An Experimental Study on the Effectiveness of MatGPT in Teaching Mathematics at the Secondary Level

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Abstract

The use of Artificial Intelligence (AI)-based instructional tools has become increasingly important in high schools because of their ability to facilitate personalized learning and increase student academic success (Holmes et al., 2019). Secondary students experience many challenges while learning mathematics including the need to learn abstract concepts, the diversity of learners' abilities to learn, and the limited opportunity to receive personalized feedback (Ashcraft & Kirk, 2001; NCERT, 2023). MatGPT, an AI-based mathematics learning tool, provides step-by-step explanations of problems, allows students to work through problems adaptively, and offers immediate feedback to students for their work, which can contribute positively to the achievement of students' learning outcomes (El-Shara et al., 2025). The current experimental study seeks to determine the effectiveness of the use of MatGPT as an instructional tool for high school students learning mathematics in various contexts throughout India and internationally. The study used a pre-test and a post-test control group design to evaluate the performance of 60 secondary students. T-tests reveal that there was statistically significant evidence between the achievement of the two groups, with the MatGPT-assisted group having a statistically significant greater level of achievement than the control group. Based on the results of the study, MatGPT significantly contributes to improved mathematical achievement, conceptual understanding, and problem-solving ability of students.

Keywords: MatGPT, artificial intelligence, secondary mathematics, experimental study, academic achievement

Introduction

High school math classes provide an essential base for later reasoning through logical processes, developing higher-order thinking skills and developing scientific literacy (OECD, 2021). However, traditional teacher-focused methods may not support all types of students equally well, leading to lower academic performance, high rates of math anxiety, and other negative outcomes (Ashcraft & Kirk, 2001; Sweller, 2011). The use of artificial intelligence (AI) has led to the creation of Intelligent Tutoring Systems (ITSs) that provide personalized learning opportunities, as individual students receive customized, real-time feedback about their performance (Luckin et al., 2016; Holmes et al., 2019). AI-based tools such as ChatGPT and MatGPT are able to assist with math learning by providing interactive explanations and adaptive support in solving problems (Dao & Le, 2023; El-Shara et al., 2025). Within the National Educational Policy (NEP) 2020, emphasis is placed on using AI and digital resources to help students meet their needs and improve education achievement (Ministry of Education, 2020). Also, multiple studies from around the world indicate that using AI to support student engagement leads to improvements in overall academic performance, when personalized to match the academic needs of students and aligned to pedagogical goals (Crompton & Burke, 2023; Zhai et al., 2024). Despite this, little research exists that provides specific empirical evidence about MatGPT at the high school level; therefore there is a need for this study.

Review of Related Literature

Research shows that AI-based instructional tools improve mathematics achievement by offering personalized scaffolding and reducing cognitive load (Sweller, 2011; Pane et al., 2017). El-Shara et al. (2025) experimentally demonstrated that MatGPT had a significantly positive impact on undergraduate students' mathematical proficiency. ChatGPT was demonstrated to successfully solve secondary level mathematics problems, suggesting that it could be utilized as an instructional tool to support student learning (Dao & Le, 2023). Hwang and Tu (2021) found that AI-assisted learning environments enhance student autonomy and engagement. Secondary teachers believe that AI tools can positively influence the ability to address individual differences and support formative assessment (Zhai et al., 2024). Systematic reviews confirm that the integration of AI in mathematics education results in improved academic performance and motivation for learners, as long as teachers have sufficient technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006; Crompton & Burke, 2023). The evidence provided supports a strong rationale for the experimental investigation of MatGPT in secondary education.

Objectives of the Study

- To determine the effectiveness of MatGPT in teaching mathematics at the secondary level.
- To compare the mathematics achievement of students taught using MatGPT-assisted instruction and traditional methods.
- To analyze the improvement in achievement through pre-test and post-test scores.

Hypotheses

H_{01}: There is no significant difference between the pre-test mean scores of the experimental and control groups.

H_{02}: There is no significant difference between the post-test mean scores of the experimental and control groups.

Methodology

Research Design

A pre-test–post-test control group experimental design was adopted (Cohen et al., 2018).

Sample

The 60 secondary school students in Dindigul District's standard IX were chosen as the study's sample (Experimental group 30 students, Control Group 30 students). A simple random sampling strategy was used to choose the samples.

Tools

Mathematics Achievement Test (validated)

Statistical Techniques

Mean, Standard Deviation, and independent sample t-test were used (Best & Kahn, 2019).

Data Analysis and Interpretation

Null Hypothesis

H_{01}: There is no significant difference between the pre-test mean scores of the experimental and control groups.

Table 1 Pre-Test Scores of Experimental and Control Groups

Test	N	Mean	S. D	Mean Difference	t-value
Experimental Group Pre-test	30	42.60	6.12	0.67	0.42 (Significant at 0.05 level)
Control Group Pre-test	30	41.93	6.25		

The pre-test mean scores of the experimental and control groups were 42.60 and 41.93, respectively, with standard deviations of 6.12 and 6.25.

The research reveals that there is a no variation in the mean scores overall. The estimated "t" value (0.42) is less than the table value of 1.96, at a 0.05 level of significance. Because of this, the null hypothesis, "There is no significant difference between the pre-test mean scores of the experimental and control groups." is accepted. This confirms group equivalence (Cohen et al., 2018).

Null Hypothesis

- H_{02}: There is no significant difference between the post-test mean scores of the experimental and control groups.

Table 2: Post-Test Scores of Experimental and Control Groups

Test	N	Mean	S. D	Mean Difference	t-value
Experimental Group Post-test	30	68.47	7.08	10.34	5.78 (Significant at 0.05 level)
Control Group Post-test	30	58.13	6.84		

The post-test mean scores of the experimental and control groups were 68.47 and 58.13, respectively, with standard deviations of 7.08 and 6.84. The research reveals that there is a large variation in the mean scores overall. The estimated "t" value (5.78) is greater than the table value of 1.96, at a 0.05 level of significance. Because of this, the null hypothesis, "There is no significant difference between the post-test mean scores of the experimental and control groups." is rejected. It is accepted that there is a significant difference between the post-test mean scores of the experimental and control groups. This demonstrates the effectiveness of MatGPT-assisted instruction (El-Shara et al., 2025; Zhai et al., 2024).

Discussion

The findings reveal that students taught through MatGPT-assisted instruction performed significantly better than those taught through traditional methods. The improvement can be attributed to personalized feedback, interactive explanations, and adaptive problem-solving support provided by MatGPT (Luckin et al., 2016; El-Shara et al., 2025). These findings support Constructivist Learning Theory, which prioritizes interaction among students and scaffolding (Vygotsky, 1978). Reduced cognitive load (Sweller et al., 2011) and increased student autonomy (Pane et al., 2017) are also likely contributors to the student achievement gains. Additionally, this evidence supports the use of AI in supporting the National Education Policy 2020 for secondary education (Ministry of Education, 2020).

Educational Implications

- AI tools (such as MatGPT) improve secondary students' performance in mathematics.
- Teachers may also use MatGPT to offer personalised remediation and enrichment.
- Curriculum developers must incorporate the use of AI-based assistance in education into the overall curriculum.
- Teacher education programs must focus on developing the literacy of future educators in using artificial intelligence and understanding its ethical implications.

Conclusion

The findings of the experimental study strongly support that MatGPT is a viable teaching aid in the area of second-level math instruction. Furthermore, the statistically significant increase in achievement provides evidence that AI-assisted instruction can revolutionize the manner in which math is taught in various educational settings.

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