



RESEARCH ARTICLE

Efficacy of multimedia courseware in achievement in Mathematics

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Abstract

This research aims to evaluate students' academic achievement levels using multimedia courseware because it creates a lively learning environment that improves educational success in mathematics learning in secondary education. Multimedia instructional materials. The chosen approach for achieving the purpose was the experimental method. The research relied on 40 female students attending Government Girls Higher Secondary School in Manaparai, Trichy. This research split its participants into an experimental group which contained 20 students and a control group consisting of 20 students. Students participating in the experimental program received lessons from multimedia courseware which the research scholar had developed, while the control group students received traditional instruction. The research data demonstrated that students who received multimedia courseware education showed better mathematics performance than students taking classes through traditional methods, with a high effect size.

Keywords: Technology-enhanced learning, Digital instructional tools, Mathematics education, Student engagement, Pedagogical innovation, Experimental research design.

Introduction

In recent decades, integrating computers into education has gained significant attention. In India, computers have primarily supported traditional teaching methods, particularly in science and mathematics. Computers have proven effective in enhancing the teaching-learning process. Computers are now used in various applications, including commerce, science, engineering, and more. Beyond numerical tasks, computers are used for non-numerical work, such as theorem proving and game playing.

In today's society, technology is a fundamental pillar. Therefore, acquiring basic technology skills and concepts is essential for individuals to succeed.

New technologies have paved the way for innovative educational frameworks that go beyond traditional teaching

methods. One such approach is multimedia courseware (MC), which has tremendous potential to enhance science and mathematics education. Multimedia facilitates students with visual, concrete representations. Tools like graphing calculators offer a tangible learning experience, enabling students to analyze images and reflect on their thought processes, procedures, and structures. This approach helps students progress toward a more formalized and advanced understanding of mathematical concepts.

Review of Related Literature

The research community shows significant interest in understanding how multimedia courseware helps secondary students achieve better results in mathematics education. Two research studies regarding interactive multimedia tools focused on mathematics education improvement (Afify, 2020; Gesualdo *et al.*, 2021; Shreyas *et al.*, 2023).

The research conducted by Banson, J., & Arthur-Nyarko, E. (2021) assessed whether interactive courseware used in geometry instruction made students perform better academically.

The research shows that interactive multimedia courseware effectively improves mathematics learning outcomes for secondary school students (Ling, L. S., & Krishnasamy, S, 2023). The study conducted by Azmi *et al.* developed an interactive MC named IMONEC by implementing Bandura's observational learning model with principles of interactive multimedia learning. This

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courseware proved suitable for education purposes and showed effectiveness for character building among students (Septiani *et al.*, 2020). According to Adeyele (2024), interactive multimedia proved to be superior to traditional instructive methods for regular school students.

Several mixed results have surfaced about multimedia tools' effectiveness among researchers. Children's interactive reading applications harbor a mixed relationship with their educational impact since multimedia components boost literacy learning but interactive game elements produce detrimental effects on reading ability according to Chuang and Jamiat (2023). A review conducted in the UK demonstrated that digital formative assessments produced positive results for mathematics education among younger children but failed to prove superior over traditional formative assessments for older students and different subjects (See *et al.*, 2021; Akanmu, A. M; Heil & Ifenthaler, 2023; Aldon & Panero, 2020).

The research conducted by Ameen K.S. Mohammed and Ayuba B (2023) suggests MC offers potential benefits for secondary school mathematics achievement yet its impact depends on tool design features. Additional thorough research is needed to determine the optimal methods for adopting multimedia courseware in secondary mathematics classrooms (Hashim, S. *et al.*, 2024).

Research Gap

The study fills multiple knowledge gaps that exist within current research about multimedia-based teaching at the secondary education level. Previous research examined the use of multimedia courseware across different subjects but failed to show sufficient evidence about its impact on mathematics achievement during secondary school education. This research establishes empirical evidence concerning how multimedia instruction helps students excel in mathematics since the subject is typically difficult to master.

The research fills an experimental research gap through its implementation of a controlled experimental model that evaluates traditional teaching methods versus multimedia-based teaching. Research based on observational methods and qualitative approaches normally studies technology in education but this quantitative research establishes multimedia courseware effectiveness through substantial effect sizes.

Research concerning multimedia benefits in higher education exists extensively but its effects on secondary school students within government educational institutions remain under investigation. The study fills this knowledge gap by demonstrating which elements of multimedia courseware work well in actual classrooms aimed at teaching government school students who lack experience with digital tools.

The research fills an essential void by demonstrating the requirement for teacher-made multimedia teaching

resources. The research investigates custom-made instructional materials that specifically address students' learning requirements instead of studying only commercial digital tools. The research demonstrates how teachers can develop suitable digital educational tools that adhere to educational standards.

This study helps address the lack of evidence about multimedia instruction effects in classrooms composed solely of women. The research fills an important knowledge gap concerning gender differences in technology-assisted learning because it examines how women from different English-speaking contexts respond to multimedia courseware in mathematics courses.

This study builds evidence for multimedia courseware adoption in mathematics teaching at the secondary level while providing instructional guidance to educators who use digital tools to improve student success.

Objective

The evaluation focuses on determining the effectiveness of multimedia courseware for boosting mathematics academic performance levels in secondary school students. Virtual learning tools used in multimedia instruction create environments that lead to better math understanding and performance for students. Under experimental research methodology, the study investigates academic results between traditional classroom students against those who learn from multimedia programs developed by researchers. This research aims to establish the effects multimedia learning methods have on student mathematical results and validate their use for classroom technology integration.

Materials and Method

The research employed an experimental design, with randomized equivalent control and experimental groups. The research examines how multimedia courseware influences mathematical achievement among 9th-class students at Government Girls Higher Secondary School in Manaparai, Trichy. Researchers have chosen Government Girls Higher Secondary School—Manaparai as their scientific sample for this investigation. The study sample comprised 40 students enrolled in standard IX at Government Girls Higher Secondary School, Manaparai, Trichy. The students were categorized into two groups based on the parity of their ranks in the list, with one group designated as the experimental group and the other as the control group. The researcher developed the achievement test in Mathematics from the standard 9th class state-board syllabus of Tamil Nadu. The investigator develops and standardizes the coursework for the students.

Coursework for the students

A thorough review of the related literature has been conducted. The limited understanding and adoption of professional development in multimedia courseware

has generated a strong desire to engage in this form of professional learning within the realm of gifted and talented education.

The researcher selected the topic Set Language and Real Numbers from the syllabus of the State Board, Tamil Nadu for the 9th standard students. The concepts are developed with only a limited number of illustrations. The abstract concepts are inadequately clarified in the textbooks. Consequently, the learners encounter numerous challenges in understanding the problems. After selecting the two units, the researcher divided them into meaningful courseware. The researcher also identified the needs of the learner and organized the content from simple to complex to provide the most effective presentation for an accessible approach. The researcher conducted the courseware for the experimental group for consecutive 8 weeks. First four weeks for 12 hours for each week the topic set language was covered and similarly, for the next 4 weeks for 12 hours, Real numbers were taught to the experimental group. On the other hand, the control group was taught in a normal classroom through the chalk-and-talk method.

Pre- and Post-Achievement Test

The developed pre and post-achievement test consists of 50 items. The mentioned items are covered with the 9th standard – 8-week syllabus covering set language and real numbers.

Reliability and Validity of the Study

The obtained r-values for the achievement test to assess the achievement level of students (0.77) were found to be high indicating the reliability of the tools used in the study. The obtained intrinsic validity of the achievement test and attitude rating scale of 0.88 is high. Hence, the tool used in the study possesses intrinsic validity.

Results

Normality

The results indicated that the control group had a Shapiro-Wilk statistic of 0.941 ($p = 0.247$), while the experimental group had a Shapiro-Wilk statistic of 0.916 ($p = 0.084$), which shows both the control and experimental groups are considered to be normally distributed (Table 1).

Mean Level Analysis

One of the primary objectives of this study is to evaluate secondary-level students' academic achievement in

Table 2: The level of academic achievement of the control group

	<i>Below-average level of achievement</i>		<i>Average level of achievement</i>		<i>Above average level of achievement</i>	
	No.	%	No.	%	No.	%
Control group						
Pre-test	11	55	6	35	3	15
Post test	10	50	7	50	3	15

mathematics. Academic achievement through multimedia courseware was assessed using mean and standard deviation. Students scoring 30 and above were classified as having high achievement, those scoring between 17.5 and 29 as having average achievement, and those scoring below 17 as having below-average achievement.

Academic achievement was categorized into three levels: above-average, average, and below-average. At the pre-test stage, 3 students (15%) demonstrated above-average achievement, 6 students (30%) exhibited average achievement, and the majority, 11 students (55%), fell into the below-average category. In the post-test, 3 the above average (15%), while there was a slight difference in the average and below average levels (Table 2).

In Table 3, among the 20 students, 3 (15%) demonstrated above-average achievement in the pre-test, while 7 (35%) exhibited average achievement. The majority, 10 students (50%), fell into the below-average category.

Following the intervention, post-test results indicated a substantial improvement in achievement levels. A total of 12 students (60%) achieved above-average levels, reflecting significant progress. Additionally, 8 students who were previously in the below-average category moved to either the average or above-average levels. In the post-test, 6 students (30%) remained at the average achievement level, while only 2 students (10%) continued to demonstrate below-average achievement.

Mean Differential Analysis

Pre-test analysis

From the above table, it can be revealed that the 't' value of pre-assessment scores of the control and experimental group on academic achievement of students (0.06) is not significant at 0.05 level. Hence, the stated hypothesis, that there exists no significant difference in the mean scores of academic achievements of the control and experimental

Table 1: Shapiro-Wilk test values

	<i>Control group</i>	<i>Experimental group</i>
Shapiro-Wilk	0.941	0.916
<i>p-value</i> of Shapiro-Wilk	0.247	0.084

Table 3: The level of academic achievement of the experimental group

<i>Level of achievement</i>	<i>Below average</i>		<i>Average</i>		<i>Above average</i>	
	No.	%	No.	%	No.	%
Experimental group						
Pre-test	10	50	7	35	3	15
Post test	2	10	6	30	12	60

Table 3.1: Lesson in the multimedia courseware

Lesson	Content
Set language	
Lesson -1	Introduction
Lesson -2	Set
Lesson -3	Representation of a set
Lesson -4	Types of set
Lesson -5	Set operations
Lesson -6	Properties of set operations
Lesson -7	De morgans law
Lesson-8	Application on cardinality of set
Real numbers	
Lesson-9	Introduction
Lesson-10	Rational numbers
Lesson-11	Irrational numbers
Lesson-12	Real numbers
Lesson-13	Radical notations
Lesson-14	Surds
Lesson-15	Rationalization of Surds
Lesson-16	Scientific notations

group of students in pre-assessment is accepted. The above analysis also reveals that both control and experimental groups were found to be statistically homogenous and equivalent groups before implementing the multimedia courseware.

Thus, both groups were found to be statistically homogeneous and equivalent groups before implementing multimedia courseware (Figure 1).

Post-test analysis

The data presented in Table 5 indicates that the 't' value for the post-assessment scores of both the control and experimental groups regarding students' academic achievement (4.51) is significant at the 0.01 level. The results indicate a significant difference in the mean scores of the control and experimental groups regarding their academic achievement after the implementation of the multimedia courseware is highly effective as Cohen's d value is 0.82. Therefore, the proposed hypothesis, that there exists a significant difference in the mean scores of academic achievements of the control and experimental groups

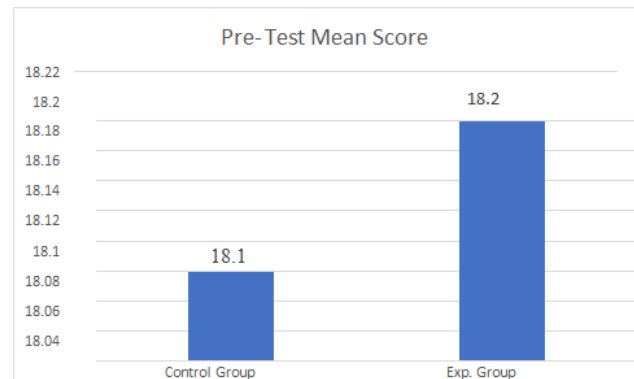


Figure 1: Graphical representation of mean and standard deviation and 't' value of academic achievement of control group and experimental students at pre-test

of students in post-assessment, is accepted. The findings indicate that both the traditional method and multimedia courseware demonstrated effectiveness (Figure 2).

Discussion

The application of multimedia courseware seems to explain the observed difference since it enabled better student engagement with learning activities within the experimental group. Operational fluidity along with engaging features of multimedia-based learning contributed to easing student discomfort and improving educational performance by providing more effective concept comprehension.

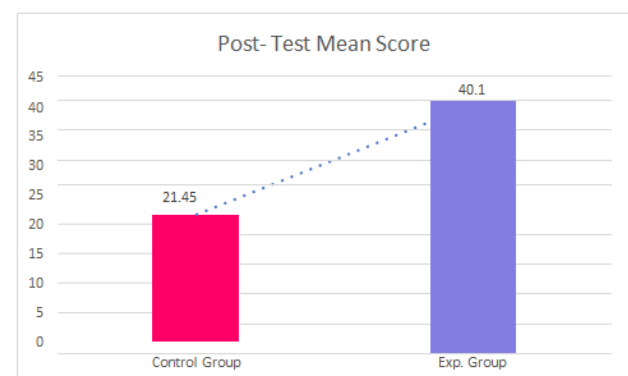


Figure 2: Graphical representation of mean and standard deviation and 't' value of academic achievement of control group and experimental students at post-test

Table 4: T-test values of pre-test

Pre-test	No.	Mean	SD	Standard error mean	Correlated 't' value
Control group	20	18.1	3.54	0.78	0.06
Exp. group	20	18.2	6.16	1.38	

Table 5: T-test values of post-assessment

Post-assessment	No.	Mean	SD	Standard error mean	Correlated 't' value	Cohen's d
Control group	20	53.85	21.40	0.80	4.51**	0.82
Exp. group	20	40.6	7.69	1.69		

Khasawneh *et al.*, (2024) previously discovered that students who received instruction with multimedia courseware-based instructional packages achieved better results than traditional methods. According to Akanmu, Morenikeji Alex *et al.* (2022) students who received instruction through multimedia courseware for linear equations word problems achieved better results than those taught through standard methods in high school. The research proved that students retained more information about linear equation word problems when they were taught using multimedia courseware-based instruction compared to traditional methods. The implementation of multimedia courseware during instruction can help reduce the mental burdens that teachers and students typically face. This teaching strategy improves both student engagement along with offering hands-on experiences thus leading to better retention outcomes according to research findings. The research of Nwanze *et al.* (2018) supports the notion that multimedia creates better learning outcomes and better retention in chemistry subjects. Traditional teaching methods compare unfavorably to the interactive e-content learning module which helps students improve retention and achievement according to Prabakaran & Saravanakumar (2020). Bolling *et al.*, (2023) back the prediction that interactive courseware will boost student performance while simultaneously creating valuable teaching aids materials according to findings. The research results supported similar findings from Azmuddin *et al.*, 2020 who proved that ITC implementation leads to higher mathematics learning performance among Malaysian students. Therefore multimedia courseware shows a significant influence over student achievement in mathematics education. The multimedia courseware delivered information through text and animated visuals which made abstract subject content easier to understand therefore students found it more accessible and engaging (Ndiokubwayo *et al.*, 2020; Pellas & Tzafilkou, 2023). Multimedia courseware demonstrates effectiveness as a teaching tool which provides better results than standardized Mathematics teaching approaches (Vagg *et al.*, 2020).

However, the study contains limitations that need attention before analyzing the research results. Analysis results cannot be applied to wider populations since the research includes only 40 students from a single school. Gender inclusion issues exist because the research enrolled only female students thus failing to analyze any possible male-female contrasts in the effectiveness of such educational media. An assessment of sustained multimedia instruction effects on mathematics achievement requires more than eight weeks of intervention to generate meaningful results. This investigation examined mathematics exclusively which prevents understanding multimedia courseware for other subjects. The research method did not examine individual learning styles for students because learning styles would

impact how students interact with multimedia lessons. The study failed to analyze how instructors played an important role during traditional and multimedia instruction as it potentially influenced the different student performance results observed. The research evaluated academic achievements only but omitted relevant elements such as motivational factors and student participation and mathematical attitude measurements.

Conclusion

Multimedia courseware has proven to be an effective tool in learning mathematics at the secondary level. Its engaging interactive visuals, personalized learning experiences, and multisensory learning approaches make it an excellent resource for students. Research findings indicate that multimedia courseware is more effective in promoting learning retention among 9th-grade students than traditional methods. These digital resources offer flexible, self-paced learning, fostering autonomy and self-efficacy. While multimedia courseware may limit social interaction, it promotes a sense of accomplishment and pride in students' abilities, especially when they complete activities independently with minimal assistance.

The findings need more generalizability because further research must sample students from multiple schools across wider demographics. Research with both male and female students would show if multimedia courseware provides equal advantages to every student. Future investigations need to analyze the effectiveness of multimedia courseware when applied to subjects beyond mathematics including science and language as well as social studies. Understanding different learning approaches creates a better understanding of how multimedia education aids different types of students. The complete assessment of multimedia courseware requires inputs from qualitative evaluations including student opinions through feedback along with surveys for motivation levels and direct classroom observation. Research studies should analyze the impact of different multimedia elements by conducting evaluations between multiple types of multimedia tools including animations, simulations and gamified learning approaches. Analysis of teaching behaviors related to multimedia instruction delivery will demonstrate how educators should integrate technology effectively in their instructional approaches.

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