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Instructional design based on multiple-solution tasks and its impact on achievement in mathematics and chemistry for intermediate stage students and their peripheral thinking

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Abstract

The research aimed to know the effect of educational design based on multiple-solution tasks on achievement and peripheral thinking among third-year intermediate students in mathematics and chemistry. To achieve the research objectives, the researchers used two approaches: the first is the descriptive approach to prepare educational design according to multiple-solution tasks, and the other is the experimental approach to identify... The impact of the program on the two dependent variables. The research sample consisted of (61) students from the third intermediate grade who were randomly distributed into two groups, the first an experimental group consisting of (30) students and the second a control group consisting of (31) students. Equivalence were conducted between the two groups in the variables of (age, prior knowledge in mathematics and chemistry, and intelligence and peripheral thinking). The researchers prepared an achievement test consisting of (30) multiple-choice items for each of the subjects of mathematics and chemistry, and a test of peripheral thinking consisting of (20) items. The validity and reliability of the two tools were verified, and the results showed, using appropriate statistical methods, that there was a statistically significant difference in both academic achievement and peripheral thinking, in favor of the experimental group.

Keywords: educational design, multiple-solution tasks, peripheral thinking.

تصميم تعليمي على وفق المهام متعددة الحلول وأثره في تحصيل مادتي الرياضيات والكيمياء لدى طلاب المرحلة المتوسطة وتفكيرهم الاحاطي

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ملخص
هدف البحث إلى معرفة أثر تصميم تعليمي على وفق المهام متعددة الحلول في تحصيل مادتي الرياضيات والكيمياء والتفكير المحيطي لدى طلاب الصف الثالث المتوسط. ولتحقيق أهداف البحث استخدم الباحثون منهجين: الأول هو المنهج الوصفي لإعداد التصميم التعليمي وفق مهام متعددة الحلول، والآخر هو المنهج التجريبي للتعرف على... أثر البرنامج على المعتمدين. المتغيرات. تكونت عينة البحث من (61) طالباً من الصف الثالث المتوسط تم توزيعهم عشوائياً إلى مجموعتين، الأولى مجموعة تجريبية مكونة من (30) طالباً والثانية مجموعة ضابطة مكونة من (31) طالباً. وتم التكافؤ بين المجموعتين في متغيرات (العمر، والمعرفة السابقة في الرياضيات والكيمياء، والذكاء والتفكير المحيطي). وقام الباحثون بإعداد اختبار تحصيلي مكون من (30) فقرة متعددة الاختيارات لكل من موضوعي الرياضيات والكيمياء، واختبار التفكير المحيطي مكون من (20) فقرة. وتم التحقق من صدق وثبات الأداتين، وأظهرت النتائج، باستخدام الأساليب الإحصائية المناسبة، وجود فرق ذي دلالة إحصائية في كل من التحصيل الدراسي والتفكير المحيطي، لصالح المجموعة التجريبية.
الكلمات المفتاحية: التصميم التعليمي، المهام متعددة الحلول، التفكير المحيطي.

Research problem

Education, especially secondary education in the current era, faces great challenges at the level of educational content and teaching methods as a result of the increasing acceleration in information, which requires those in charge of education to keep pace with this through updating the content, engineering the educational material, and diversifying the methods and methods of teaching it according to the characteristics and needs of the learners in order to improve the quality. Education, raising the level of academic achievement and thinking among learners, moving away from traditional methods that rely on memorization and memorization, and moving to modern methods that focus on active learning and effective participation of students.

Among the educational subjects that have witnessed development in a way that humanity has not known before are mathematics and chemistry, as each of these two subjects has made an effective contribution to the manifestations of scientific and technological progress taking place in today's world, such as electronic computers, satellites, simulation programs, online programs and platforms, and great progress in industries, vital processes and protection. Environment, health, etc. have relied on mathematics and chemistry.

Based on this, these two subjects occupied a large space in the academic program in the Iraqi educational system, as mathematics and chemistry are considered among the basic subjects at all educational levels, including the intermediate stage, as studying these two subjects is a basis for understanding science and mathematics in the subsequent educational stages, and understanding One of them helps a lot in understanding the other subject. Using mathematical concepts, for example, helps a lot in understanding and expressing different chemical terms, as well as finding mass,

atomic numbers, balancing chemical equations, and other issues that use mathematical tools. This relationship is by nature reciprocal, as chemistry is used in a deep understanding of concepts. And some mathematical phenomena.

The nature of these two subjects (mathematics and chemistry) also share many scientific characteristics, as their academic content includes many abstract concepts and many laws, principles, rules, issues and theories, which require their students to have higher skills in interpretation, application, analysis and synthesis to acquire these concepts.

Which made many students complain about studying it, and this is what the two researchers noticed in their field of work in following up students during the school application process, where it was found that most mathematics and chemistry teachers lack the use of modern teaching methods and methods that keep pace with scientific and technological progress, which led to weak learning outcomes. Among students, this leads to a weakness in academic achievement and an inability to use thinking skills, and this is confirmed by studies (Al-Kanaani, 2016), (Awaid and Suhad, 2014), and (Abbood, 2023).

, which showed that students' failure in mathematics or chemistry is due to a number of reasons, the most important of which are the difficulty of the content, weak teaching methods, focus on memorization and memorization, and lack of exercises and educational activities.

Through this, the researchers decided to conduct a cognitive integration study between the subjects of mathematics and chemistry for the third intermediate grade by engineering the two subjects according to multiple-solution tasks and using various teaching strategies supported by a set of activities that are compatible with the characteristics of the students and their educational needs to identify the impact of this on improving their academic achievement in these two subjects. And their peripheral thinking.

Therefore, the research problem is defined in answering the following question:
What is the effect of educational design based on multiple-solution tasks on achievement in mathematics and chemistry among middle school students and their peripheral thinking?

Research importance:

The importance of the current research is demonstrated by the following:

First: From a theoretical standpoint:

1- Instructional design based on multiple-solution tasks may contribute to enhancing academic achievement among third-year intermediate students and developing their peripheral thinking skills.

2- The research provides empirical evidence and a comprehensive overview of how constructivist theory models can be used in educational design to enhance understanding and assimilation of mathematical and chemical concepts.

3- Research into how this educational design affects the development of students' abilities in a deeper understanding of the nature of the educational material through various educational activities.
4- The research may shed light on the importance of using educational methods to enrich knowledge and how to design innovative educational programs to enhance students' abilities to solve problems creatively and comprehensively.
5- Researchers and those interested in education may benefit from the need to increase attention to the learner from all aspects.

Second: From the practical aspect:

1- Designing education according to multiple-solution tasks may contribute to enhancing students' critical thinking skills.
2- The study provides actionable recommendations for teachers and educational developers to design and implement educational activities consistent with the principles of multiple-solution tasks.
3- Research may help improve the quality of education by enriching educational practice with new tools and means that support students' critical thinking skills.
4- The results can be used to develop teacher training programs on how to teach different subjects using this multi-solution task-based design.
5- The study aims to develop traditional teaching methods for mathematics and chemistry by integrating multi-solution tasks.
6- The research provides solid teaching plans for mathematics and chemistry that teachers can benefit from.
7- Teachers of mathematics and chemistry may benefit from the achievement test and the peripheral thinking scale prepared for mathematics and chemistry.

Search aim:

The current research aims to: build an educational design based on multiple-solution tasks in the subjects of mathematics and chemistry and demonstrate its impact on achievement and peripheral thinking among middle school students.

Research assumes:

To achieve the research objectives, the following null hypotheses were formulated:
1- There is no statistically significant difference at the level of (0.05) between the average scores of the experimental group students who study using the educational design according to multiple-solution tasks, and the average scores of the control group students who study in the traditional method in the mathematics achievement test.
2- There is no statistically significant difference at the level of (0.05) between the average scores of the experimental group students who study using the educational design according to multiple-solution tasks, and the average scores of the control group students who study in the traditional method in the achievement test in chemistry.

3- There is no statistically significant difference at the level of (0.05) between the average scores of the experimental group students who study mathematics using educational design according to multiple-solution tasks, and the average scores of the control group students who study the same subject in the traditional way on the peripheral thinking test.

4- There is no statistically significant difference at the level of (0.05) between the average scores of the experimental group students who study chemistry using educational design according to multiple-solution tasks, and the average scores of the control group students who study the same subject in the traditional way on the peripheral thinking test.

Research limitations: The current research is limited to:

1- A sample of third-grade middle school students in secondary schools in the General Directorate of Karkh III Education/Baghdad Governorate for the academic year (2023-2024).

2- Topics of the content of the mathematics and chemistry books scheduled to be taught by the Ministry of Education for the third intermediate grade.

3- The first semester of the year 2023-2024.

Definition of terms:

1- Instructional design:

Al-Zand (2004) defined it as (the sum of the activities and procedures necessary to plan the educational situation within specific goals linked to a time limit and calculated and measurable steps drawn up and implemented individually or collectively in a miniature or comprehensive long-term educational situation that achieves specific and calculated results or broad objective results.)

(Al-Zend, 2004: 38).

-Procedural definition of educational design

A set of sequential and organized steps to plan the educational process, which includes the objectives of educational design, content, organization of the educational environment, accompanying activities, educational means, and evaluation methods to raise the level of achievement and peripheral thinking for third-year intermediate students, relying on the design based on multiple-solution tasks within the teaching plans prepared by the researchers.

2- Multi-solution tasks

Known by:

-John Dewey (1916): As tasks that require students to think independently and apply knowledge to new situations. (Dowie, 1916)

-George Polya (1954): They are tasks that require students to use problem-solving skills, such as analyzing information, creative thinking, and decision making (Polya, 1954).

Operational definition

They are open-ended tasks that do not have one specific solution. These tasks require students to think creatively, analyze information from different points of view, and make decisions based on the tasks assigned to them according to the teaching of mathematics and chemistry.

3- achievement:

(Abu Jado, 2003) defined it as "the outcome of what a student learns after a certain period of time and it can be measured by the grade he obtains on an achievement test in order to determine the extent of the success of the strategy that the teacher develops and plans to achieve his goals and what he reaches" (Abu Jado, 2003: 469).

- Operational definition:

A collection of knowledge and information related to the subjects of mathematics and chemistry that are responded to by the students of the research sample on the achievement test, represented by the total score obtained by the students in the test prepared by the researchers.

4- Peripheral thinking

-Arafa Brown (2008): "It is a creative process that aims to find innovative solutions to problems by deeply understanding users' needs and experiences." (Brown, 2008: 84-92)

Operational definition of peripheral thinking

It is the psychological cognitive process that third-year intermediate students use to solve the problems they face during their education. It depends on identifying basic problems, designing creative solutions, and testing them according to the test prepared for this purpose.

Theoretical framework :

First: educational design

Educational design has emerged with what the times require, and there has become an urgent need to find appropriate solutions to educational problems and establish links between learning theory and educational practice, in a way that achieves the best educational and pedagogical results and reduces the educational burden on the student, as the responsibility lies with determining modern teaching methods and methods adapted to developments. Technology is the responsibility of teachers (Al-Zand, 2004: 26-39).

Instructional design aims to develop educational outcomes to achieve the desired learning and bring about the required changes in learners' behavior. Therefore, it is necessary to understand the nature of the learning process and the different theoretical explanations for its occurrence. The instructional designer needs answers to multiple questions about the characteristics of learners, how they learn, the conditions and circumstances that facilitate this learning, the appropriate methods and procedures for learning to occur, and how to evaluate them. These are essential

questions for the design process, and theories of teaching and learning are the ones that answer them (Khamis, 2003 a: 26)

One of the theories that the researchers adopted in building educational design is the theory of multiple-solution tasks, which aims to understand how the brain accomplishes multiple tasks at the same time. The theory assumes that there are multiple systems operating in parallel in the brain, each of which is responsible for processing a different type of information. the information

(339-2002:357, Wickens).

Second: The theory of multiple-solution tasks

Historical roots of multi-solution task theory:

Multi-solution theory is one of the modern theories in psychology, which is concerned with understanding how people perform multiple tasks at the same time. The theory assumes that there are multiple systems in the brain that work in parallel to process information and accomplish tasks, and it provides an educational model that focuses on providing multiple solutions. For a single educational task, this theory arose through the development of many ideas and theories throughout history. The development of this theory began in the early twentieth century when John Dewey and William Kilpatrick began to focus on the importance of learners' participation in the learning process and problem solving. In the mid-twentieth century, problem-solving theory and creative thinking theory emerged, leading to greater emphasis on providing multiple solutions to problems, and in the late twentieth century these ideas were applied to education, leading to the emergence of multiple-solution task theory.

(John Dowey, 1916: 8) and (Kilpatrick, 1918: 3)

Philosophical roots of the theory of multiple-solution tasks:

The philosophical roots of the theory depend on the following two philosophies:

- Pragmatism: It emphasizes the importance of the practical application of learning, and believes that the value of knowledge is measured by its ability to solve problems (John Dewey, 1916: 12)
- Constructivism: believes that learners are active constructors of their knowledge, and that they learn through interaction with their experiences.

(Piaget, 1970: 7)

Multi-solution task theory models:

The theory of multiple-solution tasks is an educational model with deep historical roots. This theory arose through the development of many ideas and theories throughout history, which led to various modern applications. These models are:

• Bruner's model: focuses on providing multiple solutions to a single educational task by presenting information in different ways (Bruner, 1969: 2)

• Gardner model: This model focuses on providing multiple solutions to a single educational task by taking into account the different learning styles of learners (Gardner, 1993: 5).

Hence, we see that the theory of multiple-solution tasks has general characteristics that can be noted, which seeks to:

• Be open-ended and do not have one specific solution.
• Requires students to think critically and creatively.
• Encourages students to analyze information from different angles.
• Helps students apply knowledge in new situations.
• Develops students' problem-solving skills.
• Enhances students' academic achievement.
• It increases student interaction in the educational process.
• It helps students connect knowledge with life experiences.
• Helps students make decisions.

(Torrance, 1962: 4) (Bruner, 1960: 2)

Principles of multi-solution theory:

• The ability to process information in parallel: The theory assumes that the brain is able to process information from multiple sources at the same time (Pashler, 1998: 33).

• The presence of multiple systems in the brain: The theory assumes that there are multiple systems in the brain that work in parallel to process information and accomplish tasks (Posner, 1990: 33).

• Competition for resources: The theory posits that there is competition for resources between different systems in the brain, which leads to decreased performance when trying to do multiple tasks at the same time (Kahneman, 1973: 33).

Practical applications of the theory of multiple-solution tasks in teaching:

• Design a rich learning environment: A rich learning environment provides opportunities for students to participate in multiple activities at the same time, which helps them develop their skills in processing information in parallel (Pashler, 1998: 33).

• Using educational games: Educational games are an effective tool for enhancing students' problem-solving and decision-making skills, especially in the presence of time pressures (Prensky, 2001: 45).

• Encourage cooperative learning: Group work helps students exchange ideas and collaborate on tasks, reducing competition for resources in the brain and improving performance (Johnson, 1989:12).

• Using active learning techniques: Active learning techniques encourage students to actively participate in the learning process, which helps them focus and pay better attention (Bonwel,l 1991: 5).

Hence, the two researchers believe that the theory of multiple-solution tasks is a powerful tool that can be used to improve education, as teachers must take into account the needs of students and their level of maturity when choosing practical applications of the theory of multiple-solution tasks in education.

Third: Peripheral thinking

This type of thinking aims to understand the relationships and interconnections between the various elements of a particular system or situation, rather than focusing on each element individually. In fact, peripheral thinking reflects systems philosophy as it emphasizes the importance of understanding the entire system rather than analyzing its individual parts. It is an approach based on... A comprehensive view of topics and issues, as it is believed that a comprehensive understanding of a problem requires a comprehensive analysis of various factors and the complex relationships between them (Jeffrey, J., 2019: 296).

Introductory thinking is defined as a problem-solving process that focuses on comprehensively understanding the problem in all its aspects, before finding creative solutions. This approach includes collecting information from various sources, analyzing it, identifying patterns, understanding the relationships between the various elements, and finding innovative solutions that meet the needs of all. concerned, and are viable in the long term.

The main components of peripheral thinking:

• Empathy: The ability to understand the feelings and needs of others.
• Creativity: The ability to find new and innovative solutions.
• Critical thinking: the ability to analyze and evaluate information objectively.
• Effective communication: the ability to clearly exchange ideas and information with others.

Donald Norman identifies the general steps of peripheral thinking:

1. Define the problem: What is the problem you want to solve? What are its symptoms? What factors contribute to it?
2. Gather information: Collect information from various sources, including people affected by the problem, experts in the field, data and research.
3. Analyze information: Identify patterns and relationships between different elements.
4. Solutions: Brainstorm creative solutions that meet the needs of everyone involved.
5. Choose a solution: Choose the most effective and viable solution.
6. Implement the solution: Put the solution into practice.
7. Evaluate the solution: Evaluate the effectiveness of the solution and make the necessary adjustments.

(Norman: 2013, 11)

From the above, the two researchers believe that reflective thinking can be a powerful tool for improving the learning environment. It also helps teachers better

understand students' needs and helps design innovative and effective educational experiences.

Previous studies:

- Study by Ibrahim (2014): The study aimed to identify the effect of using the multi-solution task strategy in developing creative thinking skills among fourth grade students in science. The study was conducted at Ain Shams University. The results of the study showed that using the multiple-solution task strategy had a significant positive impact on developing creative thinking skills among fourth-grade students in science.
- Study by Muhammad Ali (2015): The study was conducted in Egypt and aimed to find out the effectiveness of using the multi-solution task strategy in developing problem-solving skills among sixth-grade students in mathematics. The results of the study showed that using the multi-solution task strategy had a significant positive impact on developing Problem solving skills of sixth grade students in mathematics.
- Study (Jones & Smith, 2018): The study aimed to identify the effects of multi-solution tasks on students' learning and participation. The results of the study showed that the use of multi-solution tasks had a positive impact on students' learning and participation in class.

Methodology of Research & Procedures

First: Experimental design: An experimental design was used for two equal groups, experimental and control, with partial control and a post-test for the variables of achievement and peripheral thinking, as in Table (1).

Table (1): Experimental design for the two research groups

Test type	Dependent variable	Independent variable	Parity	My research group
Post achievement test peripheral Thinking test	achievement peripheral Thinking	Instructional design	chronological age Previous information in mathematics and chemistry intelligent peripheral Thinking	Experimental
		The usual method		Control

Second: The research community and its sample:

1- The research community: The research community consists of all third-grade students in middle and high schools in the General Directorate of Karkh III Education in Baghdad Governorate for the academic year (2023-2024).

2- Research sample: The researchers intentionally chose the middle school (Al-Bilad for Boys) as a sample for the research due to the availability of two sections for the second middle school and the cooperation of the school administration and the mathematics and chemistry teachers with them. Section (A) was drawn in a simple random way to represent the experimental group that teaches mathematics and chemistry according to the educational design and section (B) The control group, which studies the same two subjects according to the usual method, and the number of students reached (61) students, with (30) students in the experimental group and (31) students in the control group, after statistically excluding the students who failed from the two groups.

Third: Control procedures

A) Equivalence of the two research groups: The two research groups were equivalent in terms of variables that may affect the conduct of the experiment, which are (chronological age in months, previous knowledge in the subjects of mathematics and chemistry, intelligence, and peripheral thinking).

After conducting statistical calculations for the above variables and using the t-test for two independent samples, the results showed that there were no statistically significant differences at the significance level (0.05) for all variables, which indicates their equality, as shown in Table (2).

Table (2): The arithmetic mean, standard deviation, and T-value for the variables of chronological age and previous information in the subjects of mathematics, chemistry, intelligence test, and peripheral thinking for members of the two research groups at a significance level of 0.05 and a degree of freedom (59).

Sig. 0.05	Calculated T-value	DF	standard deviation		Arithmetic average		Subject	variable
			Cont.	Exp.	Cont.	Exp.		
Non-funct.	0.196	59	13.449	14.326	167.231	167.135		age
	0.500		4.246	3.328	13.141	12.652	Math.	Test I previous information
	1.161		3.123	4.874	12.963	14.176	Chem.	
	0.643		10.04	9.36	31.8	33.4		Intelligence

	0.494		**8.237**	**7.534**	**36**	**34**		**Peripheral thinking**

Fourth - Research requirements:

It includes the procedural steps used to achieve the research objectives and hypotheses, as follows:

A) Building the educational design according to the theory of multiple-solution tasks

The researchers followed the following steps in building the educational design according to the theory of multiple-solution tasks, as follows:

1- Reviewing educational literature and previous research and studies that dealt with educational designs and the foundations of building the theory of multiple-solution tasks, such as a study (Ibrahim, 2014), a study (Muhammad Ali, 2015), and a study (Jones, 2018). The educational design included three stages: analysis, implementation, and evaluation.

2- Learn about the foundations, principles and assumptions on which the theory of multiple-solution tasks in teaching is based and the extent of the possibility of applying them according to the design to teach mathematics and chemistry.

3- Reviewing the goals of teaching mathematics and chemistry in the middle stage and emphasizing building an educational design that makes the learner active and a main focus in the educational process.

4- Identifying and analyzing the academic content of the mathematical and chemical information included in the third intermediate book and the way they are organized in order to help students understand how ideas, information, and facts are related to each other. The educational material was represented by the first three chapters of my mathematics book (Chapter One: Relationships and Inequalities in Real Numbers, Chapter Two: Algebraic quantities, Chapter Three: Equations) and chemistry (Chapter One: Atomic structure of matter, Chapter Two: The first and second groups, Chapter Three: The third group, Chapter Four: Solutions and expressing concentration)

5- Analyzing the characteristics and needs of learners by presenting a closed questionnaire to students to identify the most important educational difficulties they faced when studying the subject, as well as meeting a sample of mathematics and chemistry teachers.

6- The researchers prepared a plan for educational design according to the theory of multiple-solution tasks and presented it to a group of experts and arbitrators in the field of psychology, teaching methods, mathematics, and chemistry.

7- Special behavioral objectives were prepared and formulated for each study unit according to Bloom's classification in the field of knowledge, memory,

comprehension, application, analysis, synthesis and evaluation, and they were presented to a group of specialists in mathematics (142) objectives and chemistry (174) objectives.

8- Preparing daily teaching plans, when the researchers reviewed previous studies and literature related to the roots of the theory of multiple-solution tasks. If the researchers did not find the practical steps for this theory, they therefore worked to develop a set of steps based on the philosophical, psychological, and social roots of this theory. The steps were represented as follows: -

- Designing diverse educational content while maintaining the sequence of topics: The design includes activities that suit all learning styles by using a variety of educational materials enhanced with drawings and pictures that can be displayed through the Data show projector.
- Providing educational content in a variety of teaching methods, such as cooperative learning, discussions, and practical activities.
- Providing students with opportunities to learn through:
• Setting goals and dividing tasks into steps.
• Give students an opportunity to think about different solutions.
• Compare the solutions to choose the most appropriate one.
- Assess student learning in several ways by: using traditional tests, performance testing, and evaluating student projects and presentations.
- Providing opportunities for students to learn through their own experiences: This is done by linking the content of the subject to the real world.
Students are also provided with opportunities to apply their knowledge to real-life situations.

9- Two tests were prepared, one for achievement and the other for peripheral thinking.

10- The educational design was applied to a pilot sample of students from the research community other than the research sample, numbering 29 (29) students for a number of lessons, based on the teaching plans that were built according to the theory of multiple-solution tasks and according to the construction of the steps of the educational design in order to investigate the possibility of its application.

11- Conducting the evaluation process for the educational design, as the preliminary evaluation of the design was conducted through presentation to a group of experts and arbitrators in mathematics and chemistry, in addition to applying it to the exploratory sample. The formative (structural) evaluation of the educational design during teaching was also conducted according to the teaching steps. For the design, then conduct the final evaluation of the design at the end of the experiment.

b) Search tools:

1- Achievement test:

To determine the effect of educational design on the achievement of mathematics and chemistry among the students of the research sample, the researchers prepared an achievement test of the type of objective tests (multiple choice) with four alternatives. The test consisted of (30) items for each of the subjects of mathematics and chemistry.

1-1- Preparing the specifications table:

A table of specifications was prepared for the topics of the chapters included in mathematics and chemistry for the third intermediate grade, based on the number of behavioral objectives and their relative importance in light of the six levels of the cognitive domain from Bloom's taxonomy. The number of achievement test items reached (30) items for each of the subjects of mathematics and chemistry. The highest score for the test items was (30) and the lowest was (0).

1-2- Test instructions: Prepare the test instructions so that they are clear and understandable before the test, and explain how to answer the test items in mathematics and chemistry.

1-3- Validity of the test:

1-3-1- Apparent honesty:

The achievement test items were presented to a group of arbitrators specialized in (teaching methods, mathematics, chemistry, and measurement and evaluation) to express their opinions and comments regarding the validity of the items and the safety of their wording. The necessary amendments were made to some of the items, and the items obtained an agreement rate of more than (85%). Accordingly, All paragraphs were found to be valid.

1-3-2- Content validity:

The content validity was verified through the specifications table at.

1-4- Exploratory application of the test:

The achievement test for mathematics and chemistry was applied to a sample of third-year intermediate students, numbering (25) students, in order to verify the clarity of the test items and instructions, and to calculate the average time taken to answer. It was found that all test items are clear and understandable, as well as its instructions, and that the average Time taken 40 minutes.

1-4- Statistical analysis of the test items:

The test was applied to a sample of third-grade middle school students, numbering (100) students from schools affiliated with the research community, which is (Dijlah Middle School for Boys). After correcting the

answers, the scores were arranged in descending order, then the upper and lower extreme samples were chosen by 27%, as the number of students reached There are 27 students in each group. The following is an explanation of the procedures for statistical analysis of the test items:

A - Paragraph difficulty factor:

The difficulty factor of each item of the achievement test for mathematics and chemistry was calculated, and it was found that it ranges between (0.293-0.68), as Bloom believes that the test is considered good and valid for application if the difficulty factor of its items ranges between (0.20-0.80) (Bloom, 1971, p215).

B - The discriminating power of the paragraphs:

The test item is considered good and valid for application if its coefficient of discrimination reaches (20%) or more. After calculating the coefficient of discrimination for each item of the achievement test for mathematics and chemistry, it was found that it ranges between (0.333-0.592), and thus all test items are considered good and valid for application.

C - The effectiveness of wrong alternatives:

After calculating the effectiveness of the wrong alternatives for mathematics and chemistry, I found that all their values were negative, and thus all the wrong alternatives are considered effective.

D- Test stability:

In order to verify the stability of the achievement test for mathematics and chemistry, the Keuder-Richardson equation (20) was used for objective questions (multiple choice). The sample size was (40) students. After applying the equation, the test's reliability coefficient reached (0.882), and this indicates that the The reliability of the test is good.

2- The peripheral thinking test

After reviewing the literature, the researchers prepared a test for circumspect thinking according to the skills of peripheral thinking, which are (empathy, creativity, critical thinking, and effective communication). The test vocabulary was formulated, controlled, and put in its initial form in a way that is appropriate for the academic stage represented by third-year intermediate students, and the test is Of (20) questions of the type that require open answers, as follows:

- Empathy paragraphs (1,2,3,4).
- Creativity, paragraphs (5, 6, 7, 9, 10, 11).
- Critical thinking (12, 13, 14, 15, 16).
- Effective communication (17, 18, 19, 20).

2-1- Correcting test items

The researchers assigned three grades for each question, including two grades for the correct, appropriate answer, one grade for the answer that has a correct meaning but whose wording is inaccurate or irregular, and zero for the incorrect, left out, or repeated paragraph. Thus, the total grade for the test is (60), and the lowest grade is (0).

2-2- Validity of the test:

2-2-1-Virtual honesty:

The test was presented to a group of educational and psychological arbitrators to express their opinions and observations about the validity of the paragraphs. An agreement rate of (80%) or more was adopted between the arbitrators in amending, retaining, or deleting the paragraph, and thus the number of paragraphs remained (20).

2-2-1-1- Exploratory application of the test:

To determine the clarity and understanding of the paragraphs of the peripheral thinking test, and to calculate the response time, the test was applied to a survey sample consisting of (36) students from the research community. It became clear that the instructions are clear and the paragraphs are understandable to all students, and the average time spent answering (44) minutes was calculated.

2-3- Reliability of the peripheral thinking test:

The reliability of the test items was calculated using the Alfacrobnach equation because it is one of the common methods for calculating test reliability and it is an accurate measurement method for calculating the reliability coefficient. To estimate the internal consistency of the peripheral thinking test, the answers of the statistical analysis sample of (36) students were used to calculate the reliability, and the alpha coefficient reached (0.806).) It is a good reliability coefficient for the internal consistency of the test.

Fifth: Procedures for implementing the experiment:

The following steps were followed to implement the research experiment for both groups:

1- The two researchers visited the school to implement the research experiment, and the aim of the research was clarified.

2- The researchers provided the teachers of mathematics and chemistry with teaching plans for the experimental group, which is taught according to the educational design, with an emphasis on teaching the control group in the traditional way.

3- The researchers visited the subject teachers in the classroom to see how the experiment was implemented.

4- I started teaching the two research groups on Tuesday 10/3/2023 until 1/10/2024, with four mathematics classes per week and two chemistry classes.

Experimental group:

The group studied according to the steps based on the philosophical roots of the theory of multiple-solution tasks prepared by the researchers, which are:

- Designing diverse educational content: It includes activities that suit all learning styles by using a variety of educational materials such as texts, pictures, and videos.
- Providing educational content in a variety of teaching methods, such as cooperative learning, discussions, and practical activities.
- Providing students with opportunities to learn through their own experiences
• Setting goals and dividing tasks into steps.
• Give students an opportunity to think about different solutions.
• Compare the solutions to choose the most appropriate one.
- Evaluate student learning in several ways by: using traditional tests and performance testing. and evaluation of student projects and presentations.
- Providing opportunities for students to learn through their own experiences: This is done by linking the content of the subject to the real world.

Students are also provided with opportunities to apply their knowledge to real-life situations.

• homework.

Control group:

This group was studied using the usual method and according to the following steps:

1- Providing an introduction to the lesson topic and linking it to the students' previous experiences.
2- Explaining the scientific material by teachers, providing students with knowledge and information, and then asking questions related to the subject.
3- Then, the students discuss the answers presented.
4-Involving students in solving some activities and exercises related to the topic.
5-The teacher summarizes the material.
6- Conduct an evaluation of the most important points mentioned in the lesson.
7- Select the homework assignment from the prescribed book.

- Application of the two research tools: After completing the teaching of the two research groups, the two tools were applied to the students of the two groups on Sunday and Tuesday, corresponding to 7-9/1/2024, and their answers were corrected.

Seventh - Statistical methods: The following statistical methods were applied based on the SPSS design: the difficulty and discrimination equation and the effectiveness of alternatives for the items, the Pearson correlation coefficient and the Cronbach alpha equation, and the t-test for two independent samples.

Search results and their interpretation:

First: Presentation of the results

The first hypothesis: It states that "there is no statistically significant difference at the level (0.05) between the average scores of the experimental group students who study using the educational design according to multiple-solution tasks, and the average scores of the control group students who study in the traditional method in the mathematics achievement test."

To verify the hypothesis, the arithmetic mean of the experimental group students' scores was (24), with a standard deviation of (3.853), and the control group students' average scores were (19), with a standard deviation of (4.012), and the t-test was used for two independent samples to determine the significance of the difference. Between the two means at the significance level (0.05), it was found that there was a statistically significant difference between the two groups and in favor of the experimental group, as shown in Table (3).

The second hypothesis: It states that "there is no statistically significant difference at the level of (0.05) between the average scores of the experimental group students who study using the educational design according to multiple-solution tasks, and the average scores of the control group students who study in the traditional method in the achievement test in chemistry." .

To verify the hypothesis, the arithmetic mean of the experimental group students' scores was (26), with a standard deviation of (4.185), and the control group students' average scores were (20), with a standard deviation of (4.985), and the t-test was used for two independent samples to determine the significance of the difference. Between the two means at the significance level (0.05), it was found that there was a statistically significant difference between the two groups and in favor of the experimental group, as shown in Table (3).

Table (3)
T-test results for the two groups in the achievement test for mathematics and chemistry

	T value		SD			group	

Sig. (0.05)	Tabulation	Calculated	DF		Arithmetic average	Num.		Sub.
function	2	4.962	59	3.853	24	30	experimental	Math.
				4.012	19	31	control	
function	2	5.083		4.185	26	30	experimental	Chem.
				4.985	20	31	control	

In order to extract effectiveness by means of the effect size for each of the independent variables in the dependent variable, the researchers adopted the effect size equation, and Table (6) shows this.

Table (6)

The value of (η2) and (d) and the size of the effect of the independent variable on the achievement variable

The amount of effect size	value D	value η^2	Df	value T	Subject
Large	1.292	0.294	59	4.962	mathematics
Large	1.324	0.305		5.083	chemistry

It appears from the table above that the size of the effect of the independent variable educational design on achievement was large and in favor of the experimental group, and thus the first and second null hypotheses are rejected. The third hypothesis: It states: "There is no statistically significant difference at the level of (0.05) between the average scores of the experimental group students who study mathematics using instructional design according to multiple-solution tasks, and the average scores of the control group students who study the same subject in the traditional way on the peripheral thinking test." .

To verify the hypothesis, the arithmetic mean of the experimental group students' scores was (54), with a standard deviation of (10.986), and the control group students' average scores were (46), with a standard deviation of (11.142), and the t-test was used for two independent samples to determine the significance of the difference. Between the two means at the significance level (0.05), it was found that there was a statistically significant difference between the two groups and in favor of the experimental group, as shown in Table (4). The fourth hypothesis: It states, "There is no statistically significant difference at the level of (0.05) between the average scores of the experimental group students who study chemistry using educational design according to multiple-

solution tasks, and the average scores of the control group students who study the same subject in the traditional way on the peripheral thinking test." .

To verify the hypothesis, the arithmetic mean of the experimental group students' scores was (51), with a standard deviation of (9.681), and the control group students' average scores were (44), with a standard deviation of (8.324), and the t-test was used for two independent samples to determine the significance of the difference. Between the two means at the significance level (0.05), it was found that there was a statistically significant difference between the two groups and in favor of the experimental group, as shown in Table (4).

Table (4)
The value of the T-test for the two groups in the posttest of Peripheral thinking

Sig. (0.05)	T value		DF	SD	Arithmetic average	Num.	group	Sub.
	Tabulation	Calculated						
function	2	4.234	59	10.986	48	30	**Exp.**	**Math.**
				11.142	36	31	**Cont.**	
function	2	4.764		9.681	51	30	**Exp.**	**Chem.**
				8.324	40	31	**Cont.**	

In order to extract effectiveness by means of the effect size for each of the independent variables in the dependent variable, the researchers adopted the effect size equation, and Table (5) shows this.

Table (5)
The value of (η2) and (d) and the size of the effect of the independent variable on the peripheral thinking variable

The amount of effect size	value D	value η^2	Df	value T	Subject
Large	1.102	0.233	59	2.823	**Math.**
Large	1.249	0.278		3.031	**Chem.**

It appears from the table above that the size of the effect of the independent variable educational design on peripheral thinking was large and in favor of the experimental group, and thus the third and fourth null hypotheses are rejected.

Second: Interpretation of the results:

The results showed that the experimental group, which was taught according to the educational design using multiple-solution tasks, was superior to the control group, which was taught according to the usual method, in both achievement and peripheral thinking for the subjects of mathematics and chemistry. The researchers attribute this to:

The design of the educational material makes the educational environment rich in shapes, drawings, educational activities, and exercises, as well as the logical sequence of the educational material. All of this has increased students' abilities to understand and retain information, and then increased their abilities to discover solutions.

- Designing the educational material according to the level of the students, their characteristics, and the nature of the educational material, led to developing the students' experiences and raising their level of application, and then the ability to use it in discovering new solutions.

The nature of presenting the educational material according to a diverse and unconventional teaching strategy has had a positive impact on the students in terms of attracting their attention and stimulating their thinking.

Involving students directly in the lesson, providing immediate reinforcement, and providing feedback on design contributed to raising the efficiency of students in the experimental group and increased their abilities and activity in perceiving and understanding information and using it to discover new solutions.

Dividing the students into groups provided them with a good learning environment, each according to his capabilities, which increased the opportunity for cooperation between them and competition with other groups.

Teaching according to educational design has provided a safe educational climate for presenting ideas and freedom of movement, which has increased students' thinking capabilities.

Third: Conclusions

Based on that research results, the following can be concluded:

1- The educational design built according to the theory of multiple-solution tasks had an impact in raising the academic achievement of students.

2- The effect of educational design based on the theory of multiple-solution tasks in stimulating and developing students' peripheral thinking.

3- Instructional design improves the organization of academic content, enhances it with various activities, and improves the teaching skills of mathematics and chemistry teachers.

4- Developing circumspect thinking and its preference over the traditional method.

Fourth: Recommendations:

1- The curricula and teaching methods curriculum in colleges of education include topics on educational design.

2- Placing learning thinking, its skills and strategies within the curricula and vocabulary of colleges of education to develop the thinking abilities of learners.

3- Organizing workshops for supervisors and teachers of scientific subjects with the aim of training them on how to employ educational programs based on the theory of multiple-solution tasks to benefit from them in their field of work.

Fifth: Proposals

1- Preparing the design based on the theory of multiple-solution tasks to train teachers to acquire scientific skills such as observation, measurement, recording, research, prediction, hypotheses, and communication.

2- Preparing an educational-learning design according to the theory of multiple-solution tasks in other variables and in other academic subjects.

3- Conduct a study on the obstacles to implementing educational or enrichment designs or programs by mathematics and chemistry teachers.

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