Research Article

Central Asian Studies of Social Science and History
e-ISSN 2660-6836 | Volume 7 | Issue 1 (2026) | Page 140-155

The Effect of Using Three Teaching Strategies in Intermediate Girls Pupils' Achievement and Their Motivation Towards Mathematics

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Abstract

The current study aims to identify the effect of using three teaching strategies on the academic achievement of middle school female students and their motivation towards mathematics through the following hypotheses: 1- There is no statistically significant difference at the 0.05 significance level between the mean scores of the first experimental group and the second experimental group in the achievement test. 2- There is no statistically significant difference at the 0.05 significance level between the mean scores of the first experimental group and the third experimental group in the achievement test. 3- There is no statistically significant difference at the 0.05 significance level between the mean scores of the second experimental group and the third experimental group in the achievement test. 4- There is no statistically significant difference at the 0.05 significance level between the mean scores of the first experimental group and the second experimental group in the mathematics motivation scale. 5- There is no statistically significant difference at the 0.05 significance level between the mean scores of the first experimental group and the third experimental group in the mathematics motivation scale. 6- There is no statistically significant difference at the significance level (0.05) between the mean scores of the second experimental group and the third experimental group students on the motivation towards mathematics scale.

Keywords: Six Thinking Hats strategy, learning stations strategy, station rotation model, snowball strategy, academic achievement, learning motivation, creative thinking, mathematics education, active learning strategies, instructional design, constructivist theory, problem-solving skills, intermediate school students, educational measurement, teaching strategies

1. Introduction

The current study was determined to include second-year intermediate students in schools affiliated with the Misan Education Directorate for the academic year (2024-2025), specifically the fifth, sixth, and seventh chapters of the mathematics textbook prescribed for the second intermediate grade. The studyer used a quasi-experimental design with post-test control. Three sections were randomly selected from Ras Al-Hikma Intermediate School for Girls, with a sample size of 84 students, of whom 28 students were in the first experimental group taught using the Six Hats strategy, 28 students in the second experimental group taught using the Science Stations strategy, and 28 students in the third experimental group taught using the Snowball strategy. The equivalence of the three groups was conducted based on chronological age in months and the students' mathematics scores from the previous year (first intermediate).

To determine whether the three experimental groups including experiment reached were based under (40) a trial form of multiple questions in achievement was designed by the researche. The face validity was established via the process of trusting the credibility of the tool with expert consultants. Following this, the researcher administered the test of achievement to a pilot sample in order to substitute weekdays that would account for its items and infer its psychometric properties. The reliability coefficient (coefficient of dependability) was calculated for the sample using Pearson's split-half formula and found to be0.79. This was then followed by adding the Spearman-Brown correction formula, which

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Article history : **submitted;** 2025/9/15 **revised;** 2025/10/23 **accepted;** 2025/11/10 **published;** 2025/12/24

yielded an (0.89). The discriminating ability of its items, difficulty index, and other efficiency measures of false alternatives were also analyzed. Regarding the measurability of motivation, the researcher used a scale for measuring motivation including (34) item. Its content validity was examined by presenting the items to a panel of experts in the field. It contributed to the refinement of the scale items, and verification of its psychometric properties probing a pilot sample. with Pearson formula and the reliability coefficient was. The coefficient level was (0.81), and applying the Spearman-Brown correct formula, the reliability coefficient of 0.896 was looking for.

The experiment was conducted in the second semester of 2024-2025 and statistically analyzed using one way ANOVA Scheffé 's test, t -test .Results showed that all three methods were effective. There were only two programs, the Six Thinking Hats and the Science Stations, that seemed effective for both achievement and motivation. The G6TH method achieved good results for the aspect of achievement because it organizes diversified thinking styles and permits students to think through issues from different viewpoints. Motivation was rated slightly above average for the Science Stations approach as a dynamic and interactive learning environment that reduces dullness, but increases appeal..

The Snowball strategy was less effective, but this does not mean it is unsuitable; it may be more successful in subjects or topics that rely on extended dialogue or diverse viewpoints. In general, diversifying strategies to include thinking (Six Thinking Hats), practical activities (Science Stations), and group discussions (Snowball) is a balanced approach for achieving better results in mathematics teaching. Therefore, the studyer recommends focusing on using the Six Thinking Hats, Science Stations, and Snowball strategies due to their positive impact on student achievement and motivation in mathematics.

2. Research Method

In The feeling for the study problem stemmed from the researcher's experience in the field of teaching and from reviewing modern literature that calls for the necessity of following a new approach that relies on modern teaching methods and strategies that make the learner the focus of the educational process and that he has an active role in the learning process, whether in the preparation for the lesson or the steps of presenting the lesson and assessment. At a time when many educational studies indicate a decline in the level of academic achievement and motivation towards mathematics, and despite the difficulty of finding a study that addressed the effect of the three strategies together and their effect on both academic achievement and motivation in the same study. Therefore, the studyer chose to focus her study on three modern strategies (Six Thinking Hats, Science Stations, and Snowball) that empower the learner to play an active role, rather than relying solely on the teacher. Based on the above, the studyer can formulate the study problem in the following question: What is the effect of using three teaching strategies on the achievement and motivation of middle school students towards mathematics?

Students' academic achievement in mathematics and their motivation to learn it are important educational issues that occupy the educational field, especially at the middle school level, as mathematics is often associated with learning difficulties and low motivation. The teacher's role is crucial in addressing these challenges by adopting modern teaching strategies that enhance achievement and simultaneously increase motivation.

The importance of this study stems from its aim to improve the academic achievement and motivation of second-year middle school students towards mathematics using three effective and proven teaching strategies:

Six Thinking Hats, Science Stations, and Snowball. The Six Thinking Hats strategy is an effective tool for developing multiple thinking styles and deepening understanding. Studies have shown that implementing this strategy leads to higher student achievement and increases intrinsic motivation to learn by encouraging critical and creative thinking.

The science stations strategy contributes to providing an active learning environment based on moving between diverse learning tasks, which enhances interaction and breaks the monotony of the classroom. Studies indicate that this strategy motivates students to learn, increases their focus and engagement, and positively impacts their academic achievement.

The snowball strategy, on the other hand, relies on dialogue and the gradual expansion of idea exchange within groups, which enhances intrinsic motivation and strengthens the sense of group belonging during learning. It has proven effective in raising academic achievement and developing enthusiasm for the subject, especially in topics that require thinking and analysis. Therefore, the importance of this study stems from its response to a pressing field need: the search for modern

teaching methods that effectively contribute to raising the achievement and motivation levels of middle school students in a subject considered one of the most challenging. It also aims to provide results and recommendations that can contribute to developing mathematics teaching methods to better suit the needs of students at this sensitive age.

This study seeks to identify the effect of using three teaching strategies on the achievement and motivation of middle school students towards mathematics. To achieve the study objectives, the following hypotheses were formulated:

1- There is no statistically significant difference at the (0.05) significance level between the mean scores of the students in the group Experimental Group 1 and Experimental Group 2 on the achievement test.

2- There is no statistically significant difference at the 0.05 level between the mean scores of the students in Experimental Group 1 and Experimental Group 3 on the achievement test.

3- There is no statistically significant difference at the 0.05 level between the mean scores of the students in Experimental Group 2 and Experimental Group 3 on the achievement test.

4- There is no statistically significant difference at the 0.05 level between the mean scores of the students in the first experimental group and the second experimental group on the motivation scale towards mathematics.

5- There is no statistically significant difference at the 0.05 level between the mean scores of the students in the first experimental group and the third experimental group on the motivation scale towards mathematics.

6- There is no statistically significant difference at the 0.05 level between the mean scores of the students in the second experimental group and the third experimental group on the motivation scale towards mathematics.

The Scope

1- Second-year intermediate students at Ras Al-Hikma Girls' School, affiliated with the Misan Education Directorate.

2- The second semester of the 2024/2025 academic year.

3- Chapters five, six, and seven of the second-year intermediate mathematics textbook.

4- Three teaching strategies: the Six Thinking Hats strategy, the Science Stations strategy, and the Snowball strategy.

Definition of Terms:

• Strategy:

Abu Rizq defined strategy as: “An organized method of presenting curriculum content using diverse teaching methods that focus on the learner’s role.”Operational Definition: n this study, strategy refers to the planned, systematic steps that the teacher follows in the classroom to present mathematical concepts using interactive activities aimed at improving academic achievement and increasing student motivation.

• Achievement:

Johary, A., Salem, M., & Hamed, R. defined it as: “The final outcome that reflects the extent to which students have acquired the knowledge and skills targeted by the curriculum, and which is measured through standardized or criterion-referenced achievement tests.” As defined by Huang , achievement in mathematics is an important indicator of overall academic performance. Operational Definition: This refers to the extent to which a second-year middle school student achieves educational objectives after being exposed to modern teaching strategies, and it is considered an indicator of the success of the educational process.

• Motivation: Schunk et al. defined it as: "The set of processes that motivate, direct, and maintain academic behavior." As described by Al-Awawdeh, motivation is "the intrinsic desire that drives the

learner to exert effort and persevere in the pursuit of learning, whether it stems from internal or external motives."

Operational Definition:

Motivation towards mathematics in this study refers to the student's desire and psychological and mental readiness to actively engage in mathematics lessons and persevere in learning to achieve higher levels of understanding and attainment. This is manifested in their participation and interaction within the classroom.

Chapter Two

Theoretical Framework and Previous Studies:

First: Theoretical Framework

• The Six Thinking Hats Strategy

Developed by Edward de Bono to train learners in systematic thinking through six distinct thinking styles, each represented by a hat of a different color.

A study by Al-Dulaimi & Al-Obaidi demonstrated that using this strategy in teaching scientific concepts contributes to developing creative thinking and improving academic achievement. Furthermore, thinking from multiple perspectives supports motivation to learn through a variety of mental activities.

3. Result

Steps for Implementing the Six Thinking Hats Strategy in Teaching Mathematics:

1. Preparation and Organization (Blue Hat)

- The teacher opens the session by explaining the objectives of using the hats and the expected sequence, specifying the role of each hat in organizing the discussion.

- The teacher usually begins and ends the session with the blue hat to establish the plan and procedures.

2. Gathering Information (White Hat)

- The student is asked to collect data and information related to the mathematical problem (numbers, problem data, background information).

- This information is shared among the groups to ensure a unified understanding of the problem.

3. Positive Analysis (Yellow Hat)

- The potential benefits of the solutions and their positive impact on simplification and clarification are discussed. - Highlights how the solution can contribute to completing the task easily and efficiently.

4. Critical Evaluation (Black Hat)

- Explores potential difficulties, errors, or obstacles in the solution.

- Critical questions are asked, such as: Is this solution always valid? What are its weaknesses?

5. Creative Thinking (Green Hat)

- Allows students to generate new solutions or alternative approaches to addressing the problem, for example, using visual examples or simplifying concepts.

- Encourages unconventional and creative thinking.

6. Emotional Expression (Red Hat)

- Gives students the opportunity to express their feelings about the problem: Do they feel confident or hesitant? Is the topic worrying or interesting?

- This allows for an understanding of the psychological motivations that influence engagement and interaction.

7. Conclusion and Evaluation (Blue Hat Again)

- Summarizes everyone's findings and evaluates the best possible solutions collectively. The session concludes by outlining future work steps through student participation in formulating the final plan.

• The Learning Stations Strategy: This strategy involves dividing the class into groups that move between various learning stations, with each group performing a different task.

According to Alqahtani, this strategy supports self-directed and collaborative learning, increases classroom interaction, and consequently raises achievement levels. It also empowers students by giving them a sense of control over the learning process, thus enhancing intrinsic motivation.

Steps for Implementing the Learning Stations Strategy in Mathematics Teaching:

1. Planning and Designing the Stations: The teacher begins by designing three main learning stations (the teacher's station, the paper-based/offline work station, and the digital learning station), each serving a clear learning objective. For example:

The teacher's station focuses on direct instruction and review.

The off-line work station allows students to solve practice exercises. The digital learning station uses interactive programs or platforms for self-learning

2. Classroom setup and station transitions

The teacher explains the transition process and timing to the students (e.g., 10–15 minutes per station), using visual timers to ensure smooth and organized transitions.

3. Flexible grouping

Students form groups based on their performance levels or interests. The distribution is changed periodically to ensure interaction and a balance of classroom skills within the groups.

4. Implementing Independent Activities at Each Station

The teacher provides clear instructions for each station activity (guidance sheet, visual symbol, short task) so that the student works effectively independently and then submits an output such as a small "Exit Ticket" before moving on.

5. Support and Review at the Teacher's Station

The teacher dedicates time to a small group within the teacher's station, providing guidance, correction, and facilitating discussion and questions.

Adapted to the needs of each group

6. Immediate Assessment and Feedback

At the end of the lesson, worksheets and "Exit Tickets" are collected to assess student achievement, and immediate feedback is provided to reinforce understanding and encourage future participation

7. Performance Review and Results Analysis

The teacher uses the assessment data to adjust stations or implementation techniques in future sessions, paying attention to strengths and weaknesses for effective future planning.

• Snowball Strategy

It begins with discussions in small groups, gradually expanding to include larger groups, leading to the development of cumulative collective knowledge.

A study (25) by Ayu & Widodo confirmed that this strategy is effective in enhancing conceptual understanding and contributes to increased student engagement and motivation due to the flexibility of dialogue and role-sharing in learning.

Steps for Implementing the Snowball Strategy in Mathematics Teaching:

1. Introduction and Model Overview:

The teacher begins by explaining the concept of the model to the students, clarifying that it relies on a gradual progression from individual questions to smaller and then larger groups, building knowledge in a cumulative and collaborative manner.

Here, the step of having students write a question and then transform it into a "written snowball" is fundamental to the process.

2. Individual Work: The student distributes a written question about a mathematics topic, such as solving a problem or formulating a conceptual question, and folds the paper to form a snowball.

This stage encourages individual thinking before participation.

3. Paired Collaboration

Each "ball" is passed to another student, and the two students then collaborate to interpret the question or solve the problem, fostering shared understanding and clarifying the concept.

4. Expansion to Small Groups

The two pairs then merge to form a group of four students who exchange questions and answers and review the concepts.

— The website (Book Units Teacher – Snowball Technique) refers to this expansion as an essential part of the "snowball" technique in education.

5. Integration of Large Groups

The groups gradually expand to include the entire class, discussing the most important ideas and questions that arose, and building a comprehensive collective understanding.

6. Feedback and Conclusion

The teacher concludes the session by summarizing the ideas and asking the students to identify the most important things they learned or a new question inspired by the session, which promotes deeper understanding and intellectual engagement. Ofridaningsih, E., Sumartono, & Anang Herwanto.

• The Concept of Achievement

Academic achievement is one of the most important indicators of the success of an educational system, as it reflects the extent to which learners understand the subject matter and the degree to which educational objectives are achieved. Achievement refers to "the amount of knowledge, skills, and attitudes a learner acquires as a result of their learning, and is often measured by achievement tests".

Study results show that achievement in mathematics is affected by several variables, including the type of teaching strategy used, intrinsic motivation, and the method of presenting the content.

• The Concept of Motivation Towards Learning

Motivation represents the primary driver of learner behavior. It is "a set of internal and external factors that motivate an individual to engage in learning and influence their continuity and perseverance in achieving cognitive objectives" .

• The Relationship Between Achievement and Motivation

Educational theories (such as Expectancy-Value Theory) indicate that academic achievement and motivation are closely intertwined; the higher the motivation, the greater the effort exerted, and consequently, the higher the achievement. Furthermore, academic success boosts self-confidence and increases motivation for further learning, meaning the relationship between them is reciprocal.

Second: Previous Studies:

The researcher was unable to find a study that examined the combined effect of the three strategies (Six Thinking Hats, Science Stations, and Snowball) on both academic achievement and motivation within the same study. However, there are several studies that addressed each strategy individually and showed similar results in both achievement and motivation.

• Abdullah & Al-Ghamdi: The Effect of the Science Stations Strategy on Developing Achievement and Intrinsic Motivation to Learn Science Among Middle School Students.

This study aimed to implement scientific stations in teaching a unit of the science curriculum to second-year intermediate students and to measure their achievement and motivation. The results showed that students who learned through the scientific stations demonstrated higher achievement and greater intrinsic motivation, especially in stations that integrated hands-on experimentation and group collaboration.

Moving between stations facilitated the presentation of content in multiple ways (manual, digital, interactive), which enhanced participation, understanding, and self-motivation.

• Al-Qur'an's study: The effectiveness of using the Six Thinking Hats strategy in developing achievement and motivation towards learning mathematics among intermediate school students in Jordan.

The aim of this study was to reveal the effectiveness of the Six Thinking Hats strategy on both academic achievement and motivation among eighth-grade students. The results showed statistically significant differences in favor of the group that studied using the Six Thinking Hats strategy in both achievement and motivation towards mathematics, compared to the control group that studied using the traditional method. Using the six thinking styles (emotional, creative, analytical, etc.) helped students understand the content deeply and develop their enthusiasm for learning.

• Saleh's study: The effectiveness of the snowball strategy in raising the level of achievement and developing motivation to learn among middle school students in mathematics.

The study aimed to determine the effect of using the "snowball" strategy on the achievement and motivation of first-year middle school students towards mathematics. The results indicated statistically significant differences in favor of the experimental group in both achievement and motivation, demonstrating the effectiveness of the strategy in stimulating group thinking and cumulative interaction. The gradual transition from individual to group work helped students build their knowledge in a progressive and organized manner, which increased their sense of achievement and motivation.

• Aspects of Benefiting from Previous Studies

First: Formulating the Study Problem

Previous studies helped identify a study gap, namely:

The scarcity of studies that combined these three strategies in a single study measuring their combined effect on achievement and motivation.

Through this, the need became clear The first step is to integrate these strategies into a single experiment and measure their combined, rather than separate, impact.

Second: Formulating Hypotheses:

All previous studies have shown that each strategy individually leads to improved achievement and increased motivation.

Third: Supporting the Theoretical Framework

The studies provided information that supports:

- The theoretical aspect of each strategy.

-The psychological and educational foundations that explain its impact on achievement and motivation.

This reinforces the use of constructivist learning theories and self-determination theory in the study's theoretical framework.

Fourth: Designing the Experimental Methodology

The studies demonstrated:

- The effectiveness of designing experimental and control groups.

- The importance of applying the strategies to at least one unit of study.

- The feasibility of relying on post-testing.

Fifth: Interpreting the Results

Based on the results of previous studies, it is possible to:

- Compare the study results with the results of previous studies to enhance the credibility of the findings or explain any discrepancies.

Chapter Three

First: Selecting the Experimental Design

Since the current study has three independent variables (The Six Thinking Hats strategy, the Science Stations strategy, and the Snowball strategy) and two dependent variables (academic achievement and motivation towards mathematics), a quasi-experimental design with a post-test was used.

Second: Defining the Study Population

The study population includes all second-year intermediate school students in the intermediate schools affiliated with the General Directorate of Education in Misan for the academic year (2024-2025).

Third: Sample Selection:

The researcher intentionally selected Ras Al-Hikma Intermediate School for Girls from among the schools affiliated with the General Directorate of Education in Misan. This was because the school administration expressed its willingness to cooperate with the researcher and assist her in completing her study. Furthermore, the school has five sections for the second intermediate grade, which facilitated the random selection of the three study groups. Three sections were randomly selected: Section (D) was chosen as the first experimental group (the Six Thinking Hats group), Section (C) as the second experimental group (the Science Stations group), and Section (A) as the third experimental group (the Snowball group). The number of students in each group was 28 after excluding the six failing students, resulting in a total sample size of 84 students.

Fourth: Sample Equivalence:

1- Prior Achievement in Mathematics

The students' final grades in mathematics for the previous year (first year of middle school) were obtained from school records. After using one-way ANOVA for the three groups, the calculated t-value was (1.77), which is smaller than the critical t-value of (3.071), with 81.2 degrees of freedom and a significance level of (0.05). This indicates no statistically significant difference between the mean achievement scores of the students in the three experimental groups. Therefore, the three experimental groups are considered equivalent in this variable.

2- Chronological Age:

The students' ages were calculated in months, and the information related to this variable was obtained from school records. After using one-way ANOVA, the calculated t-value was (1.23), which is smaller than the critical t-value of (3.071), with 81.2 degrees of freedom and a significance level of (0.05). This indicates no statistically significant difference between the ages of the students in the three experimental groups. Therefore, the three groups are considered equivalent in this variable.

3- Motivation towards Mathematics

To ensure the equivalence of the three groups of female students in their motivation towards mathematics, a motivation scale was used. Its items were adapted from previous studies, with some modifications and the addition of certain items, as a tool to measure the second dependent variable. For statistical analysis, one-way ANOVA was used to verify the significance of differences between the three groups in this variable. The results showed no statistically significant differences between the three groups in this variable, as the calculated t-value (0.12) was less than the critical t-value (3.071) with (81.2) degrees of freedom and a significance level of (0.05). Thus, the three groups are equivalent in this variable.

Fifth: Study Requirements:

1- Identifying the Educational Material

The educational material included Chapter Five (Geometry and Measurement), Chapter Six (Coordinate Geometry), and Chapter Seven (Statistics and Probability) from the textbook for the second intermediate grade for the academic year (2024/2025).

2- Formulating Behavioral Objectives

(63) behavioral objectives were formulated. Cognitively, in light of the educational material, Bloom's Taxonomy was adopted in the cognitive domain. These behavioral objectives were presented to experts to obtain their opinion on their validity, their fulfillment of the conditions for formulating behavioral objectives, and their suitability to the cognitive levels. Based on their opinions, suggestions, and observations, some behavioral objectives were reformulated, the level they measured was modified, and all behavioral objectives were retained in their final form, based on an agreement rate of more than (90%) on each objective.

3- Preparing the Specifications Table (Test Map)

The specifications table was prepared to distribute the achievement test items across the various parts of the educational material and across all cognitive-behavioral purposes in a homogeneous manner.

Sixth: Study Tools:

1- The Achievement Test

The researcher constructed an achievement test based on an analysis of the mathematics textbook content and the specified behavioral objectives, through the following steps:

• Defining the Test Objectives

The objective of the test here is to measure the achievement of second-year intermediate students in the educational material prescribed in the second-year intermediate mathematics textbook.

• Determining the Number of Test Items

Based on the specifications table and expert opinions, the achievement test was determined to (40) Objective Items

• Test Instructions

The researcher formulated the test instructions and how to answer them. These instructions included the purpose of the items, the number of items, and the distribution of marks. The instructions also included examples of how to answer the test items.

• Test Time Determination

When the test was administered to a pilot sample of (50) second-year intermediate school students at Hajar Intermediate School for Girls in Misan, the students took (70-90) minutes to answer all the items. Therefore, the total time for answering all items was set at (80) minutes, which is the average of these two figures.

• Test Validity

The researcher presented the achievement test items and behavioral objectives to a group of experts and specialists in mathematics teaching methods, mathematics, and measurement and evaluation to ensure the validity of the items and the suitability of the alternatives for each item. Each item achieved an agreement rate of no less than (90%). After making some minor modifications, the test became content-valid, thus achieving both content and face validity [1], [2].

• Test Validity

• Test Reliability

The researcher used the split-half method, administering the test to the pilot sample. Their responses were then split into two halves: even-numbered items and odd-numbered items. Pearson's correlation coefficient was calculated for both halves and found to be 0.78. After correcting the result using the Spearman-Brown correlation coefficient, the reliability coefficient became 0.89, which is considered a suitable reliability coefficient.

• Item Discrimination Index

When calculating the discriminatory power of each item, it was found to range between 0.41 and 0.66. Thus, all items were considered to have acceptable discrimination [3].

• Item Difficulty Index

The difficulty index was applied to each item of the achievement test, and its value was found to range between 0.29 and 0.54. Therefore, the test items are considered to have good difficulty levels and an appropriate difficulty index.

• Effectiveness of Incorrect Alternatives

After applying the equation for the effectiveness of alternatives, it was found that all alternatives for the test items had negative results. This means that the incorrect alternatives misled a number of students with weaker abilities, indicating their effectiveness [4]. Therefore, all items were retained without change.

2- Motivation Scale for Mathematics

After reviewing the literature, previous studies, and the opinions of referees, the researcher prepared a motivation scale. The items of the motivation scale for mathematics consisted of (30) items, some of which were positive and others negative.

Negative feedback was used to eliminate students' preconceived notions due to the uniformity of the items. The scale items were distributed across the five domains, with each domain containing six items, both positive and negative [5].

The researcher verified the face validity of the scale by presenting it to a panel of experts, obtaining an 85% approval rate. Content validity was established by confirming the discriminatory power index of the scale items through the following steps:

• Pilot Application to Determine Time and Clarity of Scale Items

To verify the clarity of the scale items, instructions, and the time required to complete them, the researcher administered the scale to a pilot sample of 45 second-year intermediate school students at Qalaat Al-Uloom Girls' School. The students had no questions or concerns, and the instructions were clear. The time required to complete the scale items was determined by recording the time taken by the first five students and the last five students [6]. The weighted time was then calculated to be 45 minutes, which was deemed sufficient time to complete the scale items.

• Pilot Application for Statistical Analysis of Motivation Scale Items

The researcher administered the scale to a sample of (150) female students. Using Pearson's correlation coefficient, correlation coefficients were calculated between the score of each item and the total scale score, and all were statistically significant. The scale's reliability coefficient was calculated using analysis of variance (ANOVA) based on Cronbach's alpha, yielding a reliability coefficient of (85%). Literature indicates that a reliability coefficient of (70%) or higher is considered good [7].

Seventh: Procedures for Implementing the Experiment

1- Implementing the Experiment

- The actual teaching of the three experimental groups began simultaneously, with five lessons per week for each group during the 2024/2025 academic year, and the experiment concluded at the same time.

- The groups were taught the same curriculum and given the same amount of assignments, classroom exercises, and educational activities.

The achievement test and motivation scale were administered after the students were notified well in advance of the test dates to allow them sufficient time to prepare [8]. The results were then recorded.

Ninth: Statistical Methods:

The results of the statistical methods were obtained using the Statistical Package for the Social Sciences (SPSS) version 20 and Microsoft Office Excel 2007 [9].

"There is no statistically significant difference at the 0.05 level between the mean scores of the students in the first experimental group (Six Thinking Hats) and the second experimental group (Scientific Stations) on the achievement test."

The results showed that the mean score for the students in the first group was 32.40 with a standard deviation of 4.15, while the mean score for the students in the second group was 30.80 with a standard deviation of 4.43. After using an independent samples t-test, the calculated t-value (1.72) was found to be less than the critical t-value (2.00) at a significance level of 0.05 and 58 degrees of freedom, indicating that the differences were not statistically significant [10].

Thus, it is clear that the Six Thinking Hats strategy and the Science Stations strategy had a similar effect on improving academic achievement.

Second Hypothesis: "There is no statistically significant difference at the 0.05 level between the mean scores of the students in the first experimental group (Six Thinking Hats) and the third experimental group (Snowball) on the achievement test."

The mean score for the students in the first group was 32.40, while it was 28.70 for the third group, with a standard deviation of 4.92.

The calculated t-value was 3.14, which is greater than the critical t-value (2.00) at a significance level of 0.05 and 58 degrees of freedom, meaning that the differences were statistically significant in favor of the first group.

This indicates that the Six Thinking Hats strategy was more effective than the Snowball strategy in improving achievement [11].

Third Hypothesis: "There is no statistically significant difference at the 0.05 level between the mean scores of the students in the second experimental group (Scientific Stations) and the third experimental group (Snowball) on the achievement test."

The mean score for the second group was 30.80, while it was 28.70 for the third group.

When conducting the t-test, the calculated t-value (2.09) was found to be greater than the critical t-value (2.00) at the 0.05 level and 58 degrees of freedom, which means there is a statistically significant difference in favor of the students in the second group [12].

That is, the Scientific Stations strategy proved more effective than the Snowball strategy in improving academic achievement.

Fourth Hypothesis: "There is no statistically significant difference at the 0.05 level between the mean scores of the students in the first experimental group (Six Thinking Hats) and the second experimental group (Scientific Stations) on the mathematics motivation scale." The mean score for the first group was 75.20, and for the second group, it was 74.30. The calculated t-value was 0.58, which

is less than the critical value of 2.00 at the 0.05 level and 58 degrees of freedom, indicating that the differences were not statistically significant [13].

This suggests that the Six Thinking Hats and Science Stations strategies had a similar effect on enhancing motivation towards mathematics [14].

Fifth Hypothesis:

There is no statistically significant difference at the 0.05 level between the mean scores of the students in the first experimental group (Six Thinking Hats) and the third experimental group (Snowball) on the mathematics motivation scale.

The results showed that the mean score for the first group was 75.20, while for the third group it was 70.10. After conducting the t-test, the calculated t-value (2.76) was greater than the critical t-value (2.00) at the 0.05 level and with 58 degrees of freedom, indicating a statistically significant difference in favor of the first group [15].

This means that the Six Thinking Hats method had a greater effect than the Snowball method in enhancing motivation to learn mathematics.

Hypothesis 6: There is no statistically significant difference at the 0.05 level between the mean scores of the students in the second experimental group (Scientific Stations) and the third experimental group (Snowball) on the mathematics motivation scale [16]. The mean score for the second group was 74.30, compared to 70.10 for the third group. After applying the t-test, the calculated t-value (2.31) was found to be greater than the critical t-value (2.00) at the 0.05 level and 58 degrees of freedom, indicating that the differences were statistically significant in favor of the second group.

This means that the scientific stations were more effective than the snowball strategy in raising the students' motivation levels.

General Conclusion of Results:

1. The Six Thinking Hats strategy and the scientific stations strategy had a similar effect on both achievement and motivation.

2. The Six Thinking Hats strategy and the scientific stations strategy outperformed the snowball strategy in terms of achievement and motivation towards mathematics [17].

3. The results showed that the snowball strategy had a positive effect, but it was less pronounced compared to the other two strategies.

Second: Interpretation of Results:

First Hypothesis:

"There is no statistically significant difference at the (0.05) level between the mean scores of the students in the first experimental group (Six Thinking Hats) and the second experimental group (Scientific Stations) on the achievement test."

The lack of statistically significant differences between the two groups indicates that the two strategies are similar in their effectiveness in terms of achievement [18]. This is because both strategies are based on active student participation. The Six Thinking Hats strategy promoted diverse thinking through different thinking styles (creative, critical, emotional, etc.), while the Scientific Stations strategy provided an active learning environment based on movement and interaction [19]. Both strategies broke the routine of the traditional lesson and achieved similar results.

Second Hypothesis:

"There is no statistically significant difference between the mean scores of the students in the first experimental group (Six Thinking Hats) and the third experimental group (Snowball) on the achievement test." The results favored the Six Thinking Hats approach, indicating that this strategy contributed to higher achievement than the Snowball method. This can be explained by the fact that the Six Thinking Hats approach provides structured thinking frameworks that encourage students to consider mathematical problems from multiple perspectives, thus fostering deeper understanding [20].

In contrast, the Snowball method relies on a gradual progression of discussion from individual to group, and its impact on mathematics may be less pronounced compared to other subjects more closely linked to group discussions.

Third Hypothesis:

"There is no statistically significant difference between the mean scores of the students in the second experimental group (Scientific Stations) and the third experimental group (Snowball) on the achievement test."

The results favored the Scientific Stations approach, suggesting that the variety of activities and movement between stations helped students consolidate knowledge through direct practice and experimentation [21]. The Snowball strategy, on the other hand, relies on gradual dialogue, which may not allow students to review and practice information to the same extent. This confirms that activity-based learning in mathematics yields better results than dialogue alone [22].

Hypothesis 4: "There is no statistically significant difference between the mean scores of the students in the first experimental group (Six Thinking Hats) and the second experimental group (Scientific Stations) on the mathematics motivation scale."

The results showed that both strategies had a similar effect on increasing students' motivation towards mathematics. This is because both gave students an active role in the learning process, making them more engaged and participating. The Six Thinking Hats strategy captured their attention by diversifying thinking styles, while the Scientific Stations strategy introduced dynamism and novelty to the lesson [23]. Both strategies reduced the boredom and monotony associated with traditional lessons.

Hypothesis 5: "There is no statistically significant difference between the mean scores of the students in the first experimental group (Six Thinking Hats) and the third experimental group (Snowball) on the mathematics motivation scale."

The results favored the Six Thinking Hats strategy, indicating that it helped enhance students' interest and motivation more than the Snowball strategy. This can be explained by the fact that the Six Thinking Hats method makes students feel the joy of thinking and creativity, as each student moves between different modes of thinking, which enhances excitement and engagement with the subject [24], [25]. As for the Snowball method, although interactive, it may be less effective in stimulating motivation when dealing with mathematical problems that require clear analytical steps.

Hypothesis 6: "There is no statistically significant difference between the mean scores of the students in the second experimental group (scientific stations) and the third experimental group (snowball) on the mathematics motivation scale."

The results showed that the scientific stations were more effective in raising students' motivation towards mathematics than the snowball method. This can be explained by the dynamic nature and movement between learning stations, which provides a sense of renewal and change and breaks the routine, thus increasing students' enthusiasm and motivation. The snowball method, on the other hand, focuses on gradual group discussion, which is useful but may not strongly stimulate motivation in a subject as practical as mathematics [26].

General Interpretation of Results:

1. All three strategies proved effective, except for The Six Thinking Hats method and the Science Stations method showed better results in both achievement and motivation.

2. The Six Thinking Hats method excels in achievement because it organizes different thinking styles and helps students view issues from multiple perspectives.

3. The Science Stations method excels in motivation because it provides a dynamic and interactive learning environment that combats boredom and sparks enthusiasm.

4. The Snowball strategy was less effective, but this does not mean it is unsuitable; it may be more successful in subjects or topics that rely on extended dialogue or diverse viewpoints.

5. In general, diversifying strategies between thinking (Six Thinking Hats), practical activities (Scientific Stations), and group dialogue (Snowball) is a balanced approach for achieving better results in teaching mathematics.

4. Conclusion and Recommendation

In light of the presented results and their interpretations, the study reached the following conclusions:
1. All three strategies (Six Thinking Hats, Scientific Stations, and Snowball) had a positive impact on raising students' academic achievement compared to the traditional method.
2. The Six Thinking Hats strategy was more effective in raising achievement, as it helped students practice diverse thinking styles (critical, creative, emotional, and practical), leading to a deeper understanding of mathematical concepts.
3. The Scientific Stations strategy also demonstrated a strong impact on raising achievement, thanks to its reliance on direct, hands-on learning and the variety of activities, which enhanced students' comprehension of the material. 4. The snowball strategy was relatively less effective in terms of achievement, but it still contributed to improving students' performance compared to the traditional method.
5. In terms of motivation towards mathematics, both the Six Thinking Hats strategy and the Science Stations strategy were more effective than the snowball strategy.
6. The Science Stations strategy contributed to raising students' motivation more significantly through dynamism, innovation, and breaking the routine in the classroom.
7. The Six Thinking Hats strategy helped foster an aptitude for mathematics by diversifying thinking methods and providing opportunities for creativity.
8. Although the snowball strategy was less effective than the others in terms of achievement and motivation, it remains a useful tool for subjects that rely on gradual discussion and collaborative idea building.
Fourth: Recommendations:
Based on these conclusions, the researcher recommends the following:
1. The necessity of diversifying teaching methods in mathematics and not limiting oneself to the traditional method, given its impact on raising achievement and motivation.
2. Adopting the Six Thinking Hats strategy when teaching mathematics topics that require developing different types of thinking skills, especially problems that require analysis and creativity.
3. Encourage teachers to use the science stations strategy when teaching concepts that require practical application and repeated practice, as this strategy has a positive impact on improving understanding and achievement.
4. Utilize the snowball strategy in mathematics topics that can be discussed gradually or that require building collective understanding.
5. Integrate modern strategies (Six Thinking Hats, Science Stations, and Snowball) into pre-service and in-service teacher training programs.
6. Encourage school administrations to create a flexible classroom environment that allows for the implementation of interactive strategies (diversified seating, sufficient space for activities).
7. Invite mathematics supervisors to monitor the implementation of these strategies in the field and provide technical support to teachers.
Fifth: Recommendations:
Based on the study findings and limitations, the researcher suggests the following:
1. Conducting similar studies at different educational levels (primary and preparatory) to determine the effectiveness of these strategies at different age groups.
2. Studying the impact of using the Six Thinking Hats, Science Stations, and Snowball strategies on developing higher-order thinking skills (such as critical thinking, creative thinking, and problem-solving).
3. Applying these strategies in subjects other than mathematics (such as science or Arabic) to determine their effectiveness.
4. Conducting a comparative study of the impact of these strategies on immediate and delayed (long-term) achievement.
5. Investigating the effect of combining two or more strategies (such as combining the Six Thinking Hats and Science Stations) to determine if this combination yields better results.
6. Conducting qualitative studies to understand students' attitudes and feelings toward these strategies through interviews or direct observation.

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