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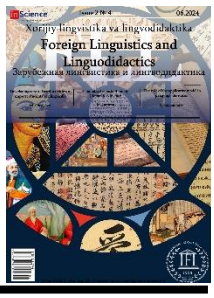

Enhancing critical thinking and problem-solving skills in high school mathematics through GeoGebra

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ABSTRACT

This article examines the role of GeoGebra, a dynamic mathematics program, in developing high school students' critical thinking and problem-solving skills. The author examines how GeoGebra's interactive and visual features help educators create effective learning environments for mastering geometry concepts. The program promotes the expansion of traditional teaching approaches by integrating dynamic mathematical systems. Hands-on explorations and challenges in GeoGebra allow students to deepen their knowledge of mathematics and develop the ability to manipulate and visualize geometric objects while providing instant feedback.

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GeoGebra dasturi orqali umumta’lim maktab matematikasida tanqidiy fikrlash va muammoni hal qilish qobiliyatlarini rivojlantirish

Kalit so‘zlar:
tanqidiy fikrlash,
muammoni hal qilish,
GeoGebra,
geometriya,
ko‘rish,
matematika.

ANNOTATSIYA

Umumta’lim maktab matematika sohasida tanqidiy fikrlash va muammoni yechish ko‘nikmalarini rivojlantirish juda muhim hisoblanadi. Ushbu maqola dinamik matematika dasturi GeoGebraning bu ta’lim maqsadlariga erishish uchun kuchli vositasiga qanday e’tibor qaratilishini tahlil qiladi. GeoGebra interaktiv va vizual imkoniyatlaridan foydalanib, pedagoglar o‘quvchilar uchun geometriya tushunchalarini o‘rganish uchun qiziqarli muhit yaratishlari mumkin. Bu metodologiya o‘qitish usullaridan tashqari, dinamik matematik tizimlarini o‘rganish jarayoniga integratsiya qilish orqali so‘nggi tahlil va

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muammolar yechish mashqlari orqali o‘quvchilar matematik asoslarini yanada chuqur o‘rganadi va geometrik shakllarni boshqarish va vizual ma’lumotlar orqali tasavvur qilishdan ma’naviy ko‘nikmalarini rivojlantiradi.

Развитие критического мышления и навыков решения задач в математике средней школы с помощью GeoGebra

Ключевые слова:
критическое мышление,
решение проблем,
GeoGebra,
геометрия,
визуализация,
математика.

АННОТАЦИЯ

В данной статье исследуется роль GeoGebra, динамической математической программы, в развитии критического мышления и навыков решения проблем у старшеклассников. Автор анализирует, как интерактивные и визуальные функции GeoGebra помогают педагогам создавать эффективные учебные среды для освоения геометрических концепций. Программа способствует расширению традиционных подходов к обучению за счет интеграции динамических математических систем. Практические исследования и задачи в GeoGebra позволяют учащимся не только углубить свои знания в математике, но и развить способность управлять и визуализировать геометрические объекты, обеспечивая мгновенную обратную связь.

INTRODUCTION

In contemporary education, the cultivation of critical thinking and problem-solving skills stands as a cornerstone of effective learning, particularly in disciplines like mathematics. High school mathematics programs strive not only to impart foundational knowledge but also to equip students with analytical abilities essential for their academic and professional futures. In this context, educational technologies have emerged as powerful partners, transforming traditional teaching methods by integrating interactive and dynamic tools into the learning process. Among these technologies, GeoGebra, a versatile software suite designed for mathematics education, has garnered attention for its ability to enhance student engagement and conceptual understanding through visual and interactive explorations of mathematical concepts. Through its interactive platform, GeoGebra offers educators innovative means to foster deeper learning and mastery of geometric and algebraic concepts, thereby preparing students to meet the challenges of a rapidly evolving technological landscape.

LITERATURE ANALYSIS

Technology integration have been implemented in educational practices, such as various observations, simulated experiments, and curriculum integrations as well. The advantages of teaching with technologies in the science classroom include more effectively delivering the dynamics of geometric shapes through multimedia animations, enabling representative scientific thinking, and enhancing support for changing teachers’ roles [1]. According to scientists, these days teachers are urged to develop learners with

relevant modern skills that match the needs of our changing world [2]. The majority of teachers have acquired firsthand knowledge of IT through teacher training programs or workshops. Despite the available resources, a significant number of school teachers still show limited interest in integrating IT into their teaching practices.

RESEARCH METHODOLOGY

The main purpose of this study was to investigate the effect of GeoGebra in the teaching and learning of mathematics in Andijan schools. The objective of this study was to determine the effectiveness of using GeoGebra on students' learning of graphs as compared to the traditional approach. The experimental research in which pre-test-post-test not equivalent control group design was used to examine the effectiveness of GeoGebra software in teaching and learning mathematics.

ANALYSIS AND RESULTS

GeoGebra is a powerful educational tool that enables students to visualize mathematical concepts, manipulate variables, and dynamically interact with geometric constructions and algebraic representations (Figure 1). It provides a platform where students can experiment with mathematical ideas, test hypotheses, and explore relationships visually and intuitively. By bridging the gap between abstract concepts and real-world applications, GeoGebra helps students develop a deeper understanding of mathematical principles.

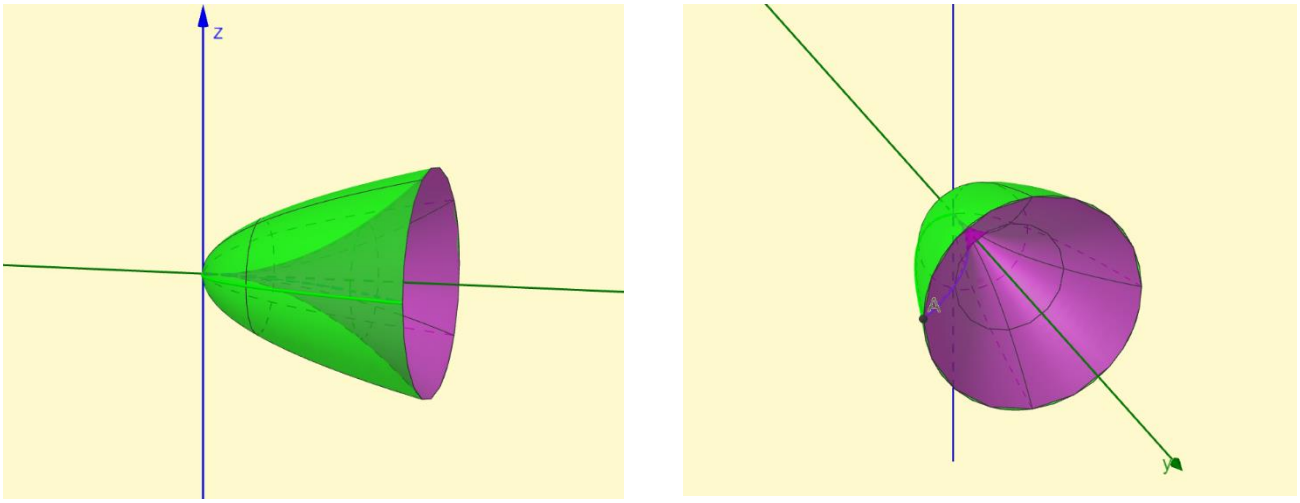

Figure 1. Animation of algebraic function.

Cultivating Critical Thinking

Critical thinking involves analyzing information, evaluating arguments, and making informed decisions. In mathematics, it manifests as the ability to reason logically, identify patterns, and apply problem-solving strategies. GeoGebra supports critical thinking by encouraging students to:

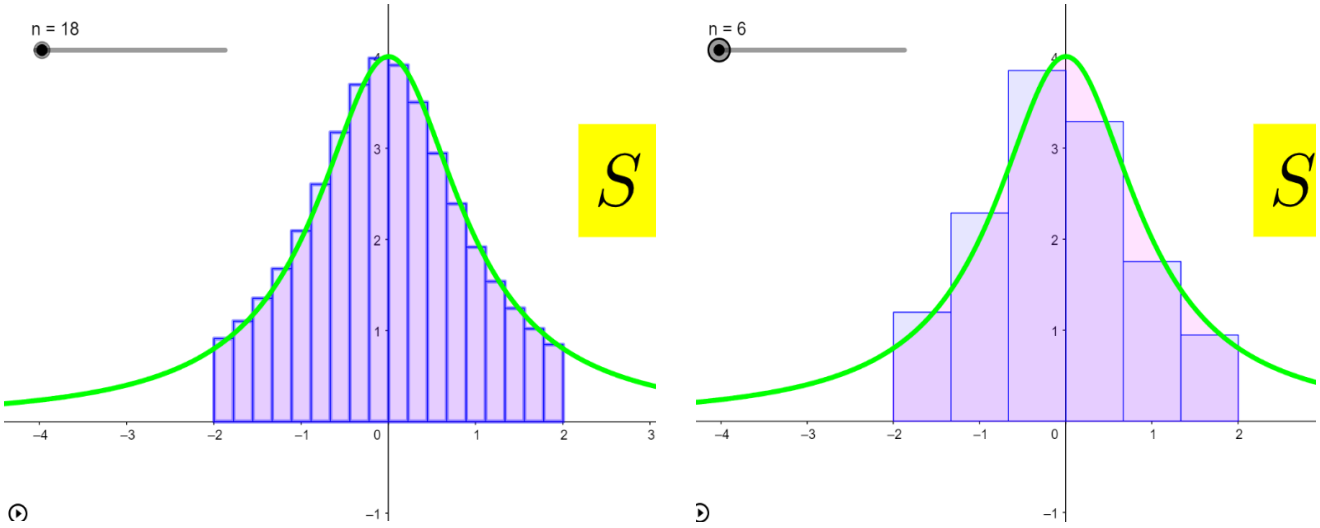

Figure 2. Calculate the surface in terms of an integral.

Explore Mathematical Relationships: Through interactive graphs (Figure 2) and geometric constructions, students can visualize how changes in variables affect outcomes, fostering a deeper understanding of mathematical relationships.

1. **Formulate and Test Hypotheses:** Students can create conjectures about mathematical properties or relationships and use GeoGebra to test these hypotheses through dynamic simulations and experiments (Figure 3).

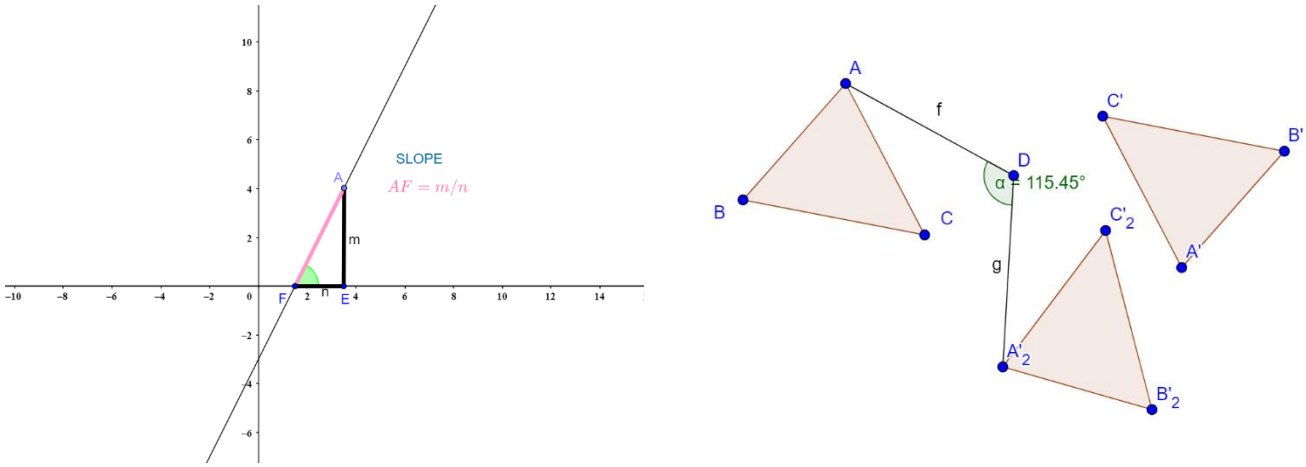

Figure 3. Dynamic graphs using GeoGebra.

2. **Analyze Data and Evidence:** GeoGebra allows students to input data, generate graphs, and interpret results, promoting analytical thinking and data-driven decision-making (Figure 4).

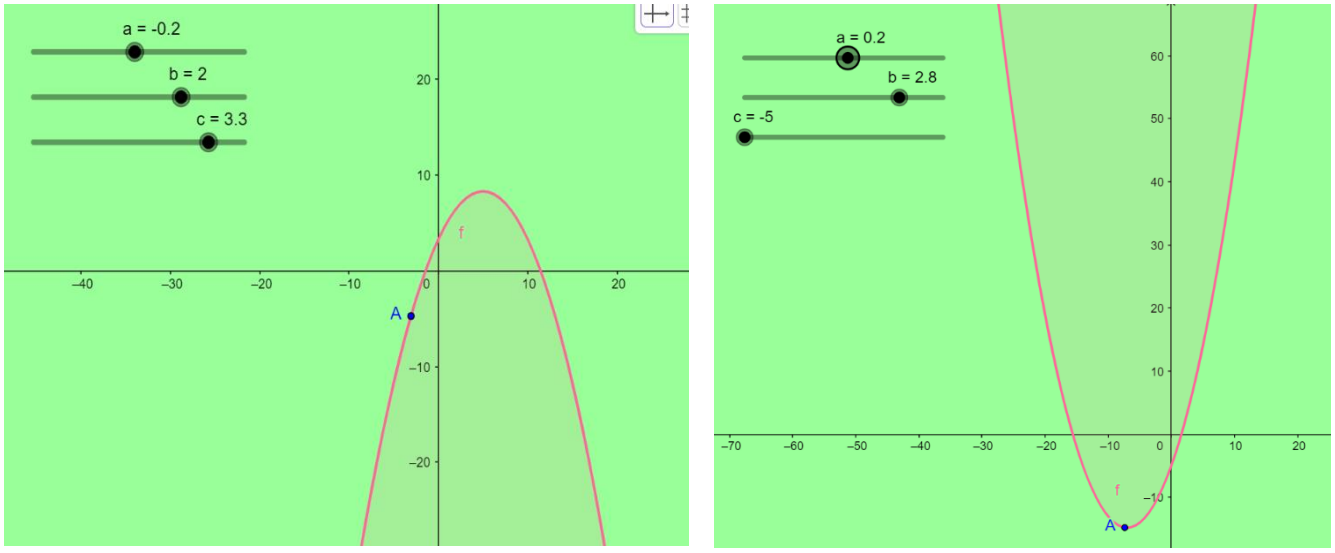

Figure 4. Changes of functions' graphs.

Enhancing Problem-Solving Skills

Problem-solving is a fundamental skill in mathematics that extends beyond finding solutions to specific questions. It involves identifying problems, devising strategies, and persisting through challenges. GeoGebra enhances problem-solving skills by:

Visualizing Problem Scenarios: Students can model complex problems using geometric constructions and algebraic equations, gaining insight into problem structures and potential solution paths.

Iterative Approach: GeoGebra supports an iterative problem-solving process where students can modify variables, adjust parameters, and refine their solutions based on real-time feedback from the software.

Collaborative Learning: GeoGebra's sharing and collaboration features enable students to work together on problem-solving tasks, fostering teamwork and collective problem-solving strategies.

Case Studies and Research Findings

Numerous studies have documented the positive impact of GeoGebra on students' mathematical learning outcomes. Research indicates that students who use GeoGebra show improvements in conceptual understanding, problem-solving skills, and overall mathematical proficiency compared to those using traditional methods alone. Case studies also highlight increased engagement and motivation among students, attributed to the interactive and exploratory nature of GeoGebra.

CONCLUSIONS AND RECOMMENDATIONS

Incorporating GeoGebra into high school mathematics education holds immense potential for nurturing critical thinking and problem-solving skills among students. By providing a dynamic and interactive learning environment, GeoGebra empowers students to explore mathematical concepts deeply, make connections across different branches of mathematics, and develop the flexibility and creativity necessary for tackling real-world challenges. As educators continue to innovate with technology-enhanced learning tools like GeoGebra, they pave the way for a generation of mathematically proficient and critically-minded individuals ready to contribute to an increasingly complex world.

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