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THE EFFECTIVENESS OF WENNING'S INVESTIGATIVE MODEL IN THE ACHIEVEMENT OF PREPARATORY STAGE STUDENTS AND THEIR CONCEPTUAL THINKING

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Abstract:
The research aims to identify the effectiveness of Wenning's investigative model in the achievement of preparatory stage students and their conceptual thinking, an experimental design with two experimental and control groups was chosen, using a post-test achievement test and a conceptual thinking scale, to achieve the research objective, a purposive sample of 60 students was selected and divided into two research groups, with 30 students in the experimental group and 30 students in the control group. The students in the two research groups were matched according to the following variables: (age calculated in months, intelligence test, previous achievement in chemistry, conceptual thinking scale) in the first semester of the academic year (2024-2025), the researcher determined the subject matter to be studied during the experiment, which consisted of the first four chapters of the fifth-grade science chemistry textbook. The researcher formulated the behavioral objectives for the topics to be studied, which amounted to 180 behavioral objectives according to Bloom's levels (remembering, understanding, applying, analyzing, synthesizing, evaluation), the researcher (48) prepared a daily plan for teaching the two research groups and presented a sample of it to a group of arbitrators to determine its validity and suitability for fifth-grade science students, to achieve the research objective, the researcher prepared the research tools, an achievement test consisting of 35 objective questions with four alternatives, and a conceptual thinking scale consisting of 56 questions, the apparent validity of these tools was extracted by presenting them to a group of arbitrators in education and science teaching methods, the content validity was also extracted in light of the test's conformity with the content studied, the discrimination power, difficulty coefficient, and effectiveness of the wrong alternatives for each item of the test and scale were calculated using appropriate statistical methods. The stability was extracted

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using the Kuder-Richardson 20 equation and the Cronbach's alpha coefficient scale, after analyzing the results statistically using the t-test for two independent samples (for the achievement test and the conceptual thinking scale), the results showed that the experimental group studied using the Wenning investigative model outperformed the control group studied using the traditional method in the achievement test and the conceptual thinking scale.

Keywords: Wenning Investigative, Achievement, Fifth-Grade Science Students, Chemistry, Conceptual Thinking

Chapter One: Introduction to the Research

First: Research Problem:

Chemistry is one of the fundamental sciences in the natural world, and it is the basis for other sciences that seek to study, analyze, interpret, and utilize natural phenomena in their pursuit of technological development that is important for the entire world, this development has contributed to the creation of technology that is currently popular in many areas of life. Despite the importance of chemistry, we find that the actual teaching of it remains stagnant, relying on rote learning and explanation by the teacher, as well as memorization and rote learning by students, this has led to the neglect of educational activities and a lack of student interaction in the classroom, resulting in a noticeable decline in academic achievement (Kadhim, 2022: 45). This has been confirmed by previous studies, such as the study by (Al-Jubouri and Kadhim, 2020), this research showed that teachers use traditional teaching methods in chemistry, which is one of the reasons for poor student success, in addition, teachers do not allow students to think about their concepts or encourage them to participate in the subject, which leads to boredom and disappointment, and consequently low academic achievement, based on this information, the research problem can be described as follows: (How effective is the Wenning investigative model in the academic achievement and conceptual thinking of middle school students?

Second: Research Importance:

According to social constructivist theory, knowledge is not given to students, nor is it absolute or fixed. Rather, it is an individual construct that takes place in the social constructivist contexts in which teaching and learning occur,

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sometimes called social cultural constructivist theory, it is considered a scientific social activity in which students engage in scientific, social, and individual activities such as discussions with their teachers and peers, the social constructivist theory emphasizes the role of culture, customs, and lifestyles within society in learning, contrary to previous learning theories such as behaviorism and cognitivism, which portrayed the student as acquiring knowledge individually without the influence of society, thus, these theories neglected the social aspect of learning, which Vygotsky sought to emphasize, he also emphasized that mental development begins from the outside and moves inward (Al-Mousawi, 2020: 142).

Recently, many modern teaching models have emerged that focus on the teacher and the student, among these modern models that teachers should be aware of and use with their students are: (Wenning's investigative model), which takes into account the individual differences of students, thereby helping students improve what they learn (Hamdan, 2018: 187).

The Wenning investigative model is based on constructivist theory and was presented by the researcher (Wenning) as a result of his work on an educational project in the United Kingdom, it aims to stimulate learners' understanding of scientific concepts and help them interact actively and energetically in their classrooms, through this model, students become active, energetic, and more interactive, as they play a positive role in acquiring knowledge themselves through the five stages of the model, which are (the attention stage, the idea-building stage, the idea-reformulation stage, the idea-application stage, and the reflection stage) (Al-Baali, 2012: 15).

The practical use of the Wenning investigative model enables learners to determine how much they have gained from the educational process through collaboration and the extent to which they can effectively integrate into the educational process. (Abd Halim & Kamarudin, 2010: 3).

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building stage, the idea-reformulation stage, the idea-application stage, and the reflection stage) (Al-Baali, 2012: 15).

The practical use of the Wenning investigative model enables learners to determine how much they have gained from the educational process through collaboration and the extent to which they can effectively integrate into the educational process. (Abd Halim & Kamarudin, 2010: 3)

This model relies on the experience and lessons learned by learners in life, which can be utilized in their new education, in this model, goals are achieved through students working together in class to learn new experiences, the teacher acts as a supervisor, guide, designer, presenter, and builder of educational activities (Al-Baali, 2012: 18-17). In this model, the teacher can give each student a specific activity to understand and absorb facts and information in order to increase their abilities and improve their academic achievement (Ghanem, 2009: 201).

Educational systems strive to improve students' academic achievement because it is a measure of students' progress in their studies and their transition from one stage to another. However, the significance of academic achievement does not end there; it continues as students apply what they have learned and absorbed from information and experiences to various aspects of their daily lives, overcoming challenges and problems (Al-Shahrani, 2010: 38).

Conceptual thinking occupies an important place in educational institutions and educational bodies in developed countries, because it is based on situations that require students to think carefully when faced with a problem, therefore, it is important for both learners and teachers, as it facilitates learners' ability to think broadly and comprehensively and also helps them find solutions to problems, and situations they encounter in their daily lives by analyzing things carefully, increasing their ability to expand and comprehensive knowledge of those situations, and then solve them easily, this increases the learner's independence of thought to develop successful and effective solutions to the situations they will face (Ibrahim et al., 2013: 7-8).

From the above, the importance of the current research lies in the following points:

1. It is a scientific attempt at a topic that has not been addressed by researchers before at the local level, according to the researcher's knowledge (the effectiveness of the Wenning investigative model in the achievement of preparatory stage students and their conceptual thinking).

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2. The importance of social constructivist theory and its teaching methods as one of the modern theories used in teaching chemistry.
3. The importance of the Wenning investigative model as an educational teaching method that makes students active and effective and emphasizes collaborative work, stimulating students to learn, which is emphasized by modern educational philosophy.
4. The importance of the Wenning investigative model in teaching chemistry, which may contribute to the development of students' academic achievement and conceptual thinking skills.

Third: Research objectives

The research aims to identify the effectiveness of Wenning's investigative model in:

1. The achievement of fifth-grade science students in chemistry.
2. The conceptual thinking of fifth-grade science students in chemistry.

Fourth: Research Hypotheses:

To verify the research objectives, the researcher developed the following two null hypotheses:

1. The average scores of the experimental group studying according to the Wenning investigative model and the average scores of the control group studying using the traditional method in the chemistry achievement
2. test do not differ statistically at the 0.05 significance level.

2. The average scores of the experimental group studying according to the Wenning investigative model and the average scores of the control group studying using the traditional method in the conceptual thinking skills test do not differ statistically at the 0.05 significance level.

Fifth: Research Limitations: The research was limited to:

1. Spatial limitations: Preparatory and secondary day schools affiliated with the Qadisiyah Education Directorate/Morning Study Center.
2. Temporal limitations: The first semester of the academic year (2024-2025).
3. Human limitations: Fifth-grade science students.
4. Cognitive limitations: Chemistry textbook.

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Sixth: Terms Definition:

1. Effectiveness is defined by:

A. (Qatami and Naifa, 2018) as: "Achieving the goal and the ability to accomplish, i.e., the measure by which we recognize the performance of the teacher and the student and the role of each in the learning and teaching process" (Qatami, 2004: 475)

B. The researcher defines it procedurally as: the effect of the Wenning investigative model on the achievement of fifth-grade science students in chemistry as a dependent variable of the curriculum to be taught for the year (2024–2025) AD, which is measured in light of the achievement test and the conceptual thinking scale prepared by the researcher for this purpose.

2. The Wenning investigative model is defined by:

A. (Obaid, 2019) defines it as: "Educational plans based on psychological foundations that have been applied to a community, adding to the learner's experiences and effective mental capabilities within the educational community, helping them to reach the highest levels of understanding" (Obaid, 2019: 349).

B. The researcher defines it procedurally as: a theoretical descriptive procedure applied to fifth-grade science students in chemistry, consisting of a set of steps aimed at organizing the learning process and teaching within the classroom, thereby enabling fifth-grade science students to achieve the highest levels of comprehension in chemistry and then achieve the desired educational goals.

3. Achievement is defined by:

A. (Ismaili, 2011) as: "All performance by students in various academic subjects, to reach a certain level of competence that enables them to solve problems they encounter in their lives and adapt to their environment, through the content of various academic subjects, this is verified through achievement tests" (Ismaili, 2011: 96)

B. The researcher defines it procedurally as: the total marks obtained by each fifth-grade science student in chemistry for the two research groups in the achievement test prepared by the researcher for this research.

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4. Conceptual thinking is defined by:

A. (Al-Mousawi, 2020) as: an individual's tendency to act intelligently when faced with a problem and the answer or solution is not available in the cognitive structures, that any pattern of intelligent behavior that leads us to productive actions when we face divisions, are confused by dilemmas, or are guided by uncertainty, and refers to the use of intelligent behavior when the student does not know the appropriate answer or solution (Al-Mousawi, 2020: 34).

B. The researcher defines it procedurally as: a mental process resulting from a set of skills, namely reflection, observation, and discovery of fallacies, reaching conclusions about the problem, providing convincing explanations, and then proposing solutions that fifth-grade applied science students will use during their study of chemistry, we measure it by the grades that students will obtain when answering the conceptual thinking test questions prepared for this purpose.

Chapter Two: Theoretical Framework and Previous Studies

First: Constructivist Theory:

1. Concept: The past decades have witnessed a clear shift in the trends and perspectives that focus on the processes of learning and teaching, after the focus was on external factors affecting the learning process and its occurrence, which are related to the teacher and his preparation, the learning environment and its elements and the extent of its organization, the learner and his motivation, and the learning content, the research shifted to focus on internal factors related to the learner, and influence the learning process, including their previous experiences and knowledge, mental abilities, information processing methods, thinking patterns, motivation to learn, and thinking styles. In other words, research shifted to what is called “meaningful learning.” Theories emerged that dealt with the construction of knowledge and the interpretation of its processes. Amid this shift, constructivism emerged as a replacement for behaviorism and cognitivism. Constructivism is based on the formation of knowledge, information processing, and the integration of learning and technology. The field of education is one of the fields most influenced by constructivism. Constructivism is a process of receiving current cognitive structures, which occurs through learners constructing new cognitive structures and meanings through active interaction between their current cognitive structures, their prior knowledge, and the learner's environment, the concept of constructivist theory

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includes three elements: first, the learner's existing cognitive structures; second, the knowledge to which the learner is exposed in the current educational situation; and the third, the learning environment with its multiple variables (Al-Obaidi, 2023: 45).

Second: Wenning's Investigative Model:

1. **Concept**: Wenning's Investigative Model is one of the modern methods of investigative-based teaching, which was introduced by Wenning in 2005 at the University of Illinois in the United States, it is based on the ideas of John Dewey in the 20th century, who advocated experiential learning and investigative to improve reading and writing skills, Dewey suggested that learning should go through a series of initial learning cycles (as a modern translation), in which students receive stimuli (Impulse), make observations (Observation), and reach conclusions through knowledge, then make a valuable judgment on this excitement. Students then complete a second cycle, causing new excitement. Through a series of these cycles, students build knowledge based on their experience. This idea had not been used before, so the investigative levels model was built on it. (Al-Saadi, 2020: 112)

2. Steps of Wenning's investigative model:

The previous levels of investigative were integrated with the modern five-stage learning cycle, which is the basic structure for each level of investigative and consists of the following steps:

A. Observation: Students observe phenomena that interest them and elicit responses from them, and formulate the phenomena they observe into a researchable and investigable question.

B. Processing: Students propose ideas for discussion, develop approaches that help understand and comprehend the phenomenon under study, and develop plans for collecting quantitative and qualitative data.

C. Generalization: Students develop novel principles or laws for the phenomenon they are studying.

D. Verification: Students formulate predictions by employing the general law that was derived from the preceding phase.

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E. Application: Students formulate the agreed conclusions derived from the previous steps and then apply them in new situations to confirm them, investigative-based learning based on the constructivist approach and the learning cycle model develops students' deeper understanding of scientific concepts and how scientists work, giving them opportunities to build and apply scientific knowledge and develop practical intellectual and practical skills. (Al-Saadi, 2020: 112)

Third: Academic Achievement:

1. Concept: Specialists in the fields of education and psychology are interested in academic achievement because of its great importance in the life of the learner, it is the result of various learning processes that take place in educational institutions, involving different skills, knowledge, and sciences that indicate the learner's cognitive activity, achievement means that the individual achieves for himself, at all stages of his life, from childhood to the advanced stages of his life, the highest level of science and knowledge, so that he can move from the present stage to the next stage and continue to acquire science and knowledge (Jalali, 21:2011).

Fourth: Conceptual Thinking:

1. Concept: According to Gale's Encyclopedia of Psychology, the idea of conceptual thinking was developed by Guilford, who sees conceptual thinking as a fundamental component of creativity and links it to four main characteristics: fluency, flexibility, originality, and expansion. Guilford believes that divergent thinking is one of the fundamental dimensions (Attiya, 2015: 45). Gardner believes that conceptual thinking is guided by four principles: (Deferred judgment: emphasizes the need to refrain from evaluating, criticizing, or praising ideas; Striving for quantity: encourages learners to think of as many ideas as possible and to freely explore unusual possibilities, which allows for the formation of many new and unique ideas; Searching for connections: encourages the group to build on the ideas of others); Conceptual thinking activities are the responsibility of the problem solver, and the facilitator of the process is the person who organizes and guides the group but refrains from participating in the generation of ideas, conceptual thinking is a skill and an important factor for creativity (Suleiman, 2020: 201), and conceptual thinking represents the mental

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and intellectual ability to generate a large number of creative, diverse, and varied ideas (Jaber, 2015: 67).

Second Axis: Previous Studies:

Previous studies form part of the reference framework and theoretical frameworks for the study problem. Their efforts extend beyond merely identifying the concepts of others and associated outcomes to critiquing and analyzing prior knowledge, evaluating its relevance or connection to the forthcoming research topic. The review must be thorough and exhaustive to facilitate efficient writing of the research later, as it is preferable to examine previous studies and the contributions of others prior to composing the research and gathering its data (Al-Munizel and Adnan, 2020: 71). Upon examining prior studies and literature, the researcher found no investigations about the independent variable.

Chapter Three: Research Methodology and Procedures

Research Methodology: The researcher chose the experimental methodology to achieve the research objective, as it is considered one of the most suitable methods for research based on experimentation.

First: Experimental Design:

This research includes one independent variable (Wenning's investigative model, the usual method) and two dependent variables (achievement and conceptual thinking), therefore, the researcher used a partially controlled experimental design for two equivalent groups, one experimental and the other control, as shown in Table 2. Figure 1 illustrates this.

Figure 1: Experimental design of the study

Group	Equivalence	Independent variable	Dependent variable	Test
Experimental	– Age calculated in months – Intelligence test – Previous achievement in chemistry – Conceptual thinking scale	Wenning investigative model	Achievement + conceptual thinking	Achievement testing + Conceptual thinking scale
Control		Standard method		

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Second: Research Community and Sample:

1. Research Community: The research community included all fifth-grade science students in public secondary and preparatory schools for boys affiliated with the Directorate of Education in Al-Qadisiyah Governorate (center) for the academic year (2024-2025). The Qadisiyah Preparatory School for Boys was deliberately chosen for the following reasons:

A. The school administration's sincere desire to develop and improve the educational process.

B. The great cooperation shown by the philosophy and psychology teacher for the fifth-grade science class.

C. There are two classes for the fifth-grade science class at the school, which means that a simple random draw can be conducted for the two research groups.

D. The school is suitable for the research objective and represents the research community in terms of the number of students.

2. Research Sample: After determining the school where the experiment would be conducted, visited Al-Qadisiyah Preparatory School for Boys, which has two classes for the fifth-grade science section (A and B). Class A represents the experimental group (30 students) and Class B represents the control group (30 students).

Third: Equivalence of the Two Research Groups:

The researcher ensured equivalence in the following variables: (age calculated in months, intelligence test, previous achievement in chemistry, and conceptual thinking scale). The following table shows the above equivalences as in Table 1

Table 1: Arithmetic mean, standard deviation, and calculated and tabulated values for the variables of the two research groups

Variable	Group	Number	Arithmetic mean	Standard deviation	Degree of freedom	The two values		Statistical significance
						calculated	Tabulator	
Chronological age	Experimental	30	205.6	11,864	58	1.94	2.000	Not statistically significant
	Control	30	200.77	5,452				
Intelligence test	Experimental	30	8.43	2,329		1.001		
	Control	30	7.83	2.31				
Previous achievement in chemistry	Experimental	30	75.27	9,167		1.275		
	Control	30	60.40	9.84				
Conceptual thinking scale	Experimental	30	13.33	2.74		0.898		
	Control	30	13.93	2.45				

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Fourth: Controlling for Extraneous Variables:

Even though the researcher made sure that the two groups were comparable with regard to several factors that could influence the reliability of the findings, he nevertheless tried to keep some irrelevant factors from influencing the experiment's trajectory. Some of these variables that were controlled for include: (sample persons, incidental factors, experimental extinction, maturation-related processes, measuring instruments, experimental methods, and experimental procedures for extinction).

Fifth: Research Requirements:

It is essential to gather the following components before carrying out the experiment:

1. Scientific material identification: The researcher identified the scientific material that the students in the two research groups were to investigate during the experiment. Table 2 illustrates that the content consisted of the first four chapters of the fifth-grade chemistry textbook.

Table 2: Chapters to be taught during the experiment

S.	Chapters	Chapter Title
1.	First	The Development of the Atomic Concept
2.	Second	Intermolecular Forces and the Geometry of Molecules
3.	Third	The Periodic Table and the Chemistry of Transition Elements
4.	Fourth	Solutions

2. Developing behavioral objectives: The researcher devised 180 behavioral objectives that were distributed among the three levels of Bloom's classification: knowledge, understanding, application, synthesis, and evaluation, in accordance with the content of the material to be investigated in the experiment. The researcher presented the study material to a group of experts in the field of education and teaching methods to ensure that the objectives were valid and fully addressed. Cooper's equation for the agreement was employed to ascertain an agreement rate of 80% or higher after the judges' responses were reviewed. A few objectives were modified in accordance with their observations and opinions. The objectives were all authorized and maintained in their final form.
3. Creation of instructional plans: Acknowledging the necessity of instructional plan formulation for effective pedagogy, the researcher developed plans for the

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chemistry topics to be covered during the experiment, ensuring alignment with the designated textbook content and the behavioral objectives defined by Wenning's investigative model for the experimental group, while utilizing conventional methods for the control group. The researcher submitted two model plans to a panel of education specialists to obtain their thoughts, critiques, and ideas for improving the plans' development and ensuring their effectiveness for the experiment. In response to the evaluators' recommendations, requisite adjustments were made, and the plans are now ready for implementation.

Sixth: Research Tool:

A instrument was developed to assess the two dependent variables in order to ascertain the degree to which the research objectives and hypothesis were realized:

1. Achievement test: The researcher developed a unique achievement test for the chemistry subject that is scheduled to be taught in the first semester of the academic year (2024–2025). The test was developed in accordance with the following steps:

A. Test objective: The objective of the achievement test is to evaluate the academic performance of fifth-grade academic students (research sample) in a chemistry course that is scheduled to be taught during the academic year (2024–2025).

B. Determine the number and type of test items: The researcher implemented objective tests of the multiple-choice variety to assess Bloom's classification levels (knowledge, understanding, application, composition, and evaluation). The total achievement test comprised thirty-five items, each of which consisted of the original item and four alternatives, one of which is accurate and the other three are incorrect. These paragraphs were presented to a panel of experts and arbitrators, who provided valuable feedback that resulted in the revision of certain paragraphs.

C. Development of a specifications table: The achievement test specifications table was generated by the researcher. This is in accordance with the behavioral objectives of the three cognitive levels of Bloom's classification. The subsequent points delineate the procedures that the researcher employed to construct the specification table.

-Ascertain the content's relative weight (importance): The relative weight of the

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content of each chemistry topic was determined by the number of pages. The number of pages for each topic was calculated using the following equation:

Relative weight of the content of each unit = (number of pages for topic,)/ (total number of pages for topics) × 100%

- Determine the relative weights of behavioral objectives: The relative weights of behavioral objectives for the six levels were determined by calculating the ratio of the behavioral objectives of each level of chemistry subjects to the total number of objectives, as in the following equation:

Relative weight of behavioral objectives to level = (objectives number for single level in behavioral)/ (total behavioral objectives total) × 100%

- Determine the number of questions for one content using the following equation:

Number of questions in each cell = total number of questions × percentage of content × percentage of objectives at each level

(Al-Yasiri, 2018:87)

Table (3) Table of specifications for the achievement test

Chaps	Page Count	Materiality	Percentage of Behavioral Goals						Total
			Rememberin g	Understandin g	Applicatio n	Analyz e	Mountin g	Calenda r	
			40%	23%	15%	10%	8%	4%	100 %
First Chapter	34	29%	4	3	2	1	1	0	11
Second Chapter	25	21%	4	3	2	1	1	0	11
Third Chapter	35	30%	4	2	1	1	1	0	9
Fourth Chapter	23	20%	2	1	1	0	0	0	4
Total	117	100%	14	9	6	3	3	0	35

D. Test item drafting: Using the information from the test map as a guide, the researcher created the achievement test items in their original format. For the fifth scientific grade, the researcher chose the multiple-choice format since it is the most objective way to evaluate the levels of Bloom's cognitive categories (knowledge, comprehension, application, analysis, synthesis, assessment) in chemistry. Each of the 35 multiple-choice test items included the original item along with four options, three of which were erroneous and one of which was correct. A set of judges with backgrounds in education and teaching techniques

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were seen the paragraphs, and some of the text was changed based on their insightful feedback.

E. Test answer correction: Following the formulation of test items, the selection of the test type, and the development of the test in its initial form, which consists of 35 test items, a standard was established to correct the answers. This standard is as follows: one score is awarded for each correct test paragraph, while zero is awarded for the wrong answer, the paragraph that was omitted and not answered, and the paragraph for which more than one choice was made. Consequently, the final score ranges from zero to 35.

F. Test validity: The researcher implemented two categories of validity to guarantee the validity of the achievement test:

– Apparent validity: The researcher distributed the achievement test, along with the behavioral objectives and specifications table, to a group of experts and specialists in education and its teaching methods. In light of their opinions and suggestions, the paragraphs or alternatives that needed to be amended after adopting a percentage of (80%) or more by the Cooper equation for the agreement were amended. The results showed the validity of all test items, and therefore, (35) test items were retained.

– Content validity: The researcher constructed the test items to ensure that they represent the content of the academic subject, thereby making the test content valid for behavioral purposes.

G. Exploratory application of the test: The achievement test was applied to two exploratory samples as follows:

- First Initial exploratory application: The achievement test was administered to a group of students in the preparatory school (Khamas for boys) in its initial exploratory phase. The test was administered to a total of 30 students to determine the clarity of the test instructions, paragraphs, and the students' comprehension of the answer alternatives. The students were informed of the test date one week prior to the application date, and the researcher personally supervised the application. The time of the test was determined by adding the times taken by all students after recording the answer time for each student on their answer sheet and by adopting the following equation: By clarifying certain paragraphs to students, the meaning and wording of all paragraphs became clear and understandable. The average time taken by all students of the first exploratory sample was (45) minutes.

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Test time = (last student's time + ⋯ + second student's time + first student's time) / (total number of students)

(Shawahin, 2018: 87)

- Second exploratory application: The researcher supervised the application of the test to a second exploratory sample of (100) fifth-grade scientific students at Al-Jawahiri Preparatory School for Boys after ensuring the clarity of the test instructions, its paragraphs, and the time required to answer in order to extract the psychometric properties of the test.

H. H. Statistical analysis of the items the purpose of analyzing the test paragraphs is to improve the test by identifying the deficiencies in its paragraphs and detecting the weak paragraphs and addressing them or excluding the invalid ones; as a result, the researcher corrected the answers of the one hundred students who were a part of the exploratory sample, and arranged them in descending order from the highest score (36), to the lowest score (9). In addition, the researcher conducted the following statistical analyses:

- Coefficient of Discrimination: The discrimination coefficient was calculated for each paragraph of the test, and it was found that the discrimination coefficient of the objective paragraphs ranged between (0.34 - 0.61).
- The researcher discovered that the effective options for the test paragraphs are limited to a range of (-0.11 - -0.31). This suggests that the incorrect alternatives drew more students from the lower group than the upper group, so it was decided to keep all of the incorrect alternatives. - This brings us to the effectiveness of false alternatives.

Paragraph Difficulty Coefficient: The researcher applied a law to calculate a difficulty coefficient, and the results showed that all difficulty coefficients for the objective paragraphs ranged between (0,38-0,67), thus, the paragraphs of the achievement test are good and appropriate in terms of difficulty and ease, and acceptable.

I. Test stability: The researcher checked the stability of the test in two ways:

- Using the Kuder-Richardson equation 20 to determine the test's stability: This approach assesses the level of homogeneity of the test paragraphs and yields an internal stability coefficient, which measures the stability of the test, with a value of 0.88. The stability of the test was computed using the equation (Kuder-Richardson 20).

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1. Preparation of the conceptual thinking scale:

A. Determining the goal of the scale: This scale aims to measure the conceptual thinking of the research sample, which are fifth-grade science students.

B. Formulating the scale paragraphs: After determining the components of the conceptual thinking scale, the paragraphs of the scale were formulated, as a set of paragraphs were obtained, numbering (56) paragraphs.

C. Determining the alternatives of the scale: Five response options were placed in front of each paragraph: (This is always true for me), (This is often true for me), (This is partially true for me), (This is not true for me), and the scores were assigned (5, 4, 3, 2, 1), where the alternative that is scored (5) is for the situation that happens to me always, and as a result, the highest score a student in the sample can achieve on the scale is (280) degrees, and the lowest possible score is (56) degrees, the hypothetical average of the scale is (168) degrees.

J. Validity of the scale: The apparent validity of the scale of conceptual thinking has been extracted as follows:

- Apparent Validity: Many of the elements in the scale have been approved by experts and specialists in the field as legitimate and suitable for their intended purpose, some sections have been modified until the scale is completed in its final form, and the percentage of the scale may range between (86% - 100%), while the value of the chi-square (ch2) ranges between (15.21 - 29), which means that the paragraphs of the scale are still considered (56) paragraphs.

K. Construction Validity:

- The correlation coefficients between the degree of the paragraph and the total score of the scale, which ranged from 0.29 to 0.77, were statistically significant for all paragraphs. Consequently, all of the paragraphs in the scale of 56 were retained.

- The correlation coefficients of the scale's components ranged from 0.50 to 0.77, indicating that the scale of conceptual thinking toward chemistry was characterized by constructive validity: the relationship between the degree of the paragraph and the total degree of the field.

-The scale's total degree is inversely proportional to the degree of the field. Consequently, the scale paragraphs are all valid in their capacity to differentiate between pupils, as the strength of discrimination ranged from (2.411 – 7.533).

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L. Scale Stability:

- Alpha-Cronbach coefficient: The alpha-Cronbach coefficient was calculated to evaluate the internal consistency of the scale from the degree of the second investigative sample. It was found to be (0.94), indicating a high level of stability.

Seventh: Statistical Methods: The researcher employed the SPSS program to conduct statistical analyses that were appropriate for the data.

Chapter Four: Presentation and Interpretation of Results

This chapter includes a presentation of the results reached by the researcher and verification of the research objective by testing the validity of the two null hypotheses, conclusions, recommendations and proposals reached as follows:

First: Presentation of Results:

1. 1. The first null hypothesis's results: Table 4 shows the results of the researcher's calculations of the arithmetic mean and T value, which were obtained by applying the T-test for two independent samples to compare the average achievement test scores of the students in the experimental group with those of the control group.

Table (4) T-test results for the two research groups for the achievement test

Statistical Group	Sample size	Arithmetic mean	Standard deviation	Contrast	Degree of freedom	The two values		Statistical significance (0.05)
						Calculated	Tabulator	
Experimental	30	19.78	5.79	2.39	85	3.137	1.99	Statistically significance
Control	30	17.51	9.79	3.13				

Table (4) above shows that the arithmetic mean of the scores of the experimental group students, thus rejecting the first null hypothesis and accepting the alternative, this means that there is a statistically significant difference between the average scores of the two research groups in the achievement test and in favor of the experimental group.

In addition, the researcher used the equation of the square (ETA) in extracting the size of the effect (d) of the independent variable Wenning's investigative model in the dependent variable achievement test, and Table (5) illustrates this:

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Table (5) Effect size (d) A Wenning Investigative Model for the Achievement Test

Independent variable	Dependent variable	Impact size value (d)	The amount of impact size
Wenning investigative Model	Achievement	0,82	big

According to the data in the table above, the teaching variable in the Wenning investigative model had a significant positive impact on the achievement test, as shown by the value of (d) the amount of the effect size being 82.0. This finding supports the results of the experimental group, and table (6) confirms this:

Table (6) Impact size values and impact amount

Value (d) impact size	Amount of impact
(2,0- 4,0)	Small
(4,0- 7,0)	Medium
(8,0) and above	Big

2. Results of the second null hypothesis:

The researcher calculated the arithmetic mean and T-value using the T-test for two independent samples to compare the average scores of the experimental group students and the average scores of the control group students in the conceptual thinking scale, as shown in Table (6):

Table (6) Results of the T-test for the two research groups for the scale of conceptual thinking skills

Statistical Group	Sample size	Arithmetic mean	Standard deviation	Contrast	Degree of freedom	The two values		Statistical significance (0.05)
						Calculated	Tabulator	
Experimental	30	16.70	3.31	1.82	58	1.176	1.99	Statistically significance
Control	30	14.32	6.33	4.10				

Table (6) indicates that the arithmetic mean of the scores of the experimental group students leads to the rejection of the second null hypothesis and the acceptance of the alternative hypothesis. This signifies a statistically significant

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difference between the average scores of the two research groups regarding the scale of conceptual thinking skills, favoring the experimental group.

Furthermore, the researcher employed the square of the effect size (ETA) to determine the magnitude of the effect (d) of the independent variable, the Wenning model, on the dependent variable, conceptual thinking skills, as demonstrated in Table 7.

Table (7) Effect size (d) Wenning Investigative Model for the Conceptual Thinking Scale

Independent variable	Dependent variable	Impact size value (d)	The amount of impact size
Wenning Investigative Model	Conceptual thinking	0,83	big

Based on the data in the table, it's clear that the experimental group benefited from using Wenning's investigative model in the conceptual thinking scale, and the effect size value of (83.0) is a good fit for explaining the effect size.

Second: Interpretation of the results:

The results of the research can be interpreted as follows:

1. 1. The interpretation of the results pertaining to the achievement test The results that were presented in Table (4) demonstrated that there were statistically significant differences between the mean scores of the students of the two research groups in the achievement test, with the experimental group having the advantage. This indicates that the students of the experimental group who studied according to the Wenning investigative model performed better than the students of the control group who studied according to the standard method in the achievement test. The researcher attributes this result to the following reasons:

A. The researcher attributes the result to the following reasons It can be used as an introduction to the subject matter and can be used as an introduction to the subject matter for students.

B. Wenning's investigative model provides an opportunity for positive interaction between the teacher and the students, as well as increased discussion

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Increase the effectiveness of the students in the classroom in working on their interest in the subject, the information they communicate in and out of the classroom, which in turn helps to improve the student's their abilities, and increases their confidence in themselves and their ability to learn more about the subject than if they were enrolled in the course.

C. The Wenning investigative model helped change students' attitude towards the subject from a negative attitude to a positive attitude through skills that motivate students to learn on their own.

2. Interpreting the results related to the conceptual thinking measure: The kindergarten teachers in Gadol (6) showed that the second-grade students in the control group who were taught according to the Wenning's investigative on the control group students who studied according to the standardized method of measuring conceptual thinking, these results can be attributed to several reasons, including:

A. Wenning's investigative model aroused the students' attention and increased their concentration, as conceptual thinking skills are skills that the students were not familiar with before.

B. The use of the Wenning Investigative Model has a positive effect on conceptual thinking and the researcher attributes this to the fact that conceptual thinking is equivalent to the integration of analytical thinking with formal thinking.

C. Wenning's investigative model made the student the center of the educational process; that is, it gave him a positive role in the educational process and made him practice higher mental processes such as (analysis, synthesis, and evaluation), which led to the development of the student's cognitive structure.

Third: Conclusions:

According to the results of the current research, the following conclusions were reached:

1. Teaching according to Wenning's investigative model contributed to raising the achievement of fifth-grade students in chemistry.

2. Teaching according to the Wenning investigative model contributed to raising the level of fifth-grade students in the conceptual thinking scale.

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Fourth: Recommendations:

In light of the research results, the researcher recommends the following: Wenning's investigative model:

1. Urge teachers to adopt the Wenning Investigative Model in teaching as one of the models that help students to use conceptual thinking skills during learning.
2. Urge chemistry teachers to familiarize themselves with modern models and methods of teaching, especially the Wenning Investigative Model, by holding courses or seminars.
3. It is important to favor conceptual thinking among students in chemistry, for all stages.
4. In order to measure conceptual thinking, the textbook content should contain a set of questions that measure these skills.

Fifth: Suggestions:

1. Comparing Wenning's investigative model with other models to see the impact of each of them on achievement or other dependent variables such as logical thinking, analytical thinking, multiple intelligences, design thinking, formal thinking (etc.).
2. Conduct research on the impact of the Wenning Investigative Model course in other stages of education, such as elementary, middle school, and university.
3. Conduct a comparative study of the impact of the Wenning Investigative Model with other models or strategies to identify their preference in the tendency towards the subject.
4. Conducting descriptive studies that include analyzing chemistry textbooks in the light of deconstruction.

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