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INVESTIGATING THE EFFECT OF AI-POWERED LEARNING TOOLS ON ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS IN MATHEMATICS

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Abstract

The application of AI has been disrupting the way teaching is being done particularly in mathematics. AI-Powered tools can be used to enhance learning among students. The purpose of conducting this study was to determine how the use of AI teaching tool influences academic performance of high-school students in math. The aims of this research were, to determine the effect of AI powered tools on the academic performance of the student in mathematics, to compare the academic performance on basis of pre and post-tests of, i) both the experiment group and control group, ii) High achievements and low achievers of the experiment group, iii) High achievements and low achievers of the control group. On the basis of the above objectives, null hypothesis was tested. Students of The East School Jehangira District Nowshera 60 (30 as experimental and 30 as control group) of grade IX were selected to take up the study. There was the use of experimental research design to compare the performance of students taught using AI-based tools with traditional teaching. Pre- and post-tests had been used to collect data to determine whether there was an increase in student achievement. The data was calculated using analyzes such as descriptive data such as mean SD variance and inferential data such as t-test to test hypothesis. The research results show that AI has stronger effects on the academic performance of students compared to the traditional approach of the teaching process through the use of AI power tools (GeoGebra) have achieved significant favourable influence on the student performance in mathematics, Thereby the researchers suggested that teachers need to consider AI powered (tools/GeoGebra) as alternative teaching method of learning and visualizing geometrical concepts in the secondary level. The effect of it can also be examined in academic achievement of male community/private students next.

Keywords: AI-Powered Tools, Academic Achievement, Secondary School Students, Mathematics, GeoGebra

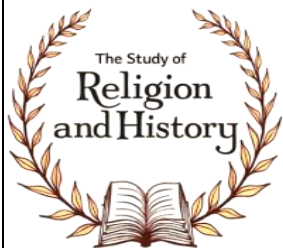
Statement of the Problem

The teaching of mathematics in secondary schools in Pakistan has a number of problems such as big classes, no personalized instructions and poor teaching materials. These problems can be discussed with the latent of AI-powered tools, which can offer modified learning experiences, real-time response, and automatic assessment. Nonetheless, there is a scarcity of practical knowledge on the extent to which these tools are practical in enhancing student learning. The aim of the study is to provide insight into the advantages of using AI-powered tools in mathematics classrooms in secondary schools and evaluate the impact of these tools on the student achievement.

Objectives of the Study

The primary purposes of the current research were;

(i) To examine the academic achievement of the experimental and the control group based on



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pre-test and post-test.

(iii) To find the academic achievement not only of high achievers but of low achievers of experimental group on the basis of pretest and post-test.

(iv) To determine the academic achievement of the high achievers and low achievers of control group on pretest and post-test basis.

Hypotheses

To achieve the above objectives, subsequent hypotheses were tested:

H01: There is no substantial difference between the mean achievement scores of controls and experimental group on pre-test. H02: There is no substantial difference between the mean achievement scores of controls and experimental group on post-test. H03: There is no substantial difference between the mean achievement scores of high achievers of control group and investigational groups on pretest

H04: There is no substantial difference between the mean achievement scores of high achievers of control group and investigational group post-test.

H05: There is no substantial difference between the mean achievement scores of low achievers for control and investigational groups of pre-tests.

H06: There is no substantial difference between the mean achievements scores of low achievers for control and investigational group post-test.

H07: There is no substantial difference between the mean achievements scores of investigational groups on pretest and post-test.

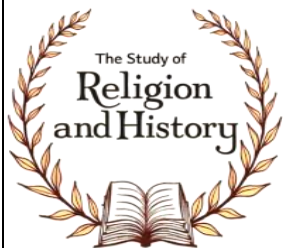
H08: There is no substantial difference between the mean achievement scores of control group on pre-test and post-test.

H09: There is no substantial difference between the mean achievement scores of high achievers for investigational group or pretest and post-test.

H010: There is no substantial difference between the mean achievement scores of low achievers for investigational group on pretest and post-test.

Significance of the Study

It will provide important insights into the possible effect of the AI technology on ornamented mathematics education. The findings will guide teachers, the policy makers and technology creators in terms of how to creatively integrate AI tools in school. The general aim of this study will be to give an insight into the effects of AI-enabled tools and hence, enable us to enhance our methods of instruction, and student involvement and learning in mathematics. This is an experimental study that was done to observe the effect of GeoGebra supported instruction on mathematics achievement and geometric thinking of the students. This learning is relevant to the mathematics instruction and research may prove useful in bringing GeoGebra mediated lesson in mathematics teaching in the Pakistani education



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system. The given study will be applicable to the needs of the total mathematics teacher community to adjust their answers to the requirements in the guidance on GeoGebra algebraic assisted instructions and mathematical thinking. Indeed, as GeoGebra is highly designed to meet the high school mathematics and in particular algebra, geometry and calculus, so too, the creators of the high/higher Mathematics program in Pakistan might consider integrating this software etc. into the prospectus of mathematics as supplementary tools of learning mathematics.

Delimitation of the Study

This research will be restricted to the district Nowshera, further restricted to secondary schools, further restricted to girl secondary schools. The present study will be further limited to Nowshera, The East school and college (girls campus) Jehangira District Nowshera.

Introduction

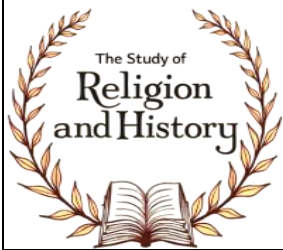
Very limited research has been conducted on the effectiveness of AI powered tools in secondary level (I Kaushal Kumar Bhagat & Chun-Yen Chang, 2014) compared the effect of using the free educational database application, GeoGebra on 9th grade student mathematics achievement when learning geometry. The study by Rashmi Khazanchi (2024) on the effectiveness of Edmentum Exact Path, an AI-based technology, to refine the mathematical success and affective and cognitive engagement of 8th-grade pupils in the Southern United States was done, but there was no research in the area regarding schools in the private sector of Khyber Pakhtunkhwa. The study will also give an insight in effectiveness of AI Powered tool (GeoGebra) in mathematics teaching.

Review of Literature

Technology is a major inclusion in the teaching and learning process because it is one of the major aids that may be critical in enhancing the teaching process and the interaction with the student. The perception and adoption of technological applications in learning institutions has been at a disturbing pace in the past years and has removed traditional classroom activities. Special-purpose software designed to support mathematics education has been developed by different developers, including GeoGebra, Geometers Sketchpad and Mathematica. This type of tools is specifically developed to assist learners in visualization of abstract mathematical concepts and also to explore relationships dynamically.

The growth of broad professional development opportunities and training have been established in the introduction of educators to the pedagogical possibilities of GeoGebra as an interactive instructional means with regard to its efficiency. GeoGebra has, therefore, emerged as a powerful tool enabling teachers to create interesting, student centered and activity based lessons, therefore, enabling active learning and improved conceptualization in mathematics classes.

Student attitude towards mathematics is an outcome of multiple interacting issues including the quality of teaching materials, classroom learning behavior, teacher personality and level of knowledge on mathematics subject (Yilmaz Altun and Olkun, 2010). In addition, such a factor as the relation between the concept of mathematics and the real life and the methods used in classroom also play a significant role in the creation of the attitude of the students towards the subject matter (Papanastasiou, 2000). The



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abstract nature of mathematics and the application of symbolic reasoning, equations and abstract ideas are other attributes that learners feel make mathematics to be a very challenging subject. As a result, majority of students cannot enjoy any fruitful engagement with complex mathematics particularly in the face as classroom environment where in most cases teaching is teacher centered.

The growing availability of multimedia and digital technologies has proven to be very promising as a solution to these learning problems by offering alternative representations and interactive learning facilities. However, mathematics teaching is a unique issue because the teacher should effectively integrate cognitive, physical and digital materials to deliver abstract mathematical ideas to students that they tend to fail in visualizing and comprehending (Prieto, Sordo Juanena, and Star, 2013). The significance of technology in education growth and optimization of teaching trends has always been mentioned (Gursul and Keser, 2009). Consequently, mathematics special software platform such as GeoGebra, Geometers Sketchpad, and Mathematica should be utilized to their maximal pedagogical potential to advance student learning and teaching. Technology in this case is not merely a medium that modifies the content of instruction and the learning goals, but is an effective tool of making the teaching-learning process enriching, and conceptual knowledge facilitation (Voogt, 2008).

In particular, GeoGebra is a famous and helpful illustration of an online tool in the instructional process of mathematics. According to Hohenwarter (2008), GeoGebra is an interactive mathematics program which was created with the objective of teaching and learning algebra and geometry. It is a Web-based open source and is usually used in primary and secondary school to assist students learn geometry, algebra and calculus (Abramovich, 2013). Even though it can be taught in any classroom, past research had found that little was studied to examine the acceptance and adoption of technological platforms such as GeoGebra among students in mathematics classrooms (Li, 2007) though it is ubiquitous and can be used in education.

Method and Procedure

The research was of experimental nature, pre-test post-test design where experimental and control group were utilized and intended to explore the impact of AI driven tool (GeoGebra) on Hypothetical Achievement of Students in Mathematics at.

The East School and College Jehangira.

Population

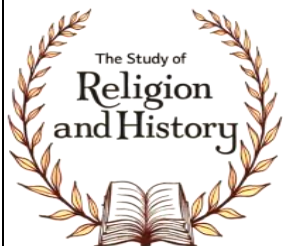
The sample size used in this study was 303982 female learners studying in high schools in Khyber Pakhtunkhwa in the academic year 2025-2026. The research targeted these students because they form the target population in this study.

Sample

A sample of sixty students (grade-9) of The East school and college Jehangira was chosen in random and separated into experimental and control group using pair random sampling basing on the pre-test scores.

Research Instrument

The research tools utilized in the study to gather the data included a post-test and pre-test. The tests consisted each of fifty



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multiple choices questions, each consisting of the well-constructed products of Chapter 17, titled Practical Geometry: Triangles. The chapter is selected because it is a Grade IX Mathematics textbook that is prescribed and published by Khyber Pakhtunkhwa Textbook Board, Peshawar. The items were designed to compare the pre instructions of the students on the understanding of the concepts of geometry, as well as after the instruction intervention.

Data Collection

The information was gathered by means of pre-test and post-test constructed by teachers. The reason behind the pre-test was to ensure that sampled students were put in similar groups (experimental and control) prior to the initiation of the treatment. Both tests consisted of fifty items which had a total of fifty marks one item one mark.

Analysis of Data

The statistical tools used to analyze the data included Mean, Standard Deviation and t-test

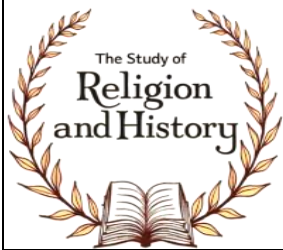
Conclusions

The current research was conducted to explore how AI-driven teaching resources, specifically GeoGebra, affect the academic performance of students of secondary school in mathematics. Through the statistical analysis and the results interpretation, various noteworthy conclusions can be made. In general, the study results give strong empirical proof that the use of AI-based tools in teaching mathematics plays an important role in improving the learning outcomes of students in comparison to standard teaching practices.

Among the most important findings of the study is the fact that, students who had been instructed by AI-driven instructional tools achieved higher academic performance in the post-test than those who were instructed in a traditional way. There was a consistent superiority of the experimental group over the control group in several comparisons which showed that AI-assisted instruction had a positive impact on the knowledge of mathematical concepts among students. The statistically significant discrepancy between the post-test stature proves that the achievement betterment was not an accidental phenomenon and it was the direct consequence of the instructional intervention.

A second significant conclusion is that the general academic performance of the experimental group improved significantly after it had been exposed to AI-based instructions. The instructional value of GeoGebra as the dynamic and interactive learning resource is evidenced by the fact that the experimental group scored higher in the post-test. The visual representations, the manipulation of mathematical objects in real time, and feedback allowed students to gain more conceptual insight, especially in geometry. This proves that AI-driven tools have the capacity to turn abstract mathematical concepts into more tangible and reachable forms, which will increase the understanding and retention.

The results also indicate that the students who performed well were positively affected by the application of AI-powered tools. The performance of high achievers in the experimental group had significantly better scores in the post-test compared to the other counterparts in the control group. It implies that, despite the fact that AI-based instructional tools can be used to help struggling learners, they can also be used to give a wider range of learners, who are academically strong, an opportunity to learn. GeoGebra facilitated the high performers to learn the complex concepts, high-order thinking and analytical reasoning skills they would not have managed to learn using the traditional instruction.



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The research has indicated that students with low performance improved significantly in case of being taught by AI-driven instruction devices. The experimental group low achievers scored much higher in the post test as compared to the control group low achievers. This observation is especially significant, as it suggests that the tools based on AI can be used to minimize learning obstacles encountered by the students that are already weak in mathematics. GeoGebra seems to address the needs of these students since it is interactive and visual, which will diminish the cognitive load and simplify the abstract concept, as well as enhance engagement, which will result in better academic achievements.

The other important conclusion is that, despite the fact that the students in the control group did improve between the pre-test and the post-test, the effect of such improvement was significantly smaller as compared to the experimental group. It implies that traditional teaching methods are capable of facilitating learning to some degree, but they are not as effective in attaining significant academic gains as AI-enhanced teaching methods are. The comparative performance highlights the level of added value of AI-powered tools to speed up the learning process and enhance comprehension.

More so, the within-group comparison of the experimental group showed significantly high results in terms of both high and low achievers between pre-test results and post-test results. These results prove that AI-based intervention produced a strong and stable effect on various categories of learners. It is evident that the findings of the study conducted by GeoGebra-based instructions indicate that this instructional method stimulates meaningful learning, academic growth, and confidence in mathematics among students.

The research confirms that AI-based educational products, in this case GeoGebra, are very efficient to enhance the academic performance of students in mathematics at the secondary school level. The results prove that AI-based education is beneficial to learners of all achievement levels, helps them to acquire conceptual knowledge, and improves the overall learning outcomes. Such findings are a vehement proponent of the application of AI-based tools in mathematics education and a strong empirical basis of future educational innovation.

Recommendations

Resting on the findings and conclusions of the research, there are several recommendations offered to make the effective implementation of AI-driven teaching tools in mathematics learning effective. These are the recommendations to schools, teachers, curriculum developers, educational policymakers, and future researchers.

First, it is highly suggested that institutions should include the use of AI-driven instructional resources in the normal classroom teaching..

Second, systematic teacher training and ongoing professional growth in the areas of AI-driven educational technologies is in dire need..

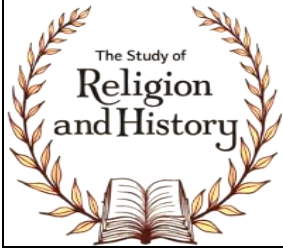
Third, the differentiated and personalized instruction should be supported by AI-powered tools.

Fourth, educational policymakers and curriculum developers must re-write and revise curriculum officially to include AI-based instructional methods.

Fifth, it may implement a blended learning model with the combination of conventional educational practices and AI-based teaching tools.

Sixth, learning institutions and administration must invest in proper technological infrastructure.

Seventh, AI-driven instructional tools should be monitored and assessed on a continuous basis.



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Student and teacher feedback should be gathered regularly to evaluate the efficiency of AI tools and point to the areas that need improvement.

The recommendations focus on the importance of careful integration, proper training, and facilitating infrastructure and constant assessment to improve the advantages of AI-driven teaching tools. It is possible to say that AI-based technologies, like GeoGebra, can be very beneficial when applied strategically to mathematics education and help to achieve better academic results among various groups of students.

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