey of Recent Research. 277-287. https://doi.org/10.1007/978-3-319-62597-3_18
- Shing, Y. L., & Brod, G. (2016). Effects of prior knowledge on memory: Implications for education. *Mind, Brain, and Education*, 10(3), 153-161.
- Sidney, P. G., & Alibali, M. W. (2014). Making Connections in Math: Activating a Prior Knowledge Analogue Matters for Learning. *Journal of Cognition and Development*, 16(1), 160–185. <https://doi.org/10.1080/15248372.2013.792091>

- Thompson, R. A., & Zamboanga, B. L. (2004). Academic aptitude and prior knowledge as predictors of student achievement in introduction to psychology. *Journal of educational psychology*, 96(4), 778.
- WAEC. (2011). The Chief Examiners for Mathematics (Core) and Mathematics (Elective) report
- WAEC. (2012). The Chief Examiners for Mathematics (Core) and Mathematics (Elective) report.
- WAEC. (2012). The Chief Examiners for Mathematics (Core) and Mathematics (Elective) report
- WAEC. (2013). The Chief Examiners for Mathematics (Core) and Mathematics (Elective) report
- WAEC. (2017). The Chief Examiners for Mathematics (Core) and Mathematics (Elective) report
- WAEC. (2020). The Chief Examiners for Mathematics (Core) and Mathematics (Elective) report
- Xhomara, N. (2020). How prior knowledge, learning, teaching and assessment affect students' achievements in Mathematics. *Research in Education and Learning Innovation Archives*, (25), 68-91
- Yalley, E., Armah, G., Ansah, R. K., & Palou, E. (2021). Effect of the VAN Hiele Instructional Model on Students' Performance in Geometry. *Education Research International*, 2021, 1-10. <https://doi.org/10.1155/2021/6993668>
- Zakariya, Y. F., Nilsen, H. K., Bjørkestøl, K., & Goodchild, S. (2023). Analysis of relationships between prior knowledge, approaches to learning, and mathematics performance among engineering students. *International Journal of Mathematical Education in Science and Technology*, 54(6), 1015-1033. <https://doi.org/10.1080/0020739X.2021.1984596>
- Zambrano, J., Kirschner, F., Sweller, J., & Kirschner, P. A. (2019). Effects of prior knowledge on collaborative and individual learning. *Learning and Instruction*, 63, 101214.

.....
Copyright: (c) 2025; Suglo Kabinaa Enoch, Issah Mohammed, Thomas Asante, Abubakari Mejira



The authors retain the copyright and grant this journal right of first publication with the work simultaneously licensed under a [Creative Commons Attribution \(CC-BY\) 4.0 License](https://creativecommons.org/licenses/by/4.0/). This license allows other people to freely share and adapt the work but must credit the authors and this journal as initial publisher.