

Enhancing Geometric Construction Skills Through Targeted Interventions: A Case Study of a Grade 10 Student

Priyanga Abeykoon^{1*}, Virajith Gamage²

¹B/President College, Ambagasdowa, ²Sri Lanka Institute of Information Technology, Malabe, Sri Lanka.

Corresponding author*: amlpriyanga476@gmail.com

Abstract

Geometric construction has been one of the topics in Mathematics that accounts for poor performance in both internal and external examinations among students in school. Geometric construction has consistently posed challenges in mathematics education, contributing to low student performance. This action research aimed to identify the causes of poor engagement and errors in geometric construction among Grade 10 students, focusing on a single case study of a student from government school in the Badulla district. Using interviews, observations, and document analysis, the study diagnosed the student's difficulties and implemented a three-stage intervention strategy: integrating digital tools, introducing design rulers, and applying traditional mathematical instruments. The results indicate that the student's engagement and construction skills improved significantly through targeted and student-centered learning activities. The study underscores the value of adaptive teaching strategies in promoting geometry learning in the 21st-century classroom.

Keywords: Geometric construction; student engagement; action research; mathematics education; 21st-century skills

Introduction

Learning geometry emphasizes exploring different representations of drawing skills of shapes, angles, straight lines, and curved lines by using a ruler and compass. Teaching geometric construction remains a significant challenge in many schools due to the lack of appropriate Teaching and Learning Materials (TLMs). Although fundamental tools such as compasses and rulers are essential, students often find geometric concepts abstract and disengaging. The situation is exacerbated by limited exposure to interactive tools and practical applications. Effective geometry instruction demands visualization, construction, and reasoning skills (Duval, 1998).

This research addresses a critical issue: a Grade 10 student's consistent disengagement from geometry lessons and poor performance in geometric construction. Through targeted interventions, this study explores how structured, engaging learning environments can foster better understanding and skills in geometry.

Literature Review

Mathematics isn't just about numbers. It's about critical thinking, problem-solving, and logical reasoning skills, geometrical drawing, which are vital in our day-to-day lives. Mathematical competency, including geometrical abilities, is the key to establishing a critical thinking capacity in students. It is important to produce a generation that is competent in the field of science and technology to continually progress in the era of globalization, transforming early educational methods into globalization practices. The gap between traditional teaching methods and effective learning outcomes in geometry has been widely documented. In Ghana and similar contexts,

the unavailability of interactive learning tools contributes to poor mathematical performance (Baffoe & Mmereku, 2010). Duval (1998) emphasized the need for cognitive approaches, highlighting visualization, construction, and reasoning as essential processes in learning geometry.

Digital methods such as computer-based intervention are the most attractive methods to students because knowledge of digital instruments is a crucial part of students' lives in the current world. Instructional methods such as the Concrete-Representational-Abstract (CRA) approach have proven effective in enhancing mathematical understanding and problem-solving skills (Witzel et al., 2008). These strategies encourage active participation and allow students to connect abstract concepts with real-world applications. Additionally, behaviorally rooted interventions, such as the ones used in this study, aim to improve classroom participation and focus, both crucial in mathematical comprehension.

Research Objectives

To identify specific issues affecting student engagement in geometric construction.

To implement targeted interventions to improve drawing accuracy and conceptual understanding.

To evaluate the impact of these interventions on student performance and classroom behavior.

Methodology

Data collection

This study employed an action research design focused on a single Grade 10 student referred to as "Pasindu." Data collection methods included: **Observations:** Classroom behaviors and attention levels were recorded over several weeks; **Interviews:** Conducted with Pasindu's former teacher, parent, and a peer to understand home and school influences, and **Document Analysis:** Academic records, reflection notes, and test results were examined to assess progress and patterns.

Research ethics

Data triangulation was employed, enhancing the validity and credibility of findings and mitigating research biases. The present study also followed the fundamental ethical principles of designing and implementing research, respect for society, and others. The permission was obtained, and the identification of the research participant was kept confidential.

Data Analysis and Problem Identification

Analysis of reflection notes, classroom logs, and academic documents revealed a recurring pattern of inattentiveness, lack of preparedness, and behavioral disturbances. Table 1 in the original data (column 2) shows that the primary issue—frequently observed—was Pasindu's avoidance of geometric construction tasks. Secondary issues included: Absence of required instruments; Careless handling of textbooks; Forgetfulness and non-responsiveness during Q&A; Classroom disruption and late arrival. These patterns provided the foundation for intervention design.

Intervention Plan

Concrete-Representational-Abstract (CRA) approach (Witzel et al., 2008) was used to develop intervention plans under three phases.

Phase 1: Digital Engagement

Objective: Build interest in geometric construction using laptop-based drawing tools.

Step 1: Allow drawing lines and shapes on a laptop

- Step 2: Create composite figures using digital tools
- Step 3: Transfer skills to book-based drawing

This phase capitalized on Pasindu’s interest in computers. The structured digital exercises helped shift focus toward construction principles.

Phase 2: Hands-On Instrument Use

Objective: Improve freehand skills and familiarity with instruments

- Step 1: Use design rulers for circular designs
- Step 2: Practice drawing straight lines
- Step 3: Construct curved and straight lines using standard tools

This phase introduced tactile experience with instruments and encouraged motor skills improvement.

Phase 3: Real-World Application and Group Work

Objective: Reinforce learning through physical construction and collaboration

- Step 1: Create shapes on colored paper
- Step 2: Construct angles using rope and measure
- Step 3: Solve geometry problems through group tasks

This phase introduced peer-based interaction, real-world application, and collaborative learning to sustain interest and participation.

Results and Discussion

All three intervention phases yielded positive outcomes. Pasindu demonstrated marked improvement in: Drawing accuracy, Proper use of instruments, Willingness to participate in class and Group activity contribution

Table 1

Mathematical parameters in mathematics

	Before activities	After activities
Listening to the given instructions clearly	Good	Very Good
Attractively engaged in activities	Good	Very Good
Draw the geometrical constructions with good attention	Weak	Good
Clearly use of mathematical instruments	Weak	Good
Reduce the slopy drawing and clear straight lines	Weak	Good

Note. Table 1 describes parameters focused on mathematical aspects.

At the end of the third step, it was achieved better than working in the classroom previously. It was able to attract the attention of the geometrical drawing instruments. It was a successful one to some extent. Reflection notes and practical observations confirmed that disruptions decreased, and Pasindu began completing tasks with visible motivation (constructions on the middle pages of the mathematics textbook show greater clarity than the drawings on the first few pages). Clarity of drawings, attractiveness, the role of engaging, stepwise, and familiar content was central to this transformation. The study also underscores the importance of teacher awareness of student behavior, context, and preferences. Teachers equipped with such knowledge can design personalized, scalable strategies for other disengaged learners.

Implications for Practice

This research presents a viable model for teachers working with under-performing students in geometry:

Start with learner-friendly, technology-based tools - Transition to hands-on activities - Integrate real-world contexts
- Reinforce through group learning

These methods, when applied consistently, can reshape students' relationship with mathematics and rebuild confidence in problem-solving.

Conclusion

This case study demonstrates that student-centered and technology-integrated approaches can significantly enhance engagement and performance in geometry. Educators must tailor instructional methods to student needs and leverage a variety of tools to make abstract concepts tangible. It is clearly mentioned that in this research, studying geometry helps to develop communication skills. Therefore, preparation of the student with a sound background understanding of geometry makes a base for future learning. The start of the lesson from the student's perspective is more powerful than starting the lesson where the teacher wants. It says that starting the activity with drawing shapes with a computer was a more attractive activity. Such kinds of activities are addressed in this research according to the problems identified from the first endeavor of the above-mentioned student.

The research supports the broader educational goal of developing 21st-century skills, including problem-solving, critical thinking, and collaboration. Long-term adoption of similar strategies may benefit curriculum planners aiming to reduce failure rates in mathematics.

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