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Effect of Multimedia-Based Instruction on Students' Attitude and Academic Achievement in Mathematics: A Psychological Study

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Abstract

The current research examined the impact of multimedia-based instruction on the academic performance and attitude of secondary school students towards mathematics in terms of psychology. The study was based on the Cognitive Theory of Multimedia Learning, Dual Coding Theory, and Expectancy-Value Theory of motivation, with a true experimental pre-test-post-test control group design. A study sample of 120 12th-grade students was randomly selected for the experimental (n=60) and control (n=60) groups. The selected mathematics units were taught using multimedia-based instructional material to the experimental group and traditional teaching methods to the control group. The Achievement Test in Mathematics was used as a standardised data-gathering tool, and an Attitude Scale Towards Mathematics was designed and validated by the researcher. Data were analysed using independent samples t-tests and gain scores.

The findings showed no significant differences between the groups at the pre-test stage, indicating no significant differences at baseline. Nevertheless, the experimental group showed much greater post-test scores, academic achievement, and attitude towards mathematics gain scores than the control group. The effect sizes obtained were moderate to large. These results indicate that multimedia-based teaching can improve thinking and emotional involvement in mathematics learning.

The study concludes that multimedia-based teaching is a psychologically efficient pedagogical tool that enhances students' performance and creates positive attitudes toward mathematics. This research has significant implications for classroom practices, instructional design, and educational policy. The research indicates that Future studies should investigate the long-term effects of multimedia-based instruction, incorporate more psychological factors such as mathematics anxiety and self-efficacy, and evaluate how particular multimedia design elements influence various educational settings.

Keywords: Multimedia-based Instruction, Mathematics Achievement, Attitude Toward Mathematics, Cognitive Theory, Secondary School Students

Introduction

Mathematics is one of the core subjects in secondary school; it is very important in introducing reasoning, problem-solving, and higher-order thinking skills. Although mathematics is a vital subject, students find it challenging, hard to understand, and a source of anxiety, which in most cases results in low academic achievements and dislike of the subject. Educational psychology underlines the fact that cognitive ability is not the only determinant of learning outcomes, and that affective factors (motivation, attitude, and emotional engagement) also play a role in determining learning outcomes.

Conventional approaches to teaching mathematics, which are largely teacher-led and text-based, have been largely criticised because of their low efficiency in meeting the needs of diverse learners. Such methods tend to focus on procedural knowledge and less on conceptual knowledge, which

causes passive learning and low student involvement. This, in turn, results in a growing need for a new instructional method that is more actively engaging for learners and aids both cognitive and affective levels of learning. Over the last few years, multimedia-based instruction, which combines text, images, animation, and interactivity, has emerged as a promising learner-centred theory that is applicable in designing learning experiences to develop meaningful learning experiences. The Cognitive Theory of Multimedia Learning implies that students learn information better when it is delivered through verbal and visual media because it helps improve cognitive processes and decreases extraneous cognitive load. Similarly, Dual Coding Theory suggests that information stored in both visual and verbal systems is easier to store and retrieve. Expectancy-Value Theory focuses on the relevance of beliefs, emotions, and perceived value of tasks to engage and perform effectively in academics based on motivational theory.

Although the success of multimedia instruction in enhancing mathematics performance has been established in previous studies, a good portion of the literature that is available gives little priority to affective constructs like students' attitudes towards mathematics. Moreover, quasi-experimental designs have been utilised in many studies, which limits the possibilities of making robust causal conclusions. Second, there is a dearth of studies that combine both cognitive and motivational theories to understand the effect of multimedia instruction on either achievement or attitude, or both, in the context of Indian secondary schools.

Thus, it is evident that there is a necessity for theoretically based experimental research which explores the dual effect of multimedia-based teaching on the academic performance as well as the attitude of students towards mathematics. This void is critical in the process of acquiring in-depth knowledge of the ways through which instructional innovations can enhance learning outcomes, not only in cognitive aspects but also in psychological aspects.

The following study explores the impact of multimedia-based teaching on the academic performance of secondary school learners in mathematics and their attitude towards the subject using a true experimental design. Combining cognitive and motivational theoretical viewpoints, this research aims to contribute to the body of knowledge in the educational psychology field and offer practical value to the areas of classroom instruction, instructional design, and educational policy.

Literature Review

A number of research studies show that multimedia-aided teaching (MAT) improves students' academic achievement, and their attitudes towards mathematics and other science subjects. For example, a study on multimedia-aided teaching (MAT) found students who received multimedia presentations for science learning had higher academic achievement and more positive attitudes than those who received conventional teaching, implying similar benefits for mathematics learning (Shah & Khan, 2015). Similarly, the study of multimedia learning materials demonstrated more effective science teaching, with statistically significant gains in achievement and student attitudes, suggesting that multimedia facilitate motivation in learning science (Ercan, 2014).

Multimedia-facilitated pedagogy (flipped learning) was also found to enhance achievement and students' attitudes in mathematics. A mixed-methods research study revealed that flipped learning activities were effective in increasing achievement scores and positive attitudes, suggesting that the use of multimedia learning materials can enhance student engagement and understanding in mathematics education (Karadag & Keskin, 2017).

Another pedagogical approach to improve mathematics education outcomes is gamification, incorporating game elements and multimedia multimedia. Gamified learning platforms have demonstrated high engagement, achievement and attitudes compared to conventional learning methods, highlighting the interactive and motivating potential of multimedia-based gamified learning (Maryana et al., 2024). Similarly, game-based learning also enhanced elementary students' mathematics achievement and attitudes, with qualitative analyses highlighting the cultivation of a growth mindset and problem-solving skills through multimedia game-based instruction (White & Mccoy, 2019).

Particular multimedia platforms such as Kahoot!, which integrates dynamic multimedia and interactive quizzes, have resulted in improved mathematics performance and multi-screen addiction among elementary students. Kahoot! users demonstrated better results than traditionally instructed students, implying multimedia interactive multimedia tools have a positive impact on learning, while also reducing the negative behavioural side effects of screen addiction (Pellas 2024).

Multimedia-based mathematics instruction not only impacts achievement, but also psychological factors like anxiety and attitudes. Pedagogies that prioritise conceptual understanding (which can be aided by multimedia platforms) have been found to enhance mathematics achievement, and positively influence student attitudes and anxiety (especially among female students) (Hussein & Csíkos, 2023).

On the other hand, research on teachers' pedagogies showed varying impacts of technology use on mathematics attitudes. Although universally accepted "good teaching" practices had positive effects on student attitudes, merely having educational technology in the classroom did not necessarily improve mathematics attitudes. Yet, ambitious teaching practices combining group work and multimedia showed complex effects depending on the students' initial attitude levels (Sonnert et al., 2014).

Further studies in language education suggest the use of multimedia-based instruction can promote students' positive affect, decrease their anxiety and boredom, and enhance academic engagement and performance (Hamedi & Arabpour, 2025). While these studies focused on grammar teaching, the results are similar to those in mathematics, as they show how multimedia approaches reduce affective hindrances and support achievement through cognitive processing (Hamedi & Arabpour, 2025).

Finally, project-based learning with multimedia components had positive effects on students' achievement in elementary mathematics, suggesting that teaching methods that actively involve students in the use of multimedia can improve comprehension and performance in mathematics (Lazić et al., 2021).

Objectives of the Study

The present study was designed to examine the psychological and educational effects of multimedia-based instruction on secondary school students' learning of mathematics. Specifically, the objectives of this study were as follows:

- To examine the effect of multimedia-based instruction on students' academic achievement in mathematics.
- To examine the effect of multimedia-based instruction on students' attitude toward mathematics.
- To compare the achievement, gain scores of students taught through multimedia-based instruction and traditional instruction.
- To compare the attitude gain scores of students taught through multimedia-based and traditional instruction.

Hypotheses of the Study

The hypotheses were formulated in the null form and tested at the 0.05 level of significance.

H_{01}: There was no significant difference in the pre-test academic achievement scores of the students assigned to the experimental and control groups in mathematics.

H_{02}: There was no significant difference in the post-test academic achievement scores of students taught mathematics through multimedia-based instruction and those taught through traditional instruction.

H_{03}: There was no significant difference in the pre-test attitude toward mathematics scores of students assigned to the experimental and control groups.

H_{04}: There was no significant difference in the post-test attitude toward mathematics scores of students taught through multimedia-based instruction and those taught through traditional instruction.

H_{05}:

There was no significant difference in the gain scores of academic achievement between students exposed to multimedia-based instruction and those exposed to traditional instruction.

H_{06}:

There was no significant difference in the gain scores of attitude toward mathematics between

students exposed to multimedia-based instruction and those exposed to traditional instruction.

Method

Research Design

The present study adopted a true experimental pre-test–post-test control group design to examine the effect of multimedia-based instruction on students' academic achievement in mathematics and their attitudes toward the subject. This design was employed to establish causal relationships by controlling extraneous variables and ensuring equivalence between groups at the pretest stage. Multimedia-based instruction served as the independent variable, while academic achievement in mathematics and attitude toward mathematics were the dependent variables.

Participants

The participants in this study were secondary school students selected from institutions that adhered to a common curriculum. The sample size and demographic composition were derived from doctoral research that provided the foundation for the current investigation. A total of 120 students participated, with 60 assigned to the experimental group and 60 to the control group through random assignment at the group level.

The two groups were comparable in terms of age, grade level, and socio-educational background. Baseline equivalence was established through pre-test assessments measuring academic achievement and attitudes toward mathematics, which indicated no statistically significant differences between groups. This finding supports the internal validity of our experimental design.

The chosen sample size of 120 students was deemed sufficient according to the established standards for experimental research, ensuring adequate statistical power and comparability between groups. The implementation of random assignment at the group level was intended to minimise potential selection bias and enhance the overall internal validity of the study.

Instruments

Achievement Test Mathematics (ATM)

The investigator created and standardised an Achievement Test in Mathematics to measure how students had mastered the selected units of mathematics, which were taught throughout the intervention period. The test had 40 objective and short-answer questions aimed at assessing conceptual knowledge, procedural skills, and application skills. An expert review was conducted to determine the content validity of the achievement test. The test items were tested by a panel of five subject experts and teacher educators for their relevance, clarity, level of difficulty, and correspondence to the objectives of instruction. According to their recommendations, the required changes were made. The test was observed to have high content validity, as the Content Validity Index (CVI) was 0.89. The split-half method was used to determine the reliability of the achievement test, and the Spearman-Brown prophecy formula was used to determine the reliability coefficient. The coefficient of reliability was determined to be r =.86, which implies that the instrument has a high degree of reliability and consistency in conducting research.

Attitude Scale toward Mathematics

Attitude Scale Towards Mathematics was an Attitude Scale that was developed and standardised by the researcher to measure towards mathematics. The scale was composed of 30 statements, which were rated on a five-point Likert scale ranging from Strongly Agree and Strongly Disagree. The scale was used to measure variables such as interest in mathematics, confidence, perceived usefulness, and emotional response towards learning mathematics. The attitude scale was tested by psychologists and mathematics teachers using the expert content validity test. The items were tested in terms of psychological relevance, clarity, and suitability for the secondary school level. The Content Validity Index (CVI) of the scale was 0.91, indicating very good content validity. Cronbach's alpha was used to determine the internal consistency reliability of the attitude scale, and it yielded a coefficient of a =.88. This value indicates the scale's great internal consistency and reliability.

Instructional Multimedia-based Materials

The instructional material used in the study was a multimedia material created by the investigator according to the principles of multimedia learning, such as coherence, signalling, and dual-channel processing. The content included text, illustrations, animation, and interaction that would promote conceptual learning and the involvement of learners in mathematics. Subject experts reviewed and validated the content to ensure its relevance to the curriculum and instructional accuracy.

Procedure

The instruction was provided through the use of multimedia in a structured format with the inclusion of animations, visual aids, step-by-step problem-solving demonstrations, and interactive activities in accordance with the mathematics curriculum. All sessions had a similar structure, which included the introduction of concepts, multimedia explanation, independent practice, and instant feedback.

The intervention took six weeks, during which both groups were equally instructed on the same topics. The control group was taught using a conventional method whereby the lecture teaching method, explanation of textbooks, and board work were applied; the only difference between the two groups was the method of instruction.

Before the experiment started, the achievement test and attitude scale were pre-tested on both the experimental and control groups. Subsequently, the experimental group was taught using multimedia-based instructional materials, whereas the control group was taught using a traditional teaching method, which included lectures, chalk-and-talk, and textbook explanations.

The teaching activity was conducted over six weeks, and the teaching time for both groups was equal. The researcher maintained consistency in syllabus coverage, teaching time, and classroom environment. The same achievement test and attitude scale were conducted at the end of the intervention to be administered to the two groups as post-tests.

Data Analysis

The data obtained during the pre- and post-administration of the test were analysed using appropriate statistical methods. The data were summarised using descriptive statistics, such as the mean and standard deviation. To determine the difference between the experimental and control groups, an independent samples t-test was employed to perform inferential analysis. To evaluate the improvement in academic achievement and attitude towards mathematics, gain scores were determined. All hypotheses were tested at the 0.05 level of significance.

Ethical Considerations

The study adhered to high ethical standards. Data collection was conducted with the permission of the school authorities before the study was conducted. All participants provided informed consent and were ensured that they participated in the study because they wanted to. Participants were assured of confidentiality and anonymity, and the data gathered were not utilised in any other manner. There was no physical or psychological risk to the participants in the study.

Results

The data obtained were computed and analysed through descriptive statistics, independent samples t-tests, and gain score comparisons to provide the effect of multimedia-based instruction on the achievement of students in mathematics and the attitude of students towards mathematics. Cohen's effect sizes were also calculated in order to determine the practical significance of the findings.

Pre-Test Equivalence of Experimental and Control Groups

Academic Achievement (Pre-Test)

Table 1 Comparison of Experimental and Control Groups on Pre-Test Academic Achievement

Group	N	Mean	SD	T
Experimental	60	41.82	6.24	
Control	60	42.15	6.10	0.30

Note. The t-value is not significant at the 0.05 level.

The pre-test academic achievement of the experimental and control groups was not significantly

different (t=0.30, p>.05). This implies that these two groups were similar before the start, so that the resulting changes in performance can be attributed to the instructional intervention, as opposed to the differences existing before the start. Accordingly, Null Hypothesis 1 was accepted.

Attitude Toward Mathematics (Pre-Test)

Table 2 Comparison of Experimental and Control Groups on Pre-Test Attitude Toward Mathematics

Group	N	Mean	SD	T
Experimental	60	96.34	10.12	
Control	60	95.87	9.85	0.26

Note. The t-value is not significant at the 0.05 level.

The pre-test attitude toward mathematics was not statistically significant between the experimental and control groups (t=0.26, p>.05). This will verify that the two groups had the same affective dispositions before the intervention, a factor that will fortify the internal validity of the research. Thus, Null Hypothesis 2 was accepted.

Effect of Multimedia-Based Instruction on Academic Achievement

Post-Test Academic Achievement

Table 3 Comparison of Experimental and Control Groups on Post-Test Academic Achievement

Group	N	Mean	SD	T	Cohen's d
Experimental	60	72.46	7.18		
Control	60	60.21	6.85	4.28**	0.78

Note. p< .01.

The experimental condition had a considerably higher post-test academic achievement, which was significantly higher than that of the control condition (t=4.28, p<.01). The effect size (d=0.78) indicates a moderate-to-large practical effect. This implies that multimedia-based learning has significant positive effects on the performance and comprehension of mathematics among students as opposed to conventional learning. Therefore, Null Hypothesis 3 was not accepted.

Achievement Gain Scores

Table 4 Comparison of Experimental and Control Groups on Achievement Gain Scores

Group	N	Mean	SD	T	Cohen's d
Experimental	60	30.64	6.21		
Control	60	18.06	5.84	4.67**	0.85

Note. p< .01.

The overall gain in academic achievement was also markedly higher in the experimental group (t=4.67, p<.01). The significant effect size (d=0.85) means that the multimedia-based instruction had constructive effects on the final performance and on the promotion of learning over time. This shows the effectiveness of multimedia teaching in instruction. Thus, Null Hypothesis 4 was rejected. Effect of Multimedia-Based Instruction on Attitude Toward Mathematics

Post-Test Attitude Toward Mathematics

Table 5 Comparison of Experimental and Control Groups on Post-Test Attitude Toward Mathematics

Group	N	Mean	SD	T	Cohen's d
Experimental	60	124.18	9.74		
Control	60	108.42	10.26	3.95**	0.72

Note. p< .01.

Students in the experimental condition exhibited a much more positive attitude towards mathematics than the control group (t=3.95, p<.01). The effect size (d=0.72) indicates a significant improvement in affective outcomes. This indicates that learning was more interesting through multimedia instruction, and the perception of mathematics was lower than the initial perceptions. Therefore, H 0 5 is rejected.

Attitude Gain Scores

Table 6 Comparison of Experimental and Control Groups on Attitude Gain Scores

Group	N	Mean	SD	T	Cohen's d
Experimental	60	27.84	8.12		
Control	60	12.55	7.96	4.41**	0.80

Note. p< .01.

The attitude change with respect to mathematics in the experimental group was also quite high (t=4.41, p<.01). The high effect size (d=0.80) demonstrates that the multimedia-based instruction had a significant positive influence on motivation, confidence, and emotional engagement with mathematics among students. Hence, Null Hypothesis 6 was not accepted.

Overall Interpretation of Findings

The results show that multimedia-based instruction has a statistically significant and practically significant influence on academic performance and attitude towards mathematics was statistically significant. The lack of differences in the pre-test results proves the category of group equivalence, whereas the high post-test and gain scores prove the effectiveness of the intervention. The moderate to large effect sizes of the outcome variables used indicate that multimedia-based instruction is not just statistically but also educationally significant. Such findings are significant in the sense that the incorporation of multimedia tools in teaching mathematics enhances the performance in cognition and the affective interest of the students.

Discussion

The present study examined the effect of multimedia-based instruction on secondary school students' academic achievement in mathematics and their attitude toward the subject from a psychological perspective. The findings clearly indicate that students exposed to multimedia-based instruction significantly outperformed their counterparts taught through traditional instructional methods in terms of both academic achievement and attitude toward math. These results provide strong empirical support for the effectiveness of multimedia instruction as a cognitively and affectively supportive pedagogical approach.

The significant improvement in the academic achievement of students in the experimental group can be interpreted in light of the Cognitive Theory of Multimedia Learning. According to this theory, learning is enhanced when instructional materials are designed to optimally utilise both verbal and visual processing channels while minimising extraneous cognitive load. Visual representations, animations, and guided explanations were also utilised in the multimedia instructional materials employed in the current study, which probably contributed to the ease of integrating new mathematical ideas with the knowledge frameworks. This two-channel processing could have facilitated more coherent mental representations in learners, resulting in better conceptual knowledge and performance in problem solving.

The high and practically significant gain scores of the experimental group also support the assumption that multimedia-based instruction encourages in-depth learning instead of superficial memorisation. This result is in line with the findings of earlier meta-analytical and experimental studies that found significant positive effects of multimedia integration on mathematics achievement. The effect size achieved in the current research was within the range of moderate-to-large, indicating that the instructional intervention was not only statistically significant but also educational in value.

What is especially interesting is the difference in the attitudes of students towards mathematics which is observed in the experimental group, because affective outcomes are not commonly considered in the research on mathematics education. Motivationally, this finding is consistent with Expectancy-Value Theory, which argues that students' achievement-related behaviours are highly affected by their beliefs about task value, beliefs about competence, and emotional experiences. Interactive features, real-time feedback, and access to visual information provided by multimedia-based instructions could have improved the interest and perceived utility of mathematics among students, thus creating more positive attitudes.

In addition, the results can be attributed to the Dual Coding Theory, according to which information coded in both verbal and visual forms is easier to process and retrieve. The cognitive difficulty decrease attained with the aid of the visualisation of abstract mathematical ideas might have relieved the frustrations and anxieties of learners and led to less negative emotional reactions to mathematics. This interpretation is justified by research showing that positive emotional engagement improves persistence and performance in academic tasks.

The findings regarding the attitude gain score reveal that multimedia-based teaching not only produced a temporary motivational effect on the affective development of the students, but also a lasting effect. These results align with previous research that found better attitudes, interest, and confidence of students in cases when interactive digital learning settings were used to teach mathematics. The current research builds upon this body of work by offering experimental data in an Indian secondary school setting and explicitly basing the development of attitudes on psychological theory.

Notably, the fact that the experiment and control groups were equivalent at the pre-test level increases the internal validity of the results and allows us to conclude that the differences at the post-test stage may be explained by the intervention instead of group differences. The application of a true experimental design additionally contributes to the credibility of the findings and overcomes the methodological shortcomings observed in previous quasi-experimental research conducted in a similar educational environment.

Overall, the results indicate that multimedia-based instruction is not only a technological improvement but also a psychologically oriented method of instruction that facilitates the process of thinking and allows one to become emotionally involved. Embracing both achievement and attitude, multimedia instruction has great potential to enhance mathematics learning outcomes and mitigate negative affective reactions to anxiety and disengagement. These findings emphasise the significance of combining cognitive and motivational theories in designing and assessing instructional interventions, especially in subjects that are traditionally viewed as challenging, such as mathematics.

Despite its strengths, the current study has some limitations. First, the sample was restricted to secondary school students that used a common curriculum, which might limit the generalisability of the results to other learning settings, grade levels, or curricula. Future research should consider the use of a broader sample in terms of geographical locations, types of schools, and sociocultural backgrounds.

Second, the instructional intervention was not very long-term. Despite the noted substantial achievement and attitude changes, more extended intervention periods can provide a better understanding of the long-term outcomes of multimedia-based instructions on learning and motivation. Follow-up studies should be conducted over long periods to investigate the sustainability of the observed gains.

Third, academic achievement and attitude towards mathematics were the outcome variables that the study mainly concentrated on. Other significant psychological measures that were not directly assessed included mathematics anxiety, self-efficacy, metacognitive skills, and cognitive load. Incorporating these variables would be more insightful in terms of the mechanisms by which multimedia-based instruction influences the learning process.

Finally, although the design of the multimedia instructional materials was made according to the accepted design principles, the study did not separate the impact of certain multimedia features such as animation, interactivity, or feedback. This means that it is not possible to establish which elements played the greatest role in the results obtained.

Based on the results of the current study, future studies can consider promising directions. This could be done in the form of longitudinal studies to evaluate the long-term effect of multimedia-based instruction on the academic progression of students, their attitudes, and emotional involvement with mathematics. These studies would be beneficial in determining the sustainability of positive effects.

Subsequent studies can also use mixed methods, whereby quantitative data are supplemented with qualitative data, such as classroom observations, student interviews, and teacher reflections. This would enable a more in-depth exploration of the cognitive and emotional experiences of learners in multimedia-based teaching.

In addition, experimental research contrasting various categories of multimedia designs, such as the presence of static imagery versus animation and guided versus exploratory interactivity, may be useful in establishing optimal instructional characteristics for mathematics learning. The psychological explanation of multimedia learning

effects could be further improved by examining the role of individual differences, such as pre-existing knowledge, learning styles, and level of motivation, in the learning process.

Lastly, the expansion of research to other areas of subjects and levels of education would assist in establishing the generalisability of multimedia-based teaching and work towards the creation of evidence-based, psychologically informed teaching methods across disciplines.

Educational Implications

The results of the current study have significant implications for educational practice, curriculum development, and policy development. To begin with, mathematics teachers ought to be advised to incorporate the use of an instructional approach based on multimedia in general classroom teaching to facilitate conceptual knowledge and minimise students' anxiety towards the subject. Animations, simulations, and interactive visual representations can be used to enable students to visualise abstract mathematical concepts, thus making the learning process more meaningful and interesting.

Second, multimedia principles based on cognitive and motivational theories should be used by curriculum developers and instructional designers to create digital learning resources. The instructional materials must be well-crafted to reduce cognitive load and maximise learner involvement by having coherent visuals, signalling cues, and an interactive feedback system. This kind of psychologically informed design can lead to improvement in academic performance as well as the emotional reactions of students towards learning mathematics.

Third, systematic training in multimedia technology pedagogical applications should be offered in teacher education and professional development programmes. Providing teachers with the skills needed to design and deliver multimedia-based instructions can ensure effective classroom integration and that technology is not used in a shallow and ineffective way.

Lastly, educational policymakers must also appreciate the contribution of multimedia-based instruction in fostering learner-centred and inclusive education. Digital infrastructure, multimedia resources, and teacher training can play a role in enhancing the results of mathematics learning and resolving the long-standing problems of poor achievements and negative attitudes towards mathematics at the secondary school level.

Suggestions

Based on the research results, the following suggestions are offered.

- The lesson plans of mathematics educators should incorporate multimedia (animations, simulations, interactive modules) to promote conceptual learning.
- Teachers need to have practical exposure to multimedia-based teaching strategies.
- Instructional materials should use the psychologically informed principle of multimedia design by curriculum developers.
- Digital infrastructure should be invested in by schools infrastructure to ensure efficient multimedia integration.

Future studies should examine other forms of psychology, such as anxiety, self-efficacy, and motivation, in multimedia learning conditions.

Conclusion

The current research proposes the impact of multimedia-based teaching on the academic performance and mathematical attitude of secondary school students using a psychological and pedagogical lens. The results also clearly show that instruction using multimedia substantially improves students' performance in mathematics and their positive attitudes towards the subject when compared to conventional instruction. The statistically significant differences in post-test scores and gain scores with moderate and large effect sizes provide strong empirical data to support the instructional effectiveness of multimedia-based learning environments.

Theoretically, the findings align with the major assumptions of the Cognitive Theory of Multimedia Learning and the dual coding theory, which state that a higher level of cognitive processing is achieved through the integration of verbal and visual representations. The identified shifts in students' attitudes towards mathematics can also

be associated with motivational views, especially the Expectancy-Value Theory, which highlights the importance of beliefs, emotions, and the value of the task in the academic engagement and achievements of learners. Multimedia-based teaching has become a psychologically viable method of teaching mathematics by focusing on cognitive comprehension and affective involvement simultaneously.

The research also adds to the current literature, as it offers experimental results in the context of an Indian secondary school, where little research has been conducted on the psychological influence of multimedia instruction. The application of a true experimental design enhances causal inferences and introduces methodological soundness to past findings that are largely based on quasi-experimental designs. Overall, the research proves that multimedia-based instruction is not only a technological improvement but also a pedagogically and psychologically efficient measure which can be used to promote the learning process and precondition the development of positive attitudes toward mathematics in learners.

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