DEVELOPING POSITIVE ATTITUDES TOWARDS NON-EUCLIDEAN GEOMETRY

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Abstract: This paper describes one teacher's attempts to teach critical geometry understandings to a Grade 11 class in methods that interest students and help them advance positive impressions of their capacity to master basic ideas of non-Euclidean geometries in a rigorous and symbolic way [1,2,3]. This study offers a four-week geometry intervention that connects concrete representations with symbolic expressions and figures by carefully using formal geometry language. The teacher expressed his hope that interventions like this will motivate more students to pursue advanced geometry courses in college.The study gathered information on student perceptions of their learning experiences, including impressions of non-Euclidean geometries as a subject domain, participation in activities, geometric understanding development, and classroom discourse quality. This study discovered that students appreciated classroom conversation far more than they did traditional geometry learning activities. Besides these findings have ramifications for both in-service and pre-service teacher education.

Keywords: Attitudes, confidence, high school students, non-Euclidean geometry, student perspective, teacher support.

Introduction and Background. This research examines one math teacher's efforts to teach essential non-Euclidean geometry concepts. Student attitudes toward geometry are critical to this process since early failure in geometry is likely to result in passive withdrawal from future study in the field or outright revolt [4]. As a result, non-Euclidean geometry studies may serve as a filter for further study in mathematics, hence developing positive attitudes toward the topic is critical to increasing student enrollment in advanced geometry subjects. According to researchers, early educational and socialisation processes are crucial to children's learning and perspectives, as well as their eventual engagement in education [5]. In conclusion, students' diminishing involvement in geometry can be attributed to the interaction of the following perceptions held by a growing proportion of students:

1. Geometry is regarded as dull and based on symbolic manipulation, with limited significance and little use in everyday life.
2. Geometry is viewed as difficult.

Some critical factors that have led students to perceive geometry in these ways include an over-reliance on textbook work with a procedural focus, teacher-dominated discourse, and closed learning activities that result in a lack of understanding and the ability to transfer knowledge [5].

Thus, the purposes of this work are as follows:

1. Briefly describe a non-Euclidean geometry intervention that engages students in active learning through hands-on activities and careful language use.

2. Describe the students' perceptions of the non-Euclidean geometry intervention, including whether they were engaged to think deeply and understand mathematical ideas, perceptions of fun, availability of teacher support, and how much they were challenged, the collaborative nature of tasks, and perceptions about the nature of geometry, specifically whether they saw algebra as essentially symbolic manipulation or as geometrical ideas.

Methodology. The study took a design-based research method in the form of a case study, with iterative cycles of design, implementation, analysis, and redesign. The study topics for each cycle arose from an analysis of the previous cycles' outcomes. This work focuses on the third iteration of the teaching intervention, during which the researcher and math teacher collaborated to conduct action research. The participants were 18 Grade 11 students who were chosen after taking a numeracy pre-test. These students had some prior knowledge with patterns, but little exposure to geometric symbols. The four-week intervention aimed to enhance comprehension through "Instructional Discourse" that linked physical things, spoken language, and symbolic representations. Key resources included *A Simple Non-Euclidean Geometry and Its Physical Basis*. The intervention's planned activities were broken down into three daily segments: teacher-led conversations, small group exercises, and non-Euclidean geometry activities designed to improve symbolic manipulation abilities. Data collecting methods included video-recorded observations of all 12 sessions, a Likert survey measuring eight learning aspects (such as depth of mathematical thinking, fun, challenge, and teamwork), and individual student interviews to validate survey responses. Students were also encouraged to draw visual contrasts between their intervention experiences and traditional math sessions. These interviews and drawings revealed further information about students' perceptions of the intervention's impact on their learning experience, including an increase in engagement, confidence, and collaborative problem-solving skills in geometry.

Findings. The investigation of students' opinions of non-Euclidean geometry intervention [1] is divided into three sections: survey results, interview data, and student work. The survey results (Table 1) were favorable, with students admitting that they thought more deeply about geometric, found activities enjoyable, and gained confidence. They also saw increased assistance from the teacher, more collaborative learning, and geometry as problem-solving rather than simply computation. Interviews supported these findings, with students contrasting the engaging intervention with their normal classes, where they perceived activities to be uninteresting and repetitious, frequently disrupted by colleagues who had "given up" on learning. Many students agreed that disruptive classmates would benefit from similar intervention-based instruction. Students liked teacher and peer help during the intervention, and collaborative learning was encouraged over time. Most students found that using actual things (such as tea cup and ball) helped them comprehend non-Euclidean geometry by providing physical representations that made topics more apparent and enjoyable [3]. Some students, such as Aisha, finally

found diagrams sufficient, whilst others, such as Ahmed, believed materials made learning feel easier, which he connected with less effort required. Student work indicated conflicting emotions during the intervention and normal classes.

Table 1:

Summary of Student Perceptions Survey Results

Learning attribute	Mean ($n = 18$)	SD (σ)
Collaborative learning	4.39	0.37
Confidence to understand	4.57	0.43
Depth of thinking	4.48	0.44
Task challenge	4.22	0.47
Teacher support	4.62	0.53
Nature of geometry	4.22	0.54
Fun and interest	4.48	0.63

One student, Ali, described how his enthusiasm dwindled in traditional math sessions, whereas he found the non-Euclidean geometry lesson to be straightforward and fascinating. This visual and verbal feedback emphasized students' preference for active, hands-on learning supported by concrete objects and collaborative activities.

Discussion and Conclusion. This section emphasizes the positive influence of a specialized geometry class in which students worked hard on geometrical challenges, engaged in meaningful debate, and demonstrated high-quality collaborative learning. Unlike traditional classes, which students frequently found boring and too focused on repetitious symbolic manipulation, this intervention employed actual objects and visual aids to integrate geometric concepts with real knowledge, a strategy advocated by several scholars. Students liked peer and teacher support, which encouraged confidence and a greater feeling of their capacity to learn geometry. Students said that these activities made non-Euclidean geometry more approachable, entertaining, and focused on problem solving rather than rote rules. This is significant because favorable math experiences frequently inspire future study in geometry. Furthermore, students indicated that disruptive behaviors, which were typical in regular courses, were less of an issue here, thanks to the lower-class size and engaging tasks that kept them engaged. The study's findings indicate that the use of hands-on materials, activities, and supportive instructional language enhanced student impressions of math while also reducing classroom management concerns. The author suggests broadening this pedagogical approach to mixed-ability courses and emphasizing the necessity of similar teaching tactics for pre-service and in-service teacher education. This technique can help alter students' perspectives on non-Euclidean geometry from rigid rules to an inquiry-based, fascinating subject that fosters comprehension and confidence.

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TEACHING EUCLIDEAN GEOMETRY AND INTRODUCING SOME NON-EUCLIDEAN GEOMETRIES: ENHANCING HIGH SCHOOL STUDENT ENGAGEMENT

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Abstract: This study explores the impact of introducing non-Euclidean concepts within a high school Euclidean geometry curriculum to enhance student engagement and deepen understanding. By examining student behaviors and responses to non-Euclidean examples, we aim to assess the effectiveness of incorporating diverse geometric perspectives. The study employed a mixed-methods approach, with qualitative observations and quantitative assessments, to evaluate student engagement and comprehension changes. Findings indicate that integrating non-Euclidean geometries can foster curiosity and critical thinking, enriching the learning experience.

Keywords: Engagement, Euclidean, curriculum inclusion, high school students, non-Euclidean, mathematics education.

Introduction. Geometry is a unique subject of mathematics and the oldest of all disciplines, dating back at least to the time of Euclid and other "natural philosophers" in ancient Greece. Geometry was first studied to understand the physical world we live in better, and this practice continues to this day. Geometry is a fundamental component of mathematics education, usually beginning with Euclidean principles due to their simplicity and historical significance. However, teaching only Euclidean geometry may limit pupils' exposure to other mathematical frameworks. Non-Euclidean geometries, such as Galilean and Taxicab, provide novel viewpoints that might push students to look beyond conventional frameworks.