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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.

This study investigates whether introducing non-Euclidean geometry alongside Euclidean geometry will increase student engagement and foster a deeper knowledge of geometric ideas in high school.

Literature Review. The literature emphasizes the importance of Euclidean geometry in high school curricula and the possible benefits of including non-Euclidean notions. The research [1] examines how high school students understand geometric ideas, focusing on typical obstacles and misconceptions. The paper emphasizes the necessity of using visual aids and active learning strategies to promote comprehension, and it recommends that educators confront misconceptions directly to improve students' geometric thinking. In the paper titled Weaknesses of Euclidean Geometry: A Step of Needs, the authors of the analysis of non-Euclidean Geometry Learning using an Ethnomathematics Approach underline the importance of connecting mathematics education to real-world contexts to improve students' understanding [2]. However, [3] discusses the issues of teaching geometry and reviews the existing literature on geometry education, such as the utilization of inquiry-based learning, academic talent profile, and the impact of various teaching approaches on student performance. The paper finishes by advocating for a full reevaluation of geometry education, highlighting the relevance of dynamic teaching strategies, technology integration, and curricular change in making geometry more accessible and exciting for students. This study [4] investigates the incorporation of the Galilean plane into the affine plane, emphasizing its geometric parallels to the Euclidean plane. It underlines the similarity between cycles in the Galilean plane and circles in the Euclidean plane and provides an alternative, intuitive definition of circles based on inscribed angles. The paper calls for including Galilean geometry in high school curricula, arguing that exposure to multiple geometric systems broadens students' mathematical viewpoints and fosters a deeper interest in geometry. This study [5] emphasizes the growing importance of modern teaching approaches in mathematics education, explicitly introducing non-Euclidean geometry concepts to help students develop their spatial imagination and scientific inquiry. Its goal is to engage secondary and high school students by exposing the exciting world of non-Euclidean geometries, beginning with a current understanding of geometry. The purpose is to increase interest and comprehension of geometry, particularly among exceptional students. After providing a quick explanation of the axiom concept, [6] explores it from a new perspective. We visually perceive important principles in Euclidean geometry; in the most basic sense, you'll learn why this subject, which follows reason and logic, can often become unworkable in non-Euclidean geometry. As a result, you'll believe that new frontiers in geometry will emerge. Galilean geometry, taxicab geometry, and finite point geometry are not commonly utilized. It is critical to present non-Euclidean geometry and ways for teaching it to future mathematicians. In this paper [7], the author highlighted the findings and approaches that have emerged in this subject, opening up new avenues for the study of non-Euclidean geometry.

Methodology. This study employed a mixed-methods approach to investigate how introducing non-Euclidean geometry affects high school students' interest and knowledge. Twenty-four tenth-grade students (12 females and 12 males) were

randomly allocated to either a control group (Euclidean geometry only) or an experimental group (Euclidean and non-Euclidean geometry). Over four weeks, both groups got typical Euclidean teachings, but the experimental group also studied fundamental Galilean and Taxicab geometry. The experimental group engaged in group discussions and visual exercises. As instructional content, both groups were introduced to the basics of Euclidean geometry (week 1). The experimental group was introduced to non-Euclidean content, which included differences in distance concept, angle sums in triangles, and cycles (weeks 2-3). Includes review and application exercises for both groups. The experimental group conducted comparisons of Euclidean and non-Euclidean geometries (week 4). Data gathering methods included pre- and post-tests on geometry understanding, engagement questionnaires, and observational logs of activities such as question-asking and peer discussion. Pair t-tests were utilized for numeric data and thematic coding for qualitative observations, emphasizing engagement indicators such as curiosity and critical thinking.

Findings and Discussion. The results showed that the experimental and control groups differed significantly regarding understanding and involvement. These findings show that students' interest and knowledge of geometry can be enhanced by including non-Euclidean geometry ideas in Euclidean training.

The engagement survey results revealed significant interest, motivation, and confidence increases in the experimental group. Table 1 depicts these differences. Observational data supported this tendency, with experimental group students asking more questions and having more frequent peer discussions. Analysis of pre- and post-test scores revealed a significant gain in knowledge for the experimental group. The experimental group improved by 21 %, while the control group improved by only 8 % on average.

Table 1: Pre- and Post-Test Scores		Control Group	Experimental Group
Pre-Test		62 %	64 %
Post-Test	only E^2	70 %	85 %
Improvement		+8 %	+21 %

These findings indicate that exposure to non-Euclidean geometries improves the grasp of fundamental geometric ideas. Gender-specific analysis revealed that male and female students in the experimental group saw comparable increases in engagement and comprehension, implying that non-Euclidean notions can benefit students of all genders. Observational logs and post-study interviews revealed that students were excited and curious about non-Euclidean geometry. Students indicated enthusiasm for learning something "new and strange" in mathematics, with several stating that they felt more motivated to study standard Euclidean subjects in light of the new perspectives offered.

Table 2 demonstrates that the experimental group had higher average ratings in each metric, showing that adding non-Euclidean notions improved student interest in high school geometry.

Table 2: Engagement Survey Results		Control Group	Experimental Group
Curiosity		3.2	4.4
Motivation	(1=Low, 5=High)	3.4	4.1
Confidence		3.1	4.0

These findings imply that using non-Euclidean geometry can improve student engagement and comprehension [8,9,10]. The unfamiliarity of non-Euclidean notions may pique students' interest, leading them to critically examine and investigate underlying geometric principles. This is consistent with contextual learning theories, which suggest that challenging current knowledge frameworks might lead to a better understanding. However, the increased complexity presented difficulties for specific students, particularly those who struggled with fundamental Euclidean concepts. Scaffolding and straightforward instructional tactics were required to guarantee students could comprehend the differences across geometric systems without becoming overwhelmed.

Conclusion. Incorporating non-Euclidean geometries into high school geometry curricula provides an excellent chance to increase student involvement and critical thinking. This study shows that, while balancing Euclidean and non-Euclidean notions is challenging, the benefits of a more comprehensive approach to geometry teaching are significant. Students exposed to numerous geometric systems demonstrate higher class involvement and a more thorough comprehension of geometric ideas. Many distinct subfields of geometry are being investigated. Even after a thousand years, geometry is as alive and exciting as ever. And there is no indication of it slowing.

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ANALYSIS OF THE DEVELOPMENT STATE AND FACTORS OF THE SERVICE INDUSTRY IN THE REPUBLIC OF KARAKALPAKISTAN

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Abstract: At the current stage of the economic development of our country, high demands are placed on the quantity and quality of services. The implementation of the experience of leading foreign countries ensures the growth of demand for services. To increase economic efficiency in service enterprises, to create certain organizational and economic conditions to increase the quality and competitiveness of services by modernizing and diversifying modern branches of the industry, to increase the level of population employment, to form consumer demand for services and fully satisfy their needs, based on modern, digital technologies development of service networks is one of the important issues. Therefore, the article discusses the analysis and factors of the development of the service industry.

Key words: service, service provision, gross domestic product, resource base.

Introduction

Development of the service sector of the Republic of Karakalpakstan is an important direction of achieving socio-economic stability. Because the need to develop enterprises and organizations in the service sector is directly related to the level of intensive development and is an important factor in solving the issues of the standard of living, quality and employment of the population.

According to the main indicators of the regional development of the Republic of Karakalpakstan, the volume of the gross regional product has stable growth dynamics and its growth rate in 2018 was 105.8%, and the growth rate in 2022 was 104.0%. According to the growth dynamics of the volume of total services in the region compared to last year, in 2018 it increased by 106.3%, and in 2022 this indicator increased by 106.0%. In this case, the volume of gross product in the