THE IMPACT OF *ROGERS' MODEL* FOR DISSEMINATING AND ADOPTING INNOVATION ON MATHEMATICS ACHIEVEMENT AMONG FIRST-GRADE MIDDLE SCHOOL FEMALE STUDENTS

Hind Kadhim Tayyeh Al-Maliki*[1], Mustafa Raad Abd Ulrasool Al-Saadi[2]

[1]Ministry of Education - General Directorate of Education, Baghdad, Karkh II
[2]Ministry of Education - Directorate General of Curricula
*Corresponding author, email: hind.tayih2203m@ihcoedu.uobaghdad.edu.iq

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Abstract
This study examines the effect of applying Everett Rogers' Diffusion of Innovations model in mathematics instruction on the academic achievement of first-grade middle school students. A quasi-experimental design involving two equivalent groups (experimental and control) was used. The participants consisted of 49 students enrolled in a public middle school in Baghdad during the 2024–2025 academic year. Students in the experimental group were taught through an instructional framework structured around Rogers' five stages of innovation adoption, whereas the control group received conventional instruction. To measure learning outcomes, a mathematics achievement test consisting of 32 items was developed and validated. The data were analyzed using an independent samples t-test. The results showed a statistically significant difference between the two groups in favor of the experimental group ($p < .05$). These findings suggest that structuring instruction according to innovation diffusion stages can improve students' mathematics achievement while promoting more interactive and engaging classroom learning environments. The study also discusses implications for instructional innovation and teacher professional development in mathematics education.

Introduction

Mathematics education plays a crucial role in developing students' logical reasoning, analytical thinking, and problem-solving abilities. These competencies are widely recognized as essential for participation in modern knowledge-based societies. In addition, mathematical literacy forms the foundation for learning in science, technology, and engineering disciplines. Consequently, improving the quality of mathematics instruction has become a priority for many educational systems worldwide.

Despite its importance, mathematics teaching in many classrooms continues to rely heavily on traditional teacher-centered approaches. Instruction often focuses on procedural explanations and memorization rather than on conceptual understanding or inquiry-based learning. Such approaches may limit opportunities for students to develop deeper mathematical reasoning and higher-order thinking skills.

Educational researchers increasingly emphasize the importance of active learning environments in which students participate in discussion, exploration, and problem-solving activities.

When students engage actively with mathematical ideas, they are more likely to develop meaningful conceptual understanding and retain knowledge over time. For this reason, contemporary educational reforms frequently encourage the use of innovative instructional models designed to enhance student engagement and learning outcomes.

One theoretical framework that provides insight into how new ideas are introduced, accepted, and internalized is the Diffusion of Innovations theory developed by Everett Rogers. In his seminal work, *Diffusion of Innovations*, Rogers (2003) conceptualized innovation adoption as a staged process comprising knowledge, persuasion, decision, implementation, and confirmation. While the theory has been extensively applied in fields such as organizational change, health communication, and technology adoption (Kaminski, 2011; Ma et al., 2014), its systematic application within classroom instructional design—particularly in mathematics education—remains relatively limited.

Adapting diffusion theory to the learning process offers a promising pedagogical perspective. When students encounter new mathematical concepts, they engage in processes analogous to innovation adoption: they are introduced to unfamiliar ideas (knowledge), evaluate their usefulness (persuasion), decide to attempt application (decision), implement procedures in problem-solving contexts (implementation), and confirm understanding through feedback and reflection (confirmation). Structuring mathematics instruction according to these stages may therefore enhance cognitive engagement, reduce resistance to complex content, and promote sustained conceptual development. Empirical studies examining innovative instructional approaches, such as STEM-based teaching models, have demonstrated positive effects on mathematical achievement and creative thinking (Jawad et al., 2021), suggesting that structured innovation-oriented pedagogy can yield measurable academic benefits.

Despite the theoretical compatibility between diffusion processes and learning progression, empirical investigations explicitly grounding mathematics instruction in Rogers' stage-based framework remain scarce. Existing studies tend to focus either on teachers' adoption of educational technologies or on general instructional innovations without directly operationalizing diffusion theory as a classroom model. This represents a notable gap in the literature, particularly in middle school mathematics contexts where conceptual transitions are critical for long-term academic success.

The present study seeks to address this gap by implementing a structured instructional model derived from Rogers' five stages of innovation adoption and examining its impact on first-year middle school students' mathematics achievement. Beyond evaluating academic outcomes, the study also considers the implications of stage-based instructional design for teacher professional practice, particularly in fostering reflective, innovation-oriented classroom environments.

Accordingly, this study aims to determine whether applying a Rogers-based instructional model results in statistically significant differences in mathematics achievement compared to traditional teaching methods. The null hypothesis guiding the investigation states that there is no statistically significant difference at the 0.05 level between the mean achievement scores of students taught using the Rogers-based instructional model and those taught using conventional instruction.

Literature Review

Diffusion of Innovations in Educational Contexts

The Diffusion of Innovations theory developed by Everett Rogers provides a systematic explanation of how new ideas, practices, or technologies are introduced and adopted within a social system. In *Diffusion of Innovations*, Rogers (2003) defines innovation as an idea, practice, or object perceived as new by an individual or group, while diffusion refers to the process through which that innovation is communicated over time among members of a social system. Central to the theory is the five-stage innovation-decision process: knowledge, persuasion, decision, implementation, and confirmation.

Although initially conceptualized within sociological and organizational contexts, diffusion theory has been widely applied to technology integration, health interventions, and institutional reform (Kaminski, 2011; Ma et al., 2014). In educational research, diffusion theory has often been used to examine teachers' adoption of instructional technologies or curriculum reforms rather than students' cognitive engagement with new knowledge. This dominant focus on institutional or teacher-level adoption leaves underexplored the potential of diffusion theory as a pedagogical design framework guiding classroom instruction itself.

Conceptually, learning can be interpreted as a process of adoption innovation. When students encounter new mathematical concepts, they are first exposed to unfamiliar ideas (knowledge stage), form evaluative judgments regarding their usefulness or comprehensibility (persuasion stage), decide whether to engage in applying them (decision stage), attempt practical use in problem-solving contexts (implementation stage), and eventually consolidate understanding through feedback and reflection (confirmation stage). Structuring instructional processes to intentionally align with these stages may support smoother cognitive transitions, reduce resistance to complex material, and enhance long-term retention.

From a theoretical standpoint, diffusion-based instructional design aligns with constructivist learning principles, which emphasize active engagement and gradual internalization of knowledge (Bransford et al., 2000). It also complements research suggesting that meaningful mathematics instruction involves structured opportunities for reasoning, discussion, and feedback (Hiebert & Grouws, 2007). Thus, diffusion theory offers not merely a sociological explanation of change but a potentially powerful framework for organizing instructional progression in mathematics classrooms.

Innovation-Based Mathematics Instruction

Contemporary mathematics education research consistently highlights the importance of student engagement, collaborative interaction, and conceptual understanding as strong predictors of academic achievement. Active learning approaches have been shown to produce significantly higher performance outcomes compared to traditional lecture-based methods (Prince, 2004). Moreover, instructional models that integrate problem-based exploration and reflective discussion promote deeper cognitive processing and creative thinking (Jawad et al., 2021).

Innovation-based pedagogy typically incorporates structured experimentation, real-world relevance, cooperative tasks, and formative feedback mechanisms. These components parallel key elements of the diffusion process, particularly in facilitating gradual acceptance and mastery of new ideas. However, while many innovative mathematics teaching models exist—such as STEM-integrated approaches or inquiry-based learning—few explicitly operationalize diffusion theory as a stage-based instructional framework.

The absence of empirical studies directly testing diffusion theory as a classroom design model represents a gap in literature. Most prior applications of Rogers' framework in education examine macro-level innovation (e.g., institutional reform, digital technology implementation) rather than micro-level instructional processes. Consequently, there remains limited experimental evidence evaluating whether structuring mathematics instruction around the five adoption stages can significantly enhance student achievement.

This study contributes to literature by translating diffusion theory into a structured classroom model and empirically examining its effect on middle school students' mathematics performance.

Conceptual Framework

The conceptual framework of this study is grounded in diffusion theory and innovation-based pedagogy, proposing a direct relationship between a stage-based instructional model and students' mathematics achievement. Within this framework, the independent variable is the Rogers-based instructional model, which organizes instruction according to the stages of innovation adoption. The dependent variable is students' mathematics achievement, representing the learning outcomes resulting from the implementation of the instructional model in mathematics teaching.

The instructional model operationalizes Rogers' five stages of innovation adoption into structured classroom strategies, as summarized below:

Table 1. Instructional Strategies Based on Rogers' Innovation Adoption Stages

Student Adoption Stage	Instructional Strategy
Knowledge	Structured and explicit introduction of new mathematical concepts
Persuasion	Linking concepts to real-life contexts through guided discussion
Decision	Supported exploratory practice with instructional scaffolding
Implementation	Cooperative problem-solving and application exercises
Confirmation	Constructive feedback, correction, and reflective reinforcement

This alignment assumes that cognitive acceptance and mastery of mathematical concepts occur progressively through these stages. By intentionally structuring instructional sequences in accordance with innovation adoption theory, the model seeks to enhance engagement, conceptual clarity, and achievement outcomes.

The framework therefore hypothesizes that students exposed to a Rogers-based instructional sequence will demonstrate significantly higher mathematics achievement compared to students taught using traditional teacher-centered methods.

Method

Research Design

This study employed a quasi-experimental design using two equivalent groups with post-test measurement. The design was selected to examine the causal effect of a structured instructional intervention under natural classroom conditions where full randomization at the individual level was not feasible. Two intact classroom groups were assigned to experimental and control conditions.

The experimental group received instruction based on a structured model derived from Everett Rogers' Diffusion of Innovations framework, operationalized into five sequential instructional stages (knowledge, persuasion, decision, implementation, and confirmation). The control group received instruction using conventional teacher-centered methods that emphasized explanation, demonstration, and individual practice.

The independent variable was the instructional model (Rogers-based vs. traditional instruction), and the dependent variable was students' mathematics achievement measured at the end of the intervention.

Participants

The study sample consisted of 49 first-year middle school students enrolled in a public intermediate school in Baghdad during the first semester of the 2024–2025 academic year. The school was selected based on administrative accessibility and official approval from the relevant educational authorities. Students were assigned to groups based on intact classroom sections in order to maintain instructional continuity within the school setting. Accordingly, the experimental group consisted of 25 students who were taught using the Rogers-based instructional model, while the control group included 24 students who received instruction through the conventional teaching method.

To ensure baseline equivalence between the two groups prior to the implementation of the instructional intervention, several statistical comparisons were conducted. These comparisons included students' prior mathematics achievement scores, a prior knowledge test covering prerequisite mathematical concepts, and an intelligence test administered according to standardized procedures. Independent samples t-tests indicated no statistically significant differences between the experimental and control groups on these variables ($p > .05$), confirming that the two groups were statistically equivalent before the intervention.

Table 2. Baseline Equivalence Between Experimental and Control Groups

Variable	Group	N	Mean	Standard Deviation	t-value	Significance
Prior Mathematics Achievement	Experimental	25	—	—	—	p > .05
	Control	24	—	—		
Prior Knowledge Test	Experimental	25	—	—	—	p > .05
	Control	24	—	—		
Intelligence Test	Experimental	25	—	—	—	p > .05
	Control	24	—	—		

Note. Independent samples t-tests indicated no statistically significant differences between the experimental and control groups on baseline variables prior to the instructional intervention.

Instructional Procedure

The instructional intervention was implemented over one academic semester and covered three mathematics units included in the official curriculum: integers, rational numbers, and polynomials. A total of 39 lesson plans were prepared for each group to ensure consistency in instructional time and content coverage. For the experimental group, the lesson plans were explicitly structured according to the five stages of innovation adoption proposed in Rogers' model. Instruction began with the knowledge stage, in which new mathematical concepts were introduced in a clear and structured manner using examples and visual representations. This was followed by the persuasion stage, where real-life applications and guided questioning were used to enhance students' engagement and perceived relevance of the concepts. During the decision stage, students participated in supported exploration activities that encouraged them to attempt initial applications of the concepts. The implementation stage involved cooperative problem-solving tasks with gradually increasing levels of complexity. Finally, the confirmation stage focused on constructive feedback, error analysis, and reflective discussion to reinforce understanding and consolidate learning outcomes.

In contrast, the control group received instruction through traditional teaching practices, which primarily involved teacher explanations, demonstration of procedures, and individual exercises based on the prescribed mathematics textbook. Both groups were taught within the same school environment, followed the same curriculum content, and were allocated equivalent instructional time to control for potential external variables that might influence learning outcomes.

Table 3. Instructional Units and Implementation of Rogers' Innovation Adoption Stages

Mathematics Unit	Number of Lessons	Rogers' Stage	Instructional Activities
Integers	13	Knowledge	Introduction of concepts using examples and visual representations
		Persuasion	Discussion of real-life applications and guided questioning
		Decision	Exploratory activities and initial problem attempts
		Implementation	Cooperative problem-solving tasks
		Confirmation	Feedback, error analysis, and reflective discussion
Rational Numbers	13	Knowledge–Confirmation	Instruction structured according to the five Rogers stages
Polynomials	13	Knowledge–Confirmation	Instruction structured according to the five Rogers stages
Total	39 Lessons		

Note**.** The experimental group received instruction structured according to Rogers' innovation adoption stages, while the control group received traditional instruction covering the same mathematical units and instructional time.

Instrumentation

An achievement test was developed to measure students' mastery of the instructional content covered during the intervention period. The final version of the test consisted of 32 items, including 23 multiple-choice items and 9 essay-type problem-solving items. The test blueprint was constructed based on Bloom's cognitive taxonomy to ensure adequate representation of different cognitive levels, including knowledge, comprehension, application, analysis, synthesis, and evaluation.

To establish the validity of the instrument, several procedures were undertaken. Face validity was confirmed through expert review by specialists in mathematics education and educational measurement. After incorporating the suggested revisions, the level of agreement among experts exceeded 90%. Content validity was further ensured by developing a detailed test specification table that aligned the test items with the instructional objectives and cognitive levels outlined in Bloom's taxonomy.

The reliability of the test was examined using Cronbach's alpha coefficient to determine internal consistency. The reliability coefficient obtained was $\alpha = 0.797$, indicating an acceptable level of reliability for educational research. In addition, item analysis was conducted using a pilot sample to examine item characteristics. The results showed that item difficulty indices ranged from 0.318 to 0.758, while discrimination indices ranged from 0.242 to 0.545. These values fall within acceptable psychometric standards, suggesting that the instrument was appropriate for measuring differences in mathematics achievement between the experimental and control groups.

Table 4. Psychometric Characteristics of the Mathematics Achievement Test

Test Characteristic	Description
Total number of items	32
Multiple-choice items	23
Essay/problem-solving items	9
Cognitive framework	Bloom's Taxonomy (Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation)
Validity procedures	Expert review (face validity) and test specification table (content validity)
Expert agreement	> 90%
Reliability coefficient	Cronbach's α = 0.797
Item difficulty range	0.318 – 0.758
Item discrimination range	0.242 – 0.545

Note. Item analysis was conducted using pilot data to ensure that the achievement test met acceptable psychometric standards for educational measurement.

Data Analysis

The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS), Version 29. Both descriptive and inferential statistical techniques were applied to examine differences in mathematics achievement between the experimental and control groups.

Descriptive statistics, including means and standard deviations, were first calculated to summarize students' achievement scores and provide an overview of group performance. Prior to conducting inferential analysis, the assumption of homogeneity of variances was tested using Levene's test to ensure that the variance between the two groups was statistically comparable.

To test the research hypothesis, an independent samples t-test was conducted to determine whether there was a statistically significant difference between the mean achievement scores of the experimental group, which received instruction based on Rogers' model for the diffusion and adoption of innovation, and the control group, which was taught using the traditional instructional method. The level of statistical significance was set at $\alpha = 0.05$. All assumptions required for parametric testing were examined before conducting the hypothesis test. Statistical significance was interpreted based on p-values, and results were reported together with the corresponding degrees of freedom.

Table 5. Statistical Procedures Used in Data Analysis

Statistical Method	Purpose
Descriptive Statistics (Mean, Standard Deviation)	To summarize and describe the achievement scores of the experimental and control groups
Levene's Test for Equality of Variances	To verify the assumption of homogeneity of variances between groups
Independent Samples t-test	To determine whether a statistically significant difference exists between the mean achievement scores of the experimental and control groups

Note**.** Statistical analyses were conducted using SPSS Version 29 with a significance level set at $\alpha = 0.05$.

Results

Descriptive Statistics

Descriptive statistics were calculated to provide an initial overview of students' mathematics achievement in both the experimental and control groups. The analysis indicated that students in the experimental group obtained higher mean scores on the post-test achievement measure compared to those in the control group. This pattern suggests that the instructional approach based on Rogers' diffusion of innovations model may have contributed positively to students' academic performance.

The standard deviations of the two groups were relatively similar, indicating comparable variability in student performance within each group. This similarity suggests that the distribution of achievement scores was relatively consistent across the two instructional conditions and that no extreme dispersion differences were present.

Overall, the descriptive statistics provide preliminary evidence of a potential instructional advantage associated with the Rogers-based learning model. However, descriptive comparisons alone cannot determine whether the observed differences are statistically meaningful. Therefore, inferential statistical analysis was conducted to test the research hypothesis and determine whether the difference between the two groups was statistically significant.

Assumption Testing

Prior to conducting the independent samples *t*-test, the assumption of homogeneity of variances was examined using Levene's test. This test determines whether the variance of the achievement scores is statistically equivalent across the two groups, which is a necessary condition for applying the standard *t*-test for independent samples.

The results of Levene's test indicated that:

$$F(1, 47) = 0.901, p = 0.347$$

Since the *p*-value was greater than the predetermined significance level of 0.05, the null hypothesis of equal variances could not be rejected. This indicates that the variance of achievement scores in the experimental and control groups was statistically homogeneous.

Consequently, the assumption of equal variances was satisfied, and the independent samples *t*-test assuming equal variances was deemed appropriate for further hypothesis testing.

Hypothesis Testing

To determine whether there was a statistically significant difference in mathematics achievement between students taught using the Rogers-based instructional model and those taught using traditional instructional methods, an independent samples *t*-test was conducted.

The results of the analysis revealed the following:

$$t(47) = 9.262, p < 0.001$$

Because the *p*-value was substantially lower than the significance threshold of 0.05, the null hypothesis was rejected. This result indicates that there is a statistically significant difference in mathematics achievement between the two instructional groups.

More specifically, students in the experimental group who received instruction based on Rogers' diffusion of innovations model achieved significantly higher scores on the post-test compared to students in the control group who were taught using conventional teacher-centered instruction. This finding suggests that the Rogers-based instructional model provides a more effective pedagogical structure for supporting students' understanding of mathematical concepts.

Furthermore, the magnitude of the obtained *t*-value indicates a strong instructional effect. The large statistical difference between the two groups suggests that the implementation of a structured innovation-based instructional framework had a substantial positive influence on students' mathematics achievement.

Overall, these findings provide empirical support for the effectiveness of the Rogers-based instructional model in enhancing academic outcomes in middle school mathematics education.

Discussion

The present study examined whether mathematics instruction structured according to the innovation adoption stages proposed by Everett Rogers could improve students' academic achievement. The results demonstrated a statistically significant improvement in mathematics performance among students exposed to the Rogers-based instructional model compared to those receiving traditional instruction. These findings support the hypothesis that instructional designs grounded in diffusion of innovations theory can enhance student learning outcomes in mathematics education.

From a theoretical perspective, the results indicate that the Rogers-based instructional framework provides a structured learning pathway that supports the gradual internalization of mathematical concepts. The staged learning process—knowledge, persuasion, decision, implementation, and confirmation—creates a systematic progression through which students encounter, evaluate, apply, and reinforce new knowledge. This structured progression aligns with contemporary learning science perspectives that emphasize meaningful learning and gradual knowledge construction (Bransford et al., 2000).

The observed improvement in achievement can be further explained through several pedagogical mechanisms associated with the stage-based instructional framework.

First, the structured progression through the five adoption stages appears to function as a form of cognitive scaffolding that facilitates conceptual consolidation. By organizing instruction into sequential phases, the model mirrors the natural process through which learners gradually internalize new ideas. This staged approach may reduce cognitive overload by allowing students to process mathematical concepts progressively rather than confronting complex tasks without sufficient conceptual preparation.

Second, the Rogers-based instructional model promotes active engagement and collaborative interaction, particularly during the decision and implementation stages. Active learning environments encourage students to participate in discussions, problem-solving activities, and peer explanations. Previous research has consistently shown that active learning strategies significantly improve student achievement and deepen conceptual understanding compared to passive instructional approaches (Prince, 2004). In the present study, cooperative tasks implemented during the application stage likely facilitated peer interaction, cognitive negotiation, and shared reasoning processes, which are strongly associated with improved mathematical understanding (Hiebert & Grouws, 2007).

Third, the persuasion and decision stages may contribute to reducing mathematics-related anxiety while simultaneously strengthening learner motivation. By allowing students to evaluate the relevance and usefulness of mathematical concepts before applying them, the model provides a gradual transition from exposure to practice. This process may enhance learners' confidence and willingness to engage with challenging problems. Previous studies have similarly reported that innovation-oriented pedagogies can positively influence students' motivation, curiosity, and creative engagement in mathematics learning environments (Jawad et al., 2021).

Finally, the confirmation stage—centered on feedback and reflective reinforcement—plays a critical role in strengthening retention and self-efficacy. Constructive feedback allows students to correct misconceptions and refine their understanding through iterative learning cycles. Feedback-based learning has long been recognized as a key factor in promoting durable knowledge acquisition and sustained academic performance.

To further illustrate the pedagogical mechanisms underlying the Rogers-based instructional model, Table 6 summarizes how each stage of the innovation adoption process contributes to students' cognitive engagement and learning outcomes.

Table 6. Instructional Mechanisms of the Rogers-Based Learning Model

Rogers Stage	Instructional Strategy	Cognitive Function	Expected Learning Outcome
Knowledge	Structured introduction of mathematical concepts using examples and visual aids	Conceptual awareness	Initial understanding of mathematical ideas
Persuasion	Discussion of relevance and real-life applications	Motivational engagement	Increased interest and positive attitudes toward learning
Decision	Guided exploratory activities and scaffolded practice	Cognitive commitment	Students decide to attempt applying the concept
Implementation	Cooperative problem-solving tasks	Active knowledge construction	Improved conceptual understanding and procedural fluency
Confirmation	Feedback, reflection, and correction of errors	Metacognitive reinforcement	Consolidated learning and increased self-efficacy

Collectively, these mechanisms suggest that diffusion theory can function not only as a macro-level explanation of organizational change but also as a micro-level framework for instructional design. By translating innovation adoption stages into structured classroom strategies, the Rogers-based model provides a systematic yet flexible pedagogical approach capable of enhancing student engagement and academic performance in mathematics learning.

Implications for Teacher Professionalism

Beyond its impact on student achievement, the Rogers-based instructional model also carries important implications for teacher professional development. Implementing this model requires teachers to shift their role from content transmitters to facilitators of learning and instructional innovation.

Teachers become responsible for guiding students through structured cognitive transitions corresponding to the stages of innovation adoption. This instructional approach encourages teachers to carefully design lesson sequences in which learning objectives, instructional activities, and feedback mechanisms are aligned with students' developmental readiness.

The pedagogical implications of this approach are summarized in Table 7.

Table 7. Pedagogical Implications of Rogers-Based Instruction for Teacher Professional Practice

Instructional Dimension	Traditional Teaching	Rogers-Based Instruction
Teacher Role	Knowledge transmitter	Innovation facilitator
Learning Structure	Linear content delivery	Stage-based instructional progression
Student Engagement	Mostly passive	Active and collaborative
Problem-Solving Approach	Individual procedural exercises	Cooperative exploration and reasoning
Feedback Process	End-of-task correction	Continuous formative feedback

Stage-based instructional planning also encourages reflective teaching practices. Teachers must continuously assess students' progression through the innovation adoption stages and adjust instructional strategies accordingly. Such adaptive pedagogy strengthens professional competence and aligns with contemporary perspectives on teacher professionalism that emphasize reflective practice, instructional leadership, and evidence-based innovation.

Moreover, diffusion-based pedagogy may serve as a framework for professional learning communities, where educators collaboratively reflect on the implementation of instructional innovations and share effective teaching practices. In this way, the Rogers-based model supports both improved student learning outcomes and sustained teacher professional growth.

Limitations

Despite its contributions, several limitations should be acknowledged. First, the sample size of the study was relatively small and drawn from a single school context, which may limit the generalizability of the findings to broader educational settings. Second, student achievement was measured immediately following the instructional intervention, which restricts conclusions regarding long-term retention and sustained conceptual understanding. Third, the study relied exclusively on quantitative achievement data. Incorporating qualitative methods such as classroom observations, interviews, or student reflections could provide deeper insight into students' engagement and cognitive processes during stage-based instruction.

Future Research

Future research should replicate this study with larger and more diverse samples across multiple educational contexts to strengthen external validity. Longitudinal studies examining learning retention over extended periods would provide valuable insights into the durability of innovation-based instructional effects.

Additionally, integrating qualitative methodologies may help capture students' perceptions of stage-based learning processes and reveal how learners experience the transition through the innovation adoption stages.

Given the increasing integration of educational technology in mathematics classrooms, future investigations may also explore how diffusion-based instructional models interact with digital learning environments, adaptive learning systems, or blended learning approaches. Such studies could further clarify the potential of innovation adoption theory as a comprehensive framework for contemporary mathematics education.

Conclusion

This study demonstrates that applying a Rogers-based instructional model in mathematics teaching can lead to significant improvements in students' academic achievement. By organizing instruction according to the stages of innovation adoption, the model provides a structured learning process that supports gradual understanding, active participation, and continuous feedback.

The findings highlight the potential of diffusion of innovations theory not only as a framework for explaining organizational change but also as a practical approach to instructional design in classroom settings. When translated into pedagogical strategies, the stages of innovation adoption can guide teachers in creating more interactive and student-centered learning environments.

From a practical perspective, incorporating innovation-based instructional approaches into mathematics teaching may enhance both student learning outcomes and professional teaching practice. Future studies are encouraged to examine the application of this model in different educational contexts and subject areas to further explore its potential for improving teaching and learning processes.

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