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THE EFFECT OF A PROPOSED STRATEGY BASED ON CONSTRUCTIVE LEARNING ON COGNITIVE FLEXIBILITY AND MATHEMATICAL DESIGN THINKING AMONG MIDDLE SCHOOL STUDENTS

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ABSTRACT

The aim of the research is to know the effect of teaching mathematics according to a proposed strategy for constructive learning on cognitive flexibility and design thinking for the experimental group, cognitive flexibility and design thinking for the control group in mathematics for the middle stage, , the research sample consisted of (63) female students From the second stage, they were divided into two groups, the first experimental (32) female students who studied according to the proposed strategy and the second officer (31) female students who studied according to the usual method for mathematics. After the end of the trial period, the two tests were applied to the two research groups, and the results of the experiment indicated the superiority of the experimental group over the control group, as its average score reached (23,515) on the cognitive flexibility test. This result gave a statistically significant difference at a significance level of 0.05 in favor of the experimental group as the results showed The research showed that there were differences in the mean scores of the Design Thinking test in favor of the experimental group students amounted to (17.47) at a significance level of 0.05. The two researchers recommended the use of strategic steps in teaching for different stages and materials. It also recommended holding training courses and workshops for teachers and teachers to train them to apply modern teaching strategies, including the proposed strategy.

RESEARCH INTRODUCTION

Since this era is characterized by being the era of science and technology, in which we need to educate the individual scientifically that creates awareness of a thinker capable of criticism, creativity and the use of knowledge in changing behavior to

face future challenges, it was necessary for the teaching methods to pay attention to these new roles of the teacher.

And that the process of developing the skills and abilities of learners does not come from adopting modern curricula only, but rather it is necessary to pay attention to the main pillar that parallels the curriculum represented in the strategies, methods and teaching activities due to their effectiveness in activating the content of the material and transforming it into educational, scientific and social performance that contributes to the growth of the personality of the learners and the development of their mental, social and physical skills.

Constructive learning is one of the modern concepts that have swept the global and Arab educational sector because of its role in effective education based on urging the learner to acquire knowledge, represent it and persevere to employ it in appropriate positions, to contribute to achieving the comprehensive goals of developing all aspects of knowledge, skills and sentiments, and the learner gains experiences provided by his available activities from Before the teacher and school.

RESEARCH PROBLEMS

The educational literature has emphasized the importance of the learner being more than a listener, so he must read, write, solve problems and think at higher levels, such as analyzing, installing and evaluating, so that he becomes the focus of the educational process instead of the teacher, and this happens when the learner interacts with the scientific material and receives encouragement for discussion, discovery and problem solving Creativity and scientific thinking.

In light of the importance of effective learning and constructive learning and their role in developing the capabilities of the learner, modern educational studies in Iraq have paid great attention to research, master's theses and doctoral theses With constructive learning and its strategies and conducted experiments, the results of which have proven the advantage of this learning in many variables such as achievement, scientific thinking, critical thinking, trends, modification of misconceptions and others. The student is the focus of the educational process. (Al-Mustansiriya University Conference, College of Education, 2013) (Wasit University Conference, College of Education, 2014) (Wasit University Conference - College of Education, 2018)

And that the student in the middle stage and in his psychological age stage sometimes suffers from a clear problem in the inability to adapt and adapt to new educational and life situations, and he also finds it difficult to accept new developments and flexibility in following them and the subsequent problems that are increasing day by day.

Local research results such as (Al-Karawi and Fadel, 2015) (Al-Samarrai, Faeq, 1998) agree on the weakness and low cognitive flexibility and creative scientific thinking of high school students, which may be due to the continuation of our

schools and universities to adopt theoretical courses only without paying attention to practical and applied aspects.
Therefore, the research problem can be identified in the following question:
Does the proposed teaching strategy based on constructive learning for teaching mathematics have an effect on cognitive flexibility and design thinking among second-grade intermediate students?

RESEARCH IMPORTANCE

Most educators stress that transforming regular learning into constructive cognitive learning within the classroom increases the positive activities and reduces the negative activities of the learner that depend on listening, recording and writing notes without participating in finding them, in a way that changes their behavior towards flexible, rational and open learning ideas even different from them. These are features of cognitive flexibility.

The difference of learners in the extent of their readiness, mental, psychological and social development, in addition to the different ways of thinking, desires and inclinations, necessitate the necessity of different and varied teaching models and methods that provide them with changing opportunities and conditions that would help them acquire information , skills ,provide interaction and positive relationships between them and their teachers. (Aqilan, 2002, p. 85)

And the cognitive structure formed by the learner resist
s change greatly, so the learner clings to his previous knowledge even though it may be incorrect, but it is convincing for him, and this resistance requires the teacher to choose multiple activities to confirm the validity of previous experiences and to clarify and explain the error in the understanding if it is present. (Ismail, Muhammad, 2000, 299)
And that every learner has information and opinions about some matters, but he is not sure of them, especially when they contradict and contradict the ideas and opinions of others, which cause doubts in his knowledge and it is the teacher's responsibility to reveal these opinions and work to imbalance him, provided that this imbalance is easy to pass by the learner and not Very difficult, in order not to discourage him, and thus he succeeds in adding new buildings to his knowledge inventory. (Ghanem, Mahmoud, 2009: 52)

Thus, teaching according to constructive learning is a cognitive learning that provides many opportunities for learners to provide them with experiences that expand their perceptions and accustom them to understand what surrounds them through communication skills and participation in responsibility and decision-making in an environment that is supportive, safe, stimulating for discovery and exciting for thinking as well as the ability to think mathematically of all kinds.
It has become clear that the goal of teaching mathematics has changed in the modern era, where the focus has begun on solving problems, and students 'ability to sustain knowledge, that is, to summon and use it in new contexts other than the previous contexts to which they are accustomed. This requires the student to be

cognitively flexible to determine exactly the appropriate contexts for applying mathematical knowledge. (Warner, LB, & others. 2003.1)

Among the most prominent benefits of constructive learning that relate it to mathematical cognitive flexibility are: 1) The learner arrives at meaningful solutions by understanding and modifying misconceptions 2) applying cognitive information in new situations 3) processing information and reproducing it 4) Adaptation and compatibility between knowledge and reality.
From the literature on design thinking, it is clear that it is a modern concept related to planning and design that can be used in the development of the educational process by giving opportunities to learners to develop solutions to multiple problems, and these solutions are not traditional, based on experience, observation, imagination and innovation.

There are those who know design thinking in mathematics as an educational approach that motivates students to deal with educational issues and situations by re-defining them creatively and re-imagining similar solutions, taking into account contradictory priorities and complex negotiation to solve a specific problem and investing the educational environment and its means to raise their desire to solve life's problems. (Cook & Bush 2018,93)

Therefore, the benefits of constructive learning that link it to design-mathematical thinking can emerge: 1) the learners' participation and their integration in shaping meaning through the interaction of their senses with the outside world 2) giving the learner the opportunity to play his role as a creator who develops a positive attitude towards learning 3) the production of new alternative ideas and innovative solutions 4) Developing the skills of dialogue, discussion, teamwork and application.
Accordingly, the importance of the current research is determined by the importance of each of:

1- Applying modern teaching strategies in teaching mathematics.
2- Constructive learning with its different strategies that are in line with the modern trends of the teaching-learning process and provide an effective classroom environment.
3- Cognitive flexibility as an important factor for success, development and creativity.
4- Design thinking and the importance of its development in accordance with modern strategies that transfer the learner to multiple roles, including the knowledge-adapted, the analyst, the debate, the critic, the discoverer and the creator.
5- Mathematics as its study provides an appropriate amount of knowledge that prepares the learner to interact and adapt to society and its changes.
6- The possibility of mathematics teachers benefiting from the teaching plans according to the proposed strategy.

7 - Take advantage of the tests of cognitive flexibility and design thinking in mathematics, as they are new models through which students' abilities can be determined.
8- Adding new knowledge to the field of mathematics teaching methods, especially with regard to a proposed constructive strategy and linking it to the variables of cognitive flexibility and design thinking.

RESEARCH OBJECTIVES:
1- Identifying the impact of a proposed strategy for teaching mathematics on mathematical cognitive flexibility among second-grade intermediate students.
2- Identifying the impact of a proposed strategy for teaching mathematics on mathematical design thinking among second-grade intermediate students.

RESEARCH ASSUMES
1- There is no statistically significant difference between the mean scores of the experimental group students and the average scores of the control group students in the mathematical cognitive flexibility test.
2- There is no statistically significant difference between the mean scores of the experimental group students and the average scores of the control group students in the Dimensional Mathematical Design Thinking test.

RESEARCH LIMITS
1- Female middle school students in middle and high schools in Baghdad.
2- Topics of the mathematics book for the second intermediate grade (first part) to be taught for the 2019-2020 academic year in Iraq.
3- The proposed strategy and its steps are: Preparation - Prediction - Observation - Discussion - Exeplanation - Bridging.

RESEARCH TERMS
The proposed strategy: It is six educational constructive steps (PPODEB) built according to constructivism theory in order to allow learners to participate in the activities of the lesson in order to encourage them to recover their previous information, forecast, observation, discussion, interpretation and employ what they have learned in life, as it begins with preparation and preparation - prediction - observation - Discussion - interpretation - bridging.

Procedural definition:

It is a group of educational experiences organized in an integrated manner that allows the application of the philosophy of constructive learning and its principles through educational content and teaching plans for the subject of mathematics of the second intermediate grade - the first part, prepared for this research according to six steps that the members of the experimental group study during the period of application of the research are: Preparing and preparing for the lesson - prediction - observation - discussion - interpretation - bridging.

Constructivist learning: It is a group of experiences that depend on scientific observation and study, where understanding and knowledge are built through practical experience and compatibility between previous experiences and new situations in the learning process, so a change in ideas may occur or be ignored. For some new information if it is irrelevant or discovering and inventing new information and solving real problems. Bada, & Olusegun, S. 2015, 67).

Procedural definition:

It is the process of students receiving (experimental research sample) of mathematical knowledge by reconstructing it and linking it to previous knowledge, predicting problem-solving, noting ideas, testing them, and participating in criticism and interpretation until its effectiveness is verified through practical application in solving environmental reality problems.

Cognitive Flexibility:

It means the ability of the individual or the learner to continuously adjust through mental representations and generate alternatives based on the situation data and his ability to change the cognitive response and process information and new and unexpected situations as well as an awareness of internal relationships and the similarities and differences between concepts. Spiro, R & others. , 1995,169).

It is the ability of the learner to generate various ideas that are not of the expected and traditional type, and the ability to shift from a certain type of thinking to another when responding to a specific situation, that is, changing the state of mind by changing the situation, it represents the qualitative aspect of creativity. (Atoum et al., 2009, 142) Procedural definition: They are psychological and behavioral features represented in four levels (awareness of opposing views, generation of alternatives, construction and cognitive modification, strategic cognitive diversity) that the student (the research sample) seeks to possess to achieve her goals in studying mathematics topics, represented by the grades she obtains after responding to paragraphs The test prepared for this research.

DESIGN THINKING

The term design thinking refers to the way designers think, which are the mental processes they use to design things and services. (Dunne, D, & Martin. 2006,517).

It is also an innovative way to solve problems that require a complex set of processes and skills that help individuals find new solutions to these problems. (Goldman & Kabayadondo.2016,2).

Procedural definition: It is a non-linear and repetitive process that the student (the research sample) uses in her study of mathematics to confront problems, feel them and redefine them to create innovative solutions for them as prototypes and then test them, represented by the degree that she gets after responding to the test items

prepared for this research, which includes five stages: Empathy - definition - thinking - prototype - testing.

Theoretical background and previous studies:
Constructivist learning:

Constructive learning in its simplest descriptions assumes that the learner builds his own knowledge through direct interaction with the learning material and linking new concepts with his previous knowledge, which leads to changes in his cognitive structure on the basis of new meanings and what takes place renewal and upgrading of his cognitive structure (Obaid and William, 2010: 178). There is a set of foundations upon which constructive learning is based, including:

1- Learning is an active and continuous constructive process that aims at guidance.
2- Preparation for learning is an essential step before the learner faces a new problem or task.
3- Learning includes rebuilding knowledge through social negotiation with others.
4- Tribal knowledge is a prerequisite for building meaningful education.
5- The aim of learning is to bring about an adaptation that is compatible with the cognitive pressures faced by the learner (Afaneh, Izzo and others, 2012: 274) .
As for the advantages of structural learning: they are many, including: -
1- The learner is the one who researches, experiences, and acquires by himself.
2- The learner is given the opportunity to use science processes such as observation, deduction, hypothesis, measurement and testing the validity of hypotheses.
3- It provides the opportunity for the learner to discuss and dialogue with the teacher or the rest of the learners.
4- He links science as theoretical knowledge with practical reality.
5- It gives the opportunity for the learner to develop scientific thinking, innovative thinking and critical thinking (Al-Zuhairi, Haider Abdul-Karim, 2017: 366) .
Suggested Strategy (PPODEB):
The proposed strategy includes six main steps:

PREPARATION:
it is the step of sensory preparation and its tasks are motivation and direction towards the goal and work to develop motivation towards learning, and here (Ali, Muhammad Al-Sayed, 2008) confirms that it is an essential preliminary step to confirm the initial understanding of the problem among students, and the difficulty of concepts The scientific study for the lesson and the formation of a simple knowledge of these concepts. (Ali, Muhammad Al-Sayed, 2008: 217).

PREDICTION:
In this step, the teacher introduces a phenomenon or question about the concept to be taught to students, then gives them the opportunity to predict the outcome of the phenomenon or question individually, and justify those predictions before any educational activities or activities begin.

OBSERVATION

In this step, students test their ideas about the problem or question, through conducting activities and experiments, in groups, and students must record their observations to ensure that they do not change them when they hear what others say about their observations. Its value in revealing understanding, and here students fall into a state of cognitive imbalance when they do not agree with the predictions.

DISCUSSION

In this step, students are provided with an opportunity to work in small groups, in order to discuss their ideas, exchange experiences and reflect together, and modify students 'predictions by reconciling their actual observations in the previous step with the predictions of the students' actual observations in the previous step. And compare, and critique their colleagues' views when discussing in his group.

EXEPLANATION

In this step, students reach a cooperative solution about the phenomenon or question, and they share their findings with other groups through the collective discussion of the whole class. The previous steps, and the amendment thereof, according to the processes that took place in the previous steps (Coştu, B. 2008,5) .

BRIDGING

It is the step of transferring learning to new life situations and its tasks are to link ideas and knowledge with similar situations and employ them in other sciences or solve problems The different life. Heidi asserts (2006) that the best use of educational situations, problem solving and discussions in the classroom helps the student to realize the useful and aesthetic aspects of mathematics and contributes to the development and growth of mental abilities, and the educational environment that employs mathematics in life will encourage learners to solve Realistic issues that require intelligence and high ability (Al-Huwaidi, 2006: 43) .

Cognitive Flexibility

Cognitive flexibility is an important psychological and behavioral feature that helps the learner to follow complex tasks, such as multitasking and finding new and adaptable solutions to changing requirements. Paying attention to customary flexibility has a great benefit in developing creativity and problem solving.

Cognitive flexibility is a type of executive function, that is, the cognitive processes necessary to control behavior and achieve goals. These processes make complex thinking possible and facilitate abstract thinking.

And when a person has cognitive flexibility, he can change his thinking to meet the demands of environmental stimuli. Cognitive flexibility is the flexibility of thinking, which is the ability to think flexibly to move from one frame of thought to another, as well as perform or think about more than one concept at a time. It is

the way we "go with the flow" when life does not go exactly as we expected (Ionescu, T. 2012,190) .

In the study (Saadeh and Marwa Salah, 2017), the components of cognitive flexibility in P4 were illustrated:
1- Flexible coding: It is the ability of the individual to encode each stimulus using multiple definitions.

2- Flexible grouping: It is the ability of the individual to generate multiple solution strategies using inductive thinking, starting with the available elements and ending with the solution.

3- Flexible comparison: It is the ability of the individual to change the solution strategies according to the new tasks and choose specific elements for the solution and compare them with several patterns.

As for the types of flexibility, they are represented in two types: adaptive flexibility and automatic flexibility (Saadeh and Marwa Salah. 2017,300) .

The current research adopted (Spiro, R & others, 1995,169) definition of cognitive flexibility in determining the levels of mathematical cognitive flexibility test, which are represented in four levels (perception of opposing views, generation of alternatives, construction and cognitive modification, strategic cognitive diversity).

DESIGN THINKING

Thinking is a hypothetical concept that refers to an internal process attributed to a cognitive, interactive and intentional mental activity directed towards solving a problem, making a specific decision, understanding a topic, or finding an answer to a question.

The individual's thinking develops and acquires new patterns according to his surrounding environmental conditions (Abu Zina, Farid and others, 2007,15).
Design thinking is a problem-solving methodology that aims to achieve innovation based on the idea of human-centered design, and can be perceived as a process of understanding meaning, as each stage represents different types of discoveries in the creative system (Sakama, N.Mori, H, & Iba, T.2018,103) .

Design thinking has emerged as a problem-solving tool to better define user application requirements,
It consists of five successive stages and all the stages are indispensable and must be performed, namely:

1- Empathize: The empathy phase is used to define the characteristics of individuals for whom the product is designed through detailed observations, interviews, or surveys. From here you can find detailed information about product users and their needs. Innovation always begins with a thorough diagnosis of the needs and

expectations of the users and potential users of the product, and an understanding of the technical conditions and market conditions of the product.

2- Define: In this step, the user's needs are identified. A multidisciplinary team works by collecting information collected during the previous stages of the empathy process, which may be verbal or written, simple or complex, and formulate a report on the real problem ending with a phrase describing the problem in a specific manner. In simple and clear terms. And the summary must contain a specific goal to meet the design, this stage is relatively difficult, because very quickly identifying solutions can lead to a situation in which the solution is not suitable.

3- Ideate: In this stage, using tools such as brainstorming, drawing and cognitive maps, the learner should generate as many creative ideas as possible. Please note that according to the rules of brainstorming, even unlikely ideas and solutions must be taken into account. Generating good ideas requires not only technical knowledge on the topic, but also dexterity, courage and creativity.

4- Create a prototype: In this step, it is necessary to build one (or in some cases several solutions) in order to present it to others and test it. During the construction phase, the prototype and physical representation are created to solve the basic problem. The function of the prototype is the ability to Provide visual solutions to users and fast feedback on its work.

5- Test: In the last stage, the prototype must be presented as a solution for the original in order to obtain opinions, in this way the validity of the solution or model can be tested, and at this stage the solution is transferred from the planning and production stage to the experiment and implementation phase on the ground. It is the validation of the model in a real environment in which the solution is used, and the testing process must be shared by many learners.

The current research relied on the previous five stages in preparing the Mathematical Design Thinking Test.

Previous Studies:

Study (Ahmed Smairat Revolution, 2010): The study aimed to investigate the effect of using Wheatley's strategy based on the constructivist approach on developing mathematical thinking and acquiring mathematical concepts among students of the seventh grade in basic education schools in South Hebron in Palestine, the sample consisted of two experimental groups (57) A student and the second officer (57) students, and parity was made with several variables, followed by the application of study tools: the mathematical thinking test and the concept acquisition test. The results showed the superiority of the experimental group in mathematical thinking and in the acquisition of concepts.

Study (Al-Karawi and Fadel, 2015): The study aimed at an educational design based on the Dun and Dunn model and to identify its effect on mental flexibility and achievement in mathematics among second-grade intermediate students. The sample consisted of two groups, the first experimental (31) and the second control (30). Equivalence with many variables and then applying three tools: a questionnaire of learning methods, a cognitive flexibility test, and an achievement test. The results showed the superiority of the experimental group in mental flexibility and achievement.

Study (Hammam, Ahmad Yasser, 2018): This research aims to know the effectiveness of a proposed unit in light of the (STEM) approach for developing design thinking skills in the science subject for students of official language schools, and the research sample consisted of (35) sixth grade students And schoolgirl. This research followed the descriptive, analytical and experimental approach, and the research tool (Design Thinking Scale in the subject of science) was applied. The results confirmed the superiority of the experimental group in the design thinking test as a whole and in its sub-skills.

SEARCH PROCEDURES:

1-Experimental Design: - The design of the control group with two pre and post tests was chosen as a suitable experimental design to verify the research hypothesis.

Groups	The test	the independent variable	The dependent variable	The test
Experimental Group	The pretest	The proposed strategy	1. Mathematical cognitive flexibility	Post test
Control Group		----------	2. Mathematic design thinking	

Figure No. (1) Research Experimental Design2-Research community and sample:

The research community identified second-grade intermediate students in intermediate and secondary schools affiliated to the General Directorate of Baghdad Education, Rusafa II, for the academic year 2019-2020.

The research sample: The research sample was chosen randomly (Rabaa Al Adawiya Intermediate School for Girls), and randomly a Division (A) was chosen to represent the experimental group whose students will study according to the proposed strategy. The control group, which will be taught in the usual way, as their number reached (31) students after excluding students who had failed.

CONTROL PROCEDURES:

The two groups were rewarded with a number of variables, namely (previous achievement in mathematics, intelligence, cognitive flexibility, design thinking). The two researchers obtained previous achievement from school records. As for the cognitive flexibility test and design thinking, the students 'grades were obtained after testing, checking their answers, and determining grades When a comparison is made between the average scores of the experimental and control groups using the t-test for two independent samples, it was found that the calculated value is less than the tabular value, which means that the two groups are equivalent to the above variables, and the following table illustrates that.

Table (1) Equality of the research sample students in cognitive flexibility, previous achievement and design thinking

Groups	Variables	Academic division	N	Mean	Std. Deviation	variance	df	t-test Calculate	t-test tabular	$\alpha = 0.05$
Experimental	Mathematical cognitive flexibility	A	32	11.38	5.332	943.0	68	0.951	2	Non-statistically significance
Control		B	31	11.29	5.628	1.011				
Experimental	Previous achievement in mathematics	A	32	67.91	17.23	3.046		0.044		
Control		B	31	67.71	18.33	3.293				
Experimental	Mathematic design thinking	A	32	12.94	3.454	0.611		0.619		
Control		B	31	12.48	3.740	0.672				

As for the intelligence variable, the Raven test (al-Dabbagh, 1983) was applied and the percentile scores of the students of the research sample were extracted and divided into ranks according to the percentile degree and the calculation of (chi – square test). The calculated values were 2,952 less than the tabular value 7.82 at a degree of freedom 3, so that the difference is not Statistically d in the IQ variable, and the following table shows that.

Table (2) The chi-square test value for difference The IQ scores of the students of the experimental and control groups were evaluated

Groups	Academic division	IQ level				N	The chi-square test value		$\alpha = 0.05$ And df 3
		5%	-III 5%-25%	III 25%-75%	-II 75%-95%		t-test Calculate	t-test tabular	
Experimental	A	3	10	19	0	32	2.90	7.82	Non-statistically significance
Control	B	5	6	18	2	31			
		8	16	37	2	63			

RESEARCH REQUIREMENTS

• Determining the scientific subject: The scientific subject to be taught in the first semester (relative numbers, real numbers, boundaries, equations and inequalities) was determined from the mathematics book for the second grade, average.

• Analysis of the scientific material: The scientific material was analyzed and the components of mathematical knowledge were extracted and presented to a group of specialists and modified according to their observations.

• Determining behavioral goals: The specific objectives for teaching the subject were set in the form of behavioral objectives according to the six levels of Bloom's classification in the cognitive domain. They were presented to a group of specialists and a percentage of agreement was taken on each goal and approved in the teaching plans.

• Preparation of the proposed strategy (PPODEB): The proposed strategy for the research topic was prepared. The six steps were previously mentioned in the theoretical background.

Preparing teaching plans

Teaching planning is a process in which a comprehensive framework for steps, procedures, methods and activities is developed to achieve specific goals within a specific time, and to ensure the degree of achievement of these goals (Abu Zina and Ababneh, 2007: 196).

The two researchers prepared daily instructional plans for the topics that will be studied in the experiment, and two model plans (for both experimental and control groups) were presented to a number of experts and specialists in curricula and methods of teaching mathematics and subject teachers to benefit from their views on it, and in their light the rest of the teaching plans were prepared.

RESEARCH TOOLS

Cognitive flexibility test: The cognitive flexibility test was prepared where the purpose of the test was determined, which is to measure the cognitive flexibility of second-grade students, the average of the research sample. The number of paragraphs was determined according to the four levels (recognition of opposing views, generation of alternatives, construction and cognitive modification, strategic cognitive diversity) so that the number of paragraphs was 20 objective paragraphs of the type of multiple choice and (5) paragraphs of the essay type, as well as the response instructions were prepared In the model paper for the test, where one score for each paragraph was approved for correction, so that the test score was between (0-20), and the essay paragraphs scored (1-2-2-4-4) for each paragraph, so that the overall score was (33), and the test items were presented And the typical answer and answer instructions on a group of specialists.

• The test was applied to a first exploratory sample outside the research sample consisting of 20 students on Wednesday 10/2/2019 to ensure the clarity of the time clauses required for the answer. The time was calculated by taking the arithmetic mean of the sample to determine the time required, and it was 55 minutes.

The test was applied to a second exploratory sample, other than the research sample, consisting of 100 students from Al-Fawz Secondary School for Girls on Thursday 3/10/2020, and the psychometric characteristics were extracted using appropriate statistical means from a calculation of difficulty transactions And the distinction and effectiveness of alternatives to the substantive paragraphs. And the calculation of the stability coefficient using the equation KR-20 was (0.78) and the frying using Alpha Cronbach was of (0.81).

• The apparent honesty was ascertained by presenting the test to a group of specialists, as well as displaying the behavioral objectives and the content of the material, or the validity of the structure was reassured by the inclusion of the test for all levels.

Design Thinking Test:

The purpose of the test was determined, which is to measure design thinking among students of the second grade average, and the items of the test were formulated according to the steps of design thinking (empathy, definition, creative thinking, prototype, experiment and test) and the number of paragraphs (22) was an objective type And (5) paragraphs of the essay type, as well as the answer instructions were prepared in the model paper for the test, where the correction was adopted one score for each paragraph, so that the test score was between (0-22) degrees and the essay items ranged from (2-6-2- 1-2) scores for each paragraph, so that the overall score is (35). The test items, answer instructions and the model answer were presented to a group of specialists.

• The test was applied to a first exploratory sample outside the research sample consisting of 20 students on Sunday 6/10/2019 to ensure the clarity of the time clauses required for the answer. The time was calculated by taking the arithmetic average, so the time was 60 minutes.

• The test was applied to a second exploratory sample, other than the research sample, consisting of 100 students from Al-Fawz Secondary School for Girls on Monday 7/10/2019, and the psychometric characteristics were extracted by using appropriate statistical means from an account of the coefficients of difficulty and distinction and the effectiveness of alternatives for the objective paragraphs. And the calculation of the coefficient of stability using the equation KR-20 was (0.76) and the frying using Alpha Cronbach was of (0.79).

• The apparent honesty was ascertained by presenting the test to a group of specialists, as well as displaying the behavioral objectives and the content of the material, or the validity of the structure was reassured by the inclusion of the test for all levels.

4 - Application Experience:

The application of the research was started with the beginning of the first semester of the academic year 2019-2020 on Monday 30/9/2019 and the IQ test was equivalent on Tuesday 10/1/2019 and the cognitive flexibility on Wednesday 10/9/2019 and design thinking on Thursday 10/10/ 2019. Then the actual teaching took place on Sunday 10/13/2019, at the rate of four lessons per week by the researcher The second and then applying the post cognitive flexibility test on Sunday 5/1/2020 and the design thinking post test on Tuesday 7/1/2020.

5 - Statistical methods:

The two researchers used the appropriate statistical methods, which are the difficulty factor equation, the discrimination coefficient equation, the efficiency of alternatives equation, the chi-square test equation, the KR20 and Alpha Cronbach equation, the t-test for two independent samples, and the percentage equation, as well as the spss statistical package. (Odeh, 1998: 285-356) (Attia, 2009: 313)

Search results:

The first null hypothesis: (There is no statistically significant difference between the mean scores of the experimental group students and the average scores of the control group students in the post-mathematical cognitive flexibility test) The answers were corrected and the total score of each student was calculated, and the grades of the two research groups (experimental and control) were calculated in the flexibility test. Cognitive by t-test, as shown in the following table.

Table (3) Statistical results of the cognitive flexibility test of the two research groups (experimental and control)

The error Standard	Std. Deviation	Mean	N	Groups	t-test		DF	$\alpha = 0.05$
0.763	4.388	23.515	32	Experimental	Connotation of The two parties	t		statistically significance
0.974	5.336	19.267	31	Control	0.001	3.464	61	

By applying (t-test) to two independent samples to find out the significance of the difference between the mean scores of the students of the experimental and control groups, the value of (t) (t) reached (3.464) at a level of significance (0.001) which is smaller than the adopted level of significance (0.05) and with a degree of freedom (61). It indicates the superiority of the female students of the experimental group that studied depending on the proposed strategy over the students of the control group who studied according to the usual method of testing cognitive flexibility. Thus, it rejects the null hypothesis.

The second null hypothesis: There is no statistically significant difference between the mean scores of the experimental group students and the average scores of the control group students in the Dimensional

Mathematical Design Thinking test. For the purpose of verifying the validity of this hypothesis, the scores of the students of the two research groups (experimental and control) in design thinking were calculated as in **Table (4).**

Table (4) Statistical results of the design thinking test for the two research groups (experimental and control)

Groups	N	Mean	Std. Deviation	The error Standard	t-test		Df	$\alpha = 0.05$
					Connotation of The two parties	t		
Experimental	32	17.47	7.322	1.294	0.002	3.232	61	statistically significance
Control	31	12.19	5.468	0.982				

By applying (t-test) to two independent samples to find out the significance of the difference between the mean scores of the students of the two groups (experimental and control), the T-value (t) reached (3.232) at a level of significance (0.002) which is smaller than the approved level of significance (0.05) and with a degree of freedom (61). This indicates the superiority of the female students of the experimental group, who studied according to the proposed strategy, over the female students of the control group, who studied according to the usual method in the mathematical design thinking test. Thus, it rejects the null hypothesis>

INTERPRETATION OF RESULTS

The researchers attributed the reason for this superiority to the experimental group that was studied according to the proposed strategy over the control group that was studied according to the usual method to:

1- The proposed strategy provided the students with an opportunity to increase participation in the lesson, link past experiences, and discuss current experiences.

2- The proposed strategy also contributes to providing students with the opportunity to explain, discover fallacies, and present logical arguments and proof.

3- Making the classroom environment a cooperative environment, through the proposed strategy, that enables students to absorb information and leads to an increase in thinking ability.

4- Asking questions and discussing among the students leads the students not to rush in issuing a judgment and focus on the answer and link the information stored in their knowledge structure by generating alternatives and differentiating between them in order to reach logical solutions.

5- The questions raised through observation, discussion and interpretation increased their self-confidence and overcoming difficulties, fear and dread of presenting new and unfamiliar ideas.

6- The last step (bridging), which is linking quasi-abstract and abstract experiences with life situations, may have contributed to their design thinking practice that grows and develops depending on the experiences and stored information present in their knowledge structure.

Conclusions:

1- The proposed strategy had the effect of changing and modifying the mathematical cognitive ideas of the experimental group for use in emergency situations and modifying the cognitive buildings according to the educational situations.
2- The proposed strategy raised the level of design thinking for the experimental group.

RECOMMENDATIONS:

1. Teaching mathematics using the proposed strategy for different stages of study.
2. Urging mathematics teachers to apply the proposed strategy in teaching mathematics.
3. The necessity of including the decisions of mathematics teacher preparation programs in the Faculties of Education for modern constructive strategies in teaching as the proposed strategy.

SUGGESTIONS:

Completing the current research, the two researchers suggest the following:
1. Study the impact of the proposed strategy on other variables such as sports communication skills, reducing cognitive burden or productive thinking.
2. Studying the effect of the proposed strategy on acquiring the subject of methods of teaching mathematics for students of the College of Education.

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