

The Effectiveness of Integrating the Dual Analysis and Synthesis Strategies and the Integration of Fragmented Knowledge and Their Impact on Mathematical Achievement and the Development of Procedural Fluency among Fifth- Grade Science Students in Mathematics

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Abstract : This research aims to study the effectiveness of integrating the two strategies of dual analysis and synthesis and the integration of fragmented knowledge and their impact on mathematical achievement and the development of procedural fluency among fifth-grade science students in mathematics. The research sample consisted of two groups: an experimental group of (31) students who studied according to the two strategies of dual analysis and synthesis and the integration of fragmented knowledge, and a control group of (33) students who studied according to the traditional method. The researcher prepared an achievement test tool consisting of objective multiple-choice items and a procedural fluency scale. After conducting the necessary statistical analyses, it was applied to the students of the two research groups. The results showed the presence of statistically significant differences in the students' mathematical achievement and the development of procedural fluency, in favor of the experimental group.

Keywords: knowledge; integration ;strategy; mathematical; achievement; procedural fluency.

First: The Research Problem

The world today faces an increasing set of challenges and crises that significantly impact various fields, leading to increased interest in scientific research as a means of addressing these crises in positive and effective scientific ways. This requires working to raise a generation of young people who are educated and aware, and who acquire information and facts using reliable scientific methods for mathematics. The general objectives of teaching mathematics in our country emphasize the importance of enabling students to obtain information functionally, in addition to helping them develop their scientific tendencies, attitudes, and values. Through my experience as a teacher at various educational levels over many years, I have observed that students face difficulty absorbing information due to teachers' reliance on rote and indoctrination methods in teaching. There is also a lack of student participation in educational situations, as mathematics teachers insist on using traditional methods, making the teacher the center of the educational process, while the student remains the sole focus. They are often passive recipients, not participating in activities that enhance the application of information and help develop their scientific ideas and attitudes toward mathematics. In addition, there is a clear deficiency in the method of communicating information (Al-Najjar, 2010: 55).

The problem at school is that students do not participate in training on enrichment examples that enhance their knowledge and expand their ability to solve textbook problems, which negatively impacts their achievement. The analysis and synthesis strategies are modern methods that, according to the researcher, can contribute to enhancing students' abilities and motivating them to actively build knowledge. This strategy provides an effective learning environment for mathematics and may also contribute to developing students' procedural fluency, which motivates them to understand and strive for progress. It also enhances their behavioral potential and expands their knowledge, leading to a strong information base, thus improving

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their ability to learn, innovate, and persevere in research and exploration. Therefore, the researcher decided to use this modern strategy in an attempt to raise the level of achievement of fourth-grade students in science and develop their scientific curiosity. Based on the above, the problem crystallized into the following question: What is the effectiveness of combining the two strategies? The duality of analysis, synthesis, and integration of fragmented knowledge and their impact on mathematical achievement and the development of procedural fluency among fifth-grade science students in mathematics?

Second: The importance of the research

The world is currently witnessing a period of development and prosperity in the fields of technology and science, which has led to radical changes in contemporary lifestyles, particularly in the field of education. Science and its applications have become an essential part of this progress, as these changes have resulted directly and indirectly from scientific development, which has become a symbol of power in the age of science and technology (Amana, 2023, p. 9).

Recent developments in the field of education have also led to a shift in trends, whereby the teacher is no longer the focus of the educational process, but rather the learner has become the primary element and the main focus of the learning process. The learner is considered the final product through which educational goals are achieved. Therefore, an individual capable of creativity and critical thinking is the goal that most educational systems around the world strive to achieve. This is due to the awareness of those in charge of these systems of the importance of the creative individual and their belief that the nation's creators and thinkers are its true wealth (Al-Huwaidi, 2008: 5).

The educational field bears a great responsibility in keeping pace with continuous technological and scientific progress, in addition to Modifying them, honing their talents, stimulating their motivation, unleashing their intellectual energies, and enriching their ideas. (Abu Alam, 2005: 33) Therefore, modern curricula seek to enhance students' abilities to access scientific

knowledge, as no single teaching method is sufficient on its own. The curriculum is considered the school's and education's tool for achieving the educational goals of any society. Through it, educational objectives are transformed into behavioral attitudes and experiences that learners interact with and learn from. (Abu Qaliq, 2019: 8-9).

The curriculum is closely linked to teaching methods, as it is one of the essential elements that contribute to students' acquisition of knowledge. When students learn ideas and concepts through lecture and indoctrination, they are generally expected to apply what they have learned in the same context (Abu Labda, 2008, p. 131).

Teaching is considered a teaching tool and a system of planned activities, and it is one of the fundamental foundations for achieving active and effective learning. Teaching must go beyond theoretical aspects to also include practical aspects. To achieve educational goals and overcome challenges, the educational process requires effective tools. One of the most prominent of these tools is a successful teacher who keeps pace with developments in the educational process in all its dimensions. A progressive teacher must encourage their students to be creative and enriching, and help them understand topics in a more in-depth way (Bagazi, 2009, p. 127).

Mathematics is considered one of the basic subjects students need at this stage, as it contains a wealth of information that helps them answer questions and inquiries that arise in their minds, in addition to providing explanations about the world in which they live.

These curricula are designed based on the concept of integration, with the environment as the focus and humans as the starting point, which contributes to enhancing interaction between them as both subject and method. (Raji, 2003) Recently, there has been increased focus on using more effective teaching methods, such as learning methods that require active student participation, which is considered a prerequisite for the learning process. The teacher's role is no longer limited to presenting scientific facts, but has evolved to include developing diverse skills, fostering curiosity, and developing more specialized

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thinking styles (Al-Qattasheh, 2009: 33). To raise student achievement, many models have emerged.

The educational process, through the content it presents, seeks to help learners achieve a lasting learning impact and increase their motivation to learn. There is also an increasing focus on long-term information retention through the use of modern strategies such as analysis, synthesis, and integration of fragmented knowledge. These methods significantly enhance the learning impact and increase interest in the educational content. Because developing procedural fluency and mathematical achievement requires innovative teaching strategies and methods, they provide learners with educational situations that include scientific problems, allowing them to practice all mental processes, creativity, discover knowledge on their own, and apply it to new situations.

The dual strategies of analysis and synthesis and integration of fragmented knowledge are considered among the most prominent learning strategies. Effective and active learning, as many studies have demonstrated its importance in the fields of teaching and learning. This strategy has been applied in teaching a variety of subjects, and the results were consistent with its effectiveness in enhancing learners' scientific knowledge (Abu Qaliq, 2019, p. 67).

This strategy includes a set of sequential steps that enhance learner interaction throughout the educational process, starting with small groups and progressing to larger groups. It also contributes to increasing the volume of information available to students through discussions and dialogue between the teacher and students, as well as among the students themselves. (Hoda, 2018, p. 66).

Based on the above, the importance of this research is evident through the following points:

.It contributes to the development of curricula, teaching methods, and measurement and evaluation techniques that help measure and develop these skills that distinguish the research with its originality, especially at the local level.

.The importance of the dual analysis and synthesis strategies and the integration of fragmented knowledge as modern active learning strategies.

.The importance of procedural fluency as a modern variable applied in schools by teachers and instructors.

Third: Objective Research

The current research aims to study the effectiveness of integrating the dual analysis-synthesis and fragmented knowledge integration strategies and their impact on mathematical achievement and the development of procedural fluency among fifth-grade science students in mathematics.

To verify the research objective, the following two null hypotheses were formulated:

Fourth: Research Hypotheses

There is no statistically significant difference at the significance level (0.05) between the average scores of students in the experimental group who learn according to the dual analysis-synthesis and fragmented knowledge integration strategy and students in the control group who receive instruction using the traditional method on the mathematics achievement test.

.There is no statistically significant difference at the significance level (0.05) between the post-test procedural fluency development averages of students in the experimental and control groups.

Fifth: Research Limits

.Fifth-grade science students in a government daytime preparatory school in Mosul.

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

.Topics in the mathematics curriculum for fifth-grade science students (grades six and seven). Eighth: The curriculum for teaching.

Sixth: Research Terminology

Strategy: Define it

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To specificity and specificity. The goal of analysis is to understand the parts or elements as components of a whole (Abu Sharkh, 55: 2017).

Steps of the dual strategy of analysis and synthesis:

Define the topic or problem.

Gather information: Gather relevant information, whether data, evidence, or ideas, to help you understand the topic in a comprehensive way.

Analyze and deconstruct: Divide the topic into its basic elements and identify its main components or parts.

Interpret each part separately, identifying its relationships to the other parts.

Use analytical tools such as comparison, classification, or identification. (Adas, 2001: 89)

Consider how the parts interact with each other and how they form the overall picture.

Synthesis (re-composition or synthesis):

Integrate the analyzed parts in a logical manner, creating a unified and coherent picture.

-Develop a model, plan, or conclusion based on the constituent parts.

-Try to present it in a new or more integrated form based on the analysis.

Final Result and Evaluation

State the final results or conclusions.

Evaluate the extent to which the synthesis succeeded in achieving the objective of the analysis. (Al-Azouni, 2013: 33).

Strategy for Integrating Fragmented Knowledge

The Concept of Cognitive Integration:

The concept of cognitive integration has become an urgent necessity in light of the new and broad developments that highlight the importance of achieving cognitive integration among different types of knowledge. Understanding this concept requires knowledge of the various paths that cognitive integration takes. Because cognitive integration overlaps with complex concepts, it requires first examining the concepts of integration in general, then presenting the concept of cognitive integration in light of the educational approach presented.

Atallah's (2002) vision, which addressed the concept of cognitive integration from an educational philosophical perspective, defined cognitive integration as "Establishing

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interconnected relationships between dispersed knowledge to achieve the principle of cognitive communication, and establishing strong relationships between a set of knowledge, while ensuring that each remains distinct in its nature" (Atallah, 2002, p. 306).

Ali (2000), who introduced the concept of cognitive integration from a systematic perspective, defined integration as "the connection between a set of knowledge that by nature belong to one or more fields of knowledge, which reinforces the separation and isolation between topics and knowledge." (Ali, 2000: 37)

Steps for implementing the cooperative integration strategy:

.Students are divided into groups of six members.

.The curriculum is divided into five parts.

Each group member learns one part of the content, with the exception of two students who specialize in one part.

Each individual is assigned to explain their assigned part to the rest of the group.

Students who have studied similar parts exchange knowledge among themselves, and then the group members write a collective report on what they have learned. (Ayash, 2007: 144)

Procedural Fluency:

In the United States, the National Council of Teachers of Mathematics (NCTM) indicates that mathematics is considered a basic subject whose concepts and skills students must master well, given its great importance in developing thinking skills. However, mathematics remains a challenge for many learners. The teaching method significantly affects how well students understand what they are learning. If teaching is based on understanding, it becomes clearer and easier, facilitating the acquisition of skills. Mathematics goes beyond simply memorizing facts or procedures; it requires understanding and the ability to use a single procedure in a given situation. Therefore, it is essential to enable students to master procedures based on theoretical understanding and strategic thinking, in addition to problem solving. (NCTM, 2014).

A report by Masjewski, Mquombello, and Savard (2011) indicated that the focus in mathematics education has recently shifted toward teaching concepts, with less emphasis on procedures. Procedural ability is often assumed to develop naturally, making it less interesting from the perspective of research on conceptual knowledge. According to Wong and Evans (2007), students struggle to understand and use solution algorithms when their knowledge is primarily based on memory, rather than consolidating this knowledge through the assimilation of underlying concepts. Therefore, it is essential to enhance students' understanding and skills in implementing the steps in a way that makes sense for each, by developing their procedural fluency. (Suwaidan and Haidar, 2018: 89)

Components of Fluency in Mathematics:

Mathematical fact mastery means the ability to quickly recall addition, subtraction, multiplication, and division facts through conceptual learning and the use of memorization strategies. The four basic elements for determining mastery level are: 1. Flexibility, 2. Appropriate use of the strategy, 3. Efficiency, and 4. Accuracy (Shabr, 2005: 90).

Second: Previous Studies

Studies that addressed the dual analysis and synthesis strategy:

-Study (Amana, 2023): The effect of using the dual analysis and synthesis strategy in science teaching on developing innovative thinking and learning motivation among first-year middle school students.

The study was conducted in Egypt and aimed to identify (the effect of using the dual analysis and synthesis strategy in science teaching on developing innovative thinking and learning motivation among first-year middle school students.)

The researcher prepared an innovative thinking test and a motivation test for first-year middle school students. These tests were presented to the judges for their feedback and suggestions, and then modified based on these observations. Conducting a pilot study of the measurement tools, represented by the Creative Thinking Test and the Motivation to Learn Scale, on a group of first-year secondary school students, with the aim of verifying

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their validity and reliability. Preparing the final version of the research tools, which include the Creative Thinking Test and the Motivation to Learn Scale, after verifying their validity and reliability. Implementing the pre-test of the research tools, represented by the Creative Thinking Test and the Motivation to Learn Scale, on the two research groups (control and experimental). Teaching the Energy Resources Unit using the binary analysis and synthesis strategy to students in the experimental group. Conducting the post-test of the research tools, represented by the Creative Thinking Development Test and the Motivation to Learn Scale, on the two research groups (control and experimental). Using appropriate statistics, it was found that there was a statistically significant difference between the experimental group, which studied using the binary analysis and synthesis strategy. Studies that addressed the fragmented **knowledge integration strategy:**

Study (Hoda, 2018): The Effect of the Cognitive Integration Strategy on Developing Planning Skills for Teaching Art Education Units and Self-Confidence among Teachers Graduated from the Faculty of Fine Arts

This study was conducted in Egypt and aimed to identify (the effect of the cognitive integration strategy on developing planning skills for teaching art education units and self-confidence among teachers graduates from the Faculty of Fine Arts). The research sample consisted of (30) male and female students. A planning skills test and a self-confidence test were administered. The study consisted of two groups: the first experimental group, taught according to the cognitive integration strategy, and the second group, taught according to the traditional method. Using statistical methods, a statistically significant difference was found in favor of the experimental group, which studied according to the cognitive integration strategy.

Studies on Procedural Fluency:

Study (Fadwa, 2018): The Effect of Using an Instructional Strategy Based on Procedural Fluency on Developing

Mathematical Thinking, Conceptual Comprehension, and Attitudes toward Mathematics among Fourth-Grade Students in Jordan This study was conducted in Jordan and aimed to investigate the effect of an instructional strategy based on procedural fluency on enhancing mathematical thinking, conceptual comprehension, and attitudes toward mathematics. A sample of (108) fourth-grade students was selected during the 2014/2015 academic year from the schools of the Basira District Directorate. The sample was divided into two equal groups: an experimental group taught using an instructional strategy based on procedural fluency, and a control group taught using the traditional method. Data were collected through a mathematical reasoning test, a concept comprehension test, and a mathematics attitude scale. The results of the study showed statistically significant differences ($\alpha = 0.05$) in mathematical thinking, concept comprehension, and attitudes toward mathematics in favor of students in the experimental group. Research Methodology and Procedures.

First: Research Methodology

The researcher chose the experimental method as a means to achieve the objectives of their study, as this method is appropriate for the research procedures and helps in arriving at the results. The term "experimental" refers to making changes to a specific element and observing the effect of this change on another element (Al-Aloul, 2012, p. 59).

Second: Research Procedures:

The study procedures include the steps necessary to achieve its objectives and verify its hypotheses, which are Selecting the Experimental Design:

The experimental design represents the general structure of the experiment used to test the research hypotheses (Abdul Latif, 2010, p. 194). The researcher chose a two-group equivalent design with partial control. The experimental group consists of students studying the topics of the first three chapters of the textbook using the analysis and synthesis strategies and the fragmented knowledge integration strategy, while the control group studies the same topics using the traditional method. Both groups are subjected to a pre-test measuring procedural fluency.

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At the end of the experiment, an achievement test in geography is administered, in addition to another test measuring procedural fluency.

.Figure (1) illustrates this design

Post-test	dependent change	independent variable	Pre-test	The group	T
procedural fluency Athletic achievement	procedural fluency Athletic achievement	Analysis and synthesis strategy	procedural fluency	First experimental	1
		fragmented knowledge integration strategy		The second experiment	2
		The usual way		The officer	3

Figure (1) Experimental Research Design

Research Population

The population of this research consists of female students at daytime intermediate schools affiliated with the General Directorate of Education in Nineveh for the academic year (2024-2025). This population was intentionally selected from among the general directorates in Nineveh Governorate, with Al-A'dhamiyah District randomly selected, specifically Al-Intisar Intermediate School for Girls, as the study area.

Research Sample:

After the researcher visited the school in question, it was found that it had two fifth-grade literary classes. Using random sampling, two research groups were identified. Class (A) became an experimental group taught using the analysis and synthesis strategies and the fragmented knowledge integration strategy, while Class (B) was a control group taught using the traditional method. The number of fifth-grade literary students at the school was (65) students, distributed across the two classes, with Class (A) comprising (31) students and Class (B) comprising (34) students. After statistically excluding the students who failed from both groups, the number of students in the experimental

group became (31) students, while the number of students in the control group reached (33) students, as shown in Table (1).

(Table (1)

Individuals of the final research sample

Number of sample members	Number of failures	Total number	The branch	The group
31	-	31	A	empiricism
33	1	34	for	The officer
64	1	65		the total

Equivalence of the two research groups:

The researcher conducted a statistical analysis to balance the two research groups (experimental and control) in terms of a number of variables that could affect the validity of the experiment and the accuracy of the results. These variables include: chronological age, intelligence level, pre-procedural fluency scale, previous year's math grades, and parents' academic achievement.

A - Chronological age calculated in months

The students' ages were calculated in months as of October 7, 2024. Comparing the mean ages of the two groups, it was found that the mean age of the experimental group students was 202.5 months, while the mean age of the control group was 199.5 months. Using the t-test to examine the significance of the differences between the two groups on this variable, no statistically significant differences were found at the 0.05 level, as the calculated t-value (0.947) was lower than the tabular t-value (2.02) with 62 degrees of freedom. Therefore, the two groups can be considered equivalent in this variable (see Table 2).

B- Intelligence Level Test.

The researcher used the Raven test, which was standardized by Al-Dabbagh et al., due to its suitability for the Iraqi context and its high degree of validity and reliability (Haider, 2000, p. 60). Intelligence test scores were calculated for the experimental group students, with an average of 37.43, while the average score for the control group was 37.70. Using the t-test to test the significance of differences between the two groups

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on this variable, it was found that there were no statistically significant differences at the 0.05 level. The calculated t-value (0.217) was less than the tabulated t-value (2.001) with a degree of freedom of 62 (Table 2).

H- Pre-Procedural Fluency Scale Test

The average scores of the pre-Procedural Fluency Scale test were calculated after both research groups had taken the test before the start of the experiment. The mean score of the experimental group was 132.20, while the mean score of the control group was 130.91. Using the t-test to test the significance of the differences between these means, it was found that there were no statistically significant differences at the 0.05 level, as the calculated t-value (0.115) was less than the tabular t-value.

D- Mathematics Grades for the Previous Academic Year

Mathematics grade averages for the previous academic year were calculated based on the school's grade records. The mean score of the experimental group was 66.66, while the mean score of the control group was 65.81. Using the t-test to test the significance of the differences between these two means, it was found that there were no statistically significant differences at the 0.05 level, as the calculated t-value (0.379) was less than the tabular t-value (2.02) with a degree of freedom of 62. (Table 2)

(Table 2)

Variables for which the two research groups were rewarded

valuet		n=32 Officer		n=32 Experimental		Variables
Tabular	The calculated	standard deviation	arithmetic mean	standard deviation	arithmetic mean	
2,001	0.947	10:45	199.5	14.54	202.5	Chronological age
2,001	0.217	5.63	37.70	3.66	37.43	intelligence test
2,001	0.115	41.51	130.91	38.52	132.20	Pretest procedural fluency scores
2,001	0.379	85.48	65,181	9.369	66.66	Previous year math grades

Research Requirements

A - Defining the Academic Subject Matter

The academic subject matter includes the first three chapters of the mathematics textbook for the fifth-grade science curriculum in the Republic of Iraq.

B - Educational Objectives and Behavioral Objectives

Behavioral objectives play an important role in measuring student progress, as they can be measured after the learner has completed a specific learning experience (Al-Dasouqi, 2000, p. 10). Based on the general objectives of teaching mathematics for the fifth-grade science curriculum and the content of the three prescribed chapters, (113) behavioral objectives were formulated, distributed across Bloom's cognitive levels. These objectives, along with the educational material content, were then presented to a group of specialists to verify their comprehensiveness of the aforementioned levels and the accuracy of their formulation. Based on their opinions and comments, some objectives were reformulated, resulting in a final version of (113) behavioral objectives.

H - Preparing Instructional Plans

The instructional plan is a framework that includes a set of organized procedures and steps developed by the teacher to ensure the success of the teaching process and the achievement of the desired educational goals (Al-Dulaimi, 2005, p. 72).

Daily lesson plans were prepared for each of the research groups, totaling (27) plans. These plans were designed according to the analysis and synthesis strategy and the fragmented knowledge integration strategy for the experimental group, while similar plans were prepared for the control group using the traditional method. Samples of these plans were presented to a group of experts and arbitrators to benefit from their opinions and suggestions. The plans were deemed valid after achieving an 80% consensus.

Research Tools

The following is an explanation of the procedures for preparing the research tools:

Achievement Test: The test is a structured tool aimed at measuring the extent of students' learning. It also helps assess their interest in the lesson topic and reveal their readiness, which

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contributes to organizing their experiences and facilitating their learning process, in addition to identifying their strengths and weaknesses (Raji, 2003, p. 41).

To examine the effect of the independent variable (analysis and synthesis strategy and fragmented knowledge integration strategy) on mathematics achievement among the research sample, the researcher prepared an achievement test. 1. Defining the Test Objective: This test aims to measure the achievement level of fifth-grade science students in mathematics, using the first three chapters of the approved Natural Mathematics textbook for the 2024-2025 academic year.

.Defining the Test Levels: The six levels of the cognitive domain were identified according to Bloom's Taxonomy: knowledge, comprehension, application, analysis, synthesis, and evaluation.

.Preparing the Test Map (Table of Specifications): This step is considered crucial and essential in the process of constructing achievement tests (Abujado, 2003, p. 49). The table of specifications contributes to ensuring the validity of the test content, as it helps the teacher distribute questions across the various sections of the subject, preventing tests based solely on memorization (Al-Rikabi, 2001, p. 31). The researcher prepared the test map based on content analysis, taking into account the number of pages and behavioral objectives for the six levels of Bloom's Taxonomy. Table (3) illustrates this.

Table (3)
Test Map (Table of Specifications) according to content importance

the total	Calendar	Composition	Analysis	Application	understanding	knowledge	Levels	field Cognitive content	
%100	%12	%14	%18	%12	%20	%24	Its weights	Number of pages	the chapter
							Relative weight of pages		
22	3	3	4	3	4	5	%45		
18	2	3	3	2	4	4	%36	56	2

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10	1	1	2	1	2	3	%19	29	3
test 50 paragrap hs	6	7	9	6	10	12	%100	155	the total

Based on the specifications table, the researcher relied on objective tests as the basis for formulating the achievement test items. The test included (50) items, of which (42) were objective multiple-choice items with four alternatives. This is due to their advantages in measuring diverse educational knowledge and skills across different cognitive levels, making them suitable for all students at all educational levels (Zaytoun, 1999, p. 143). In addition, the test included (8) essay items, which measure higher cognitive levels such as analysis, synthesis, and evaluation, as well as lower cognitive levels such as recall, comprehension, and application (Zaytoun, 2007, p. 47).

Test Validity:

The test is considered valid because it was developed for the purpose for which it was prepared. The researcher verified apparent validity by matching the assessments of experts and arbitrators to whom the test was presented in its initial form with a list of behavioral objectives and the corresponding Bloom's levels they cover. Some proposed modifications were made based on their opinions. Content validity is related to the adoption of the test map as one of its indicators. The degree of content validity of achievement tests is assessed by the extent to which the test items represent the specifications table (Ibrahim, 2004, p. 275).

Instructions for scoring achievement test items:

A model answer was prepared for all test items, which the researcher relied on in the scoring process. A score of 1 was awarded for a correct answer and 0 for an incorrect or omitted answer. Therefore, the total score for the test was set in the range (0-42) for objective multiple-choice items, while the total score for essay items was set in the range (0-33). Thus, the final total score for the test ranged from (0-75) points.

Application of the achievement test to a pilot sample:

To verify the psychometric properties of the test, the clarity of its items, and to estimate the appropriate time to complete, the

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test was administered to a pilot sample of (78) female students randomly selected from fifth-grade science students. The students were informed of the exam date in advance. The time taken to complete the test was calculated at the time the first student completed (35) minutes, while the time taken at the time the last student completed (45) minutes, for a total average of (40) minutes. The researcher corrected the answers according to a pre-prepared correction key, and all scores were organized in a table for statistical analysis.

Statistical Analysis of the Achievement Test Items:

.Discriminating Power:

The discrimination coefficient for the objective items was used, with the discriminating power of these items ranging from (0.33-0.63). For the essay items, the coefficient was also used, with the discriminating power ranging from (0.39-0.47). Al-Harthi (2003) indicates that an item with a discrimination coefficient greater than (0.30) is considered acceptable and distinctive (Al-Harthi, 2003, p. 91). Difficulty Coefficient:

Using the difficulty coefficient for objective items, its values ranged between 0.22 and 0.61. Meanwhile, the difficulty coefficient values for essay items ranged between 0.33 and 0.54 when applying their respective equation. Therefore, test items are considered acceptable if their difficulty coefficient exceeds 0.20 (Hussein, 2019, p. 237)

.Effectiveness of Incorrect Alternatives

The effectiveness of a given alternative is evaluated by comparing the number of respondents from the upper and lower groups. The number of respondents from the lower group who chose the alternative must be greater than the number from the upper group (Al-Hamwi, 2008, p. 131).

When using the alternative effectiveness equation to evaluate the scores of the upper and lower groups for each multiple-choice item (related to the first question of the test), it was found that the alternatives were effective, with negative values ranging between -0.33 and -0.30, indicating that they appealed more to the lower group than the upper group.

Reliability of the Achievement Test:

Reliability of a test refers to the stability and consistency of its results. If the test is re-administered to the same individuals, similar or close results should be obtained (Adas, 2001, p. 118). Reliability of the objective items was calculated using the Kuder-Richardson-20 equation, which is considered the most common method for measuring internal consistency of test items. A score of one is assigned for a correct answer and zero for an incorrect answer (Qatit, 2012, p. 16). The reliability coefficient for these items was 0.97. Cronbach's alpha coefficient was used to measure the reliability of the essay items, as this measure is considered appropriate for tests containing multiple-point questions (Abu Sha'ira, 2007, p. 170). The results showed that the reliability of these items was 0.76, indicating that unstandardized tests are considered good if their reliability coefficient is 0.67 or higher (Abu Labda, 2008, p. 146)

With regard to the consistency of the scoring reliability of the essay items, essay questions are considered subjective, which requires them to be scored by more than one teacher to ensure the accuracy and consistency of the assessments (Al-Ahmad, 2002, p. 118).

To ensure the consistency of scoring, the researcher took a random sample of papers scored by another examiner. After a period of time, the researcher corrected the test himself, and used Cooper's equation to calculate the consistency of correction stability between the researcher and the other corrector, which reached (0.90), while the consistency of correction between the researcher and himself over time reached (0.93)

Procedural Fluency Scale

After the researcher reviewed a number of previous literature and studies related to procedural fluency, the scale contains 44 items distributed across these areas.

Reformulating the scale items and identifying answer alternatives:

The scale items were prepared according to the following procedures:

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A. Relevant Scales: The scales developed to measure procedural fluency were reviewed, and some of their items were utilized by reviewing previous studies.

B. Previous Literature and Theories: The literature addressing the procedural fluency variable and its measurement methods was relied upon.

The following points were taken into consideration when drafting the scale items:

Use clear language:

Formulate statements to suit the respondents' level of knowledge.

Include content within their study materials and cognitive background.

Present information in a clear and direct manner:

The researcher relied on the Likert scale method to prepare the scale alternatives, which is a common and preferred method in this field (Bagazi, 2009, p. 148). The researcher found it appropriate to use four-item alternatives for responses, namely: "Applies to a great extent, Applies to a moderate extent, Applies to a small extent, and Does not apply to me." This is because it is appropriate for the age group of middle school students, as the four-item format is considered the most appropriate for grading responses at this stage (Al-Najjar, 2010, p. 208).

Logical Analysis of Items:

Logical analysis of items is essential when developing a scale, as it reflects the item's ability to visibly measure the targeted trait (Ayash, 2007, p. 171).

Therefore, the researcher presented the items and their associated domains, along with a definition of each domain, to a group of specialists in education and psychology to obtain their opinions on the validity of the items in measuring procedural fluency and their suitability for middle school students. Based on their comments and opinions, some items were modified.

Exploratory Experiment:

The researcher administered the scale to a sample of 66 female students from the fifth grade of science at Sayed Hamad

Girls' School. The students were asked to read the scale's instructions and paragraphs carefully, inquire about any ambiguities, and report any difficulties they encountered while answering. The results of this experiment showed that the students clearly understood the scale's instructions and that its paragraphs were clear. The time taken to complete the scale was measured, with the first student taking 42 minutes, while the last student took 50 minutes, for an overall average of 46 minutes.

Scale correction:

The scale was corrected by assigning weights to the previously mentioned alternatives (4, 3, 2, 1) in sequence. Total scores were calculated for each individual in the sample and for each item on the scale, reflecting the student's raw score. Therefore, the highest possible score for the scale is 200, and the lowest is 50, with a theoretical average of 125. Psychometric Properties of the Scale:

Discriminatory Power of Items:

The discriminatory power of the items in the procedural fluency scale ranged between 0.37 and 0.63, making the items of this scale distinctive according to the opinions of specialists.

Scale Validity:

Face Validity:

The face validity of the scale was verified by presenting it to a group of experts and specialists in the fields of education and psychology. (Shabar, 2005) indicates that the best way to ensure face validity is for a group of specialists to assess the extent to which the statements represent the trait to be measured. (Shabar, 2005: 23).

Construct Validity:

Construct validity refers to the relationship between the results of tests and scales and the theoretical concept the test seeks to measure (Abdul Latif, 2010, p. 70). This type of validity was verified through two indicators:

.Discriminatory power of the scale items: The discriminatory power equation showed that its values ranged between (0.37 - 0.63).

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.Internal consistency (the relationship between the item and the total score).

Internal consistency was verified using the Pearson correlation coefficient, with correlation values ranging between (0.012 - 0.912). All items were statistically significant at the (0.05) level and with a degree of freedom of (148).

Scale reliability:

To calculate the reliability of the procedural fluency scale, the researcher used the Cronbach's alpha equation, which provides a reliable estimate of reliability in most cases. The scale's reliability coefficient reached (0.93), based on the number of sample questionnaires subjected to statistical analysis, which amounted to (66) questionnaires. This coefficient is considered good according to the opinions of specialists (Abu Jado, 2003, p. 203), making it reliable for the purposes of this research.

Implementing the Research Experiment

Before beginning the actual experiment, the researcher sought to achieve equivalence between the two research groups (experimental and control) on several variables, namely: (chronological age, IQ test, parents' academic achievement, previous year's math grades, and pre-procedural fluency scale.(The research experiment began on Sunday, October 7, 2024, with three lessons per week for each of the two research groups. The researcher relied on the analysis and synthesis strategy and the fragmented knowledge integration strategy in teaching the experimental group, while the control group was taught using the traditional method.

The research experiment lasted for 12 weeks, during the first semester of the 2024-2025 academic year, beginning on October 7, 2024, and ending on January 7, 2025. The achievement test was administered on Tuesday, January 8, 2024, while the post-test procedural fluency scale was administered to the two research groups (experimental and control) on Wednesday, January 9, 2025.

Statistical Methods:

The researcher used the following tools using the statistical software (SPSS).

.Two-independent-samples t-test (T-test): This was used to compare the equivalence of the two research groups on variables such as chronological age, IQ level, and previous year's math scores, in addition to processing the achievement test and procedural fluency scale data.

.Chi-square: This was applied to the parent's achievement data .

.Cronbach's alpha equation: It was used to determine the reliability of the essay items in the achievement test and the reliability of the procedural fluency scale.

Research Results

Presentation and Interpretation of Results :

The research findings will be presented, analyzed, and interpreted in accordance with the educational literature, taking into account the objectives and hypotheses. This will be achieved by comparing the average scores of the mathematics achievement test for the two research groups, as well as comparing the average scores on the procedural fluency scale between the two groups. The details of the results are as follows:

First: Presentation of Results:

.Results of the Mathematics Achievement Test

To identify the effect of the analysis and synthesis strategy and the fragmented knowledge integration strategy on mathematics achievement, the hypothesis states that "there is no statistically significant difference between the average achievement scores of the experimental group students studying mathematics using the analysis and synthesis strategy and the fragmented knowledge integration strategy and the average achievement scores of the control group studying the subject using the traditional method." The arithmetic means and standard deviations for the two groups were calculated as shown in Table (4).

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Table (4)

Arithmetic mean, standard deviation, and calculated and tabulated t-value for the mathematics achievement .test for the experimental and control groups

Significance level	T-value		standard deviation	arithmetic mean	Number of sample members	The group
Statistically significant	Tabular	The calculated				
	2,001	5.02	10.41	57.51	31	empiricism
			11.42	43.54	33	The officer

By analyzing the table, it is clear that the arithmetic mean for the experimental group was (57.51), while the mean for the control group was (43.54). Using a t-test for two independent samples, a statistically significant difference was revealed at the (0.05) level. The calculated t-value (5.02) was greater than the tabular t-value (2.001) at a degree of freedom of (62), leading to the .rejection of the null hypothesis

Results of the Procedural Fluency Scale Test:

To reveal the effect of the analysis and synthesis strategy and the fragmented knowledge integration strategy on procedural fluency, the hypothesis states that "there is no statistically significant difference at the (0.05) level between the average scores of students in the experimental group, who study mathematics using the analysis and synthesis strategy and the fragmented knowledge integration strategy, and the average scores of students in the control group, who study the same subject using the traditional method, on the procedural fluency scale."

Second: Interpretation of the Results

The results of this research indicate that the experimental group students, who studied using the analysis and synthesis strategy and the fragmented knowledge integration strategy, outperformed the control group students, who studied using the traditional method, on the mathematics achievement test and

procedural fluency. This superiority can be attributed to the fact that the students who used the analysis and synthesis strategies and the fragmented knowledge integration strategy focused on organizing scientific knowledge. Through these strategies, they sought to build scientific knowledge and improve their academic performance. A. The low academic achievement of the control group does not indicate a weak learning ability or a lower academic level. Rather, it is due to their weak ability to use the analysis and synthesis strategy and the fragmented knowledge integration strategy in a positive manner.

B. Furthermore, this strategy teaches students how to think and search for information, which enhances their desire to explore and achieve goals. This, in turn, raises a set of questions that contribute to raising their level and fluency.

Chapter Five: Conclusions, Recommendations, and Suggestions

First: Conclusions

Based on the research results, the following conclusions can be reached:

.The analysis and synthesis strategy and the fragmented knowledge integration strategy demonstrate superiority in improving mathematics achievement among fifth-grade science students, helping to raise their achievement level significantly compared to the traditional method.

.The analysis and synthesis strategy and the fragmented knowledge integration strategy are effective in enhancing procedural fluency among fifth-grade science students, contributing to a greater level of achievement and procedural fluency than traditional methods.

.Teaching using the analysis and synthesis strategies and the fragmented knowledge integration strategy contributed to increasing students' motivation for lessons, due to the use of numerous activities, events, and educational tools.

.The analysis and synthesis strategies and the fragmented knowledge integration strategies help teachers reorganize content in an organized and appropriate manner, which contributes to better achieving educational objectives.

Second: Recommendations

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Based on the research results, the researcher recommends the following:

.Focus on the use of modern teaching strategies, including the analysis and synthesis strategies and the fragmented knowledge integration strategies, in teaching mathematics.

.Integrate the analysis and synthesis strategies and the fragmented knowledge integration strategies into the curriculum and teaching methods curriculum in colleges of education.

.Raise awareness of the importance of the analysis and synthesis strategies and the fragmented knowledge integration strategies and how to apply them, both for students and teachers of various subjects, especially mathematics teachers.

Third: Suggestions :

In the context of completing the current study, the following research can be proposed:

.Study the impact of other types of strategies, such as the analysis and synthesis strategy and the fragmented knowledge integration strategy, on various dependent variables such as attitude, retention, cognitive preference, concept acquisition, and others.

.Compare the impact of the analysis and synthesis strategy and the fragmented knowledge integration strategy with other effective teaching strategies such as mental description, constructivist learning, and the multiple intelligences strategy.

.Conduct a study to explore the impact of the analysis and synthesis strategy and the fragmented knowledge integration strategy on other academic subjects and educational levels.

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