

The Effectiveness of Using Penta Gram Strategy in The Critical Thinking Skills For Females Students of Fifth Scientific Class.

Abbas Naji Abdulameer¹, Doaa Kareem Mahdi²

¹ Department of mathematics, College of Basic Education, University of Al- Mustansiriyah, Iraq

² Ministry of Education, Directorate of Education of the Al-Karkh-3, Baghdad, Iraq.

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Abstract:

The aim of the current research is to identify (The Effectiveness of Using Penta Gram Strategy in The Critical Thinking Skills for Females Students of Fifth Scientific Class. The number of the sample members reached (58) students, (29) students were for the control group, and (29) students for the experimental group. The researchers chose the experimental method and one of the partial control designs for the two equivalent groups (experimental and control) with a pre and post test. The researchers also prepared a test for critical thinking skills consisting of (25) objective paragraphs of the multiple choice type with four alternatives. The validity and consistency were verified. The Keoder-Richardson equation (k-R20) was used to calculate the factor of the test stability, the t-test was used for two independent samples to process the data using the statistical program (SPSS). The following result was concluded; There is a statistically significant difference between the average scores of the pre and post tests of the critical thinking skills of the students of the experimental group for the benefit of the post, which indicates that the Penta Gram strategy is effective in improving the level of critical thinking among the students of the experimental group, and in light of this , the null hypothesis was rejected .

First: The Research Problem

The problem of the research is to answer the following question;

What is the effectiveness of using Penta Gram strategy in the critical thinking skills for the females students of fifth scientific class?

Second: The importance of the research

1- Penta Gram strategy may help in training students in critical thinking skills through realistic training situations prepared for this purpose based on the Penta Gram strategy.

2- The current research is the first of its kind in Iraq at this stage and the other stages (according to the researchers' knowledge), which deals with the Penta Gram strategy in the critical thinking skills for the females students of fifth Biological (scientific) class. This research will pave the way for conducting complementary researches in this field.

Third: The aim of the research

The current research aims to identify the effectiveness of using the Penta Gram strategy in the critical thinking skills for the females students of fifth scientific class.

Fourth: Research hypotheses

To achieve the goal of the research, the researchers sought to verify the following hypothesis:

There is no statistically significant difference at the level of significance (0.05) between the average scores of the experimental group students who studied by the Penta Gram strategy , and the average scores of the control group students who studied by the ordinary method in the pre and post test of critical thinking skills .

Fifth: Research limits

The current research is limited to: the first semester of the academic year 2020-2021, females students of fifth-scientific (biological) class of in public schools in the State Directorate of Education - AL - Karkh /3 - Baghdad. The researchers dealt with the following chapters of the content of the

mathematics book for the fifth class of scientific (biological) branch , eleventh edition of 2019 , (second chapter , sequences, third chapter conical segments, and fourth chapter , circular functions) . The experiment was carried out at AL -Duha High School for females, affiliated to Directorate of Education - AL –Karkh / 3.

Sixth: Terms Definitions

Penta Gram strategy:

(Abdulaziz, 2016) defined it: (as: “A new educational strategy aimed at developing higher-order thinking skills, such as planning, monitoring, and evaluation, as well as presenting a new educational system for students, as it is flexible and can be used in all academic stages including universities (Abdulaziz, 2016 , 71)

Critical thinking:

(Otoum & others, 2011) defined it as "meditative thinking which is governed by the rules of logic and analysis. It is the product of multiple aspects of knowledge, as knowledge assumptions, interpretation and evaluation of discussions, education and conclusion, a corrective process that uses the rules of logical thinking in dealing with variables . Critical thinking is a complex mental process of skills and tendencies "(Al-Atoum & others, 2011: 73).

Theoretical background and previous studies:

Meaning of constructivism theory:

In the context of talking about the constructivist theory , (Zaitoun, 1992: 1), states that "There is a difficulty in finding a specific meaning for it. But constructivism represents a theory of knowledge in the sense that it is concerned with the science of knowledge."

The International Dictionary of constructive Education defines it as “a vision in the theory of learning and child development , based on the concepts that the child plays an active role in building the patterns of thinking he / she has as a result of the interaction of his innate capacity with experience” (Sabih, 2003: 70)

Penta Gram strategy:

Penta gram is a word consisting of two syllables, the "penta" which means five, and the "gram" is a circular design, which means the circular pentagram design. Penta Gram strategy is an instructional strategy of modern teaching strategies It is intended for setting plan and a set of procedures that occur regularly and sequentially. It aims to solve the problem prepared in advance, so that the individual is aware, knowledgeable of his thinking processes and their management. The individual will be able to plan and make decisions, to implement them, to monitor and evaluate his / her thoughts through meditation, self-evaluation and mental activities used before, during and after solving the problem. (Abdulaziz and Nevin, 2017: 12)

Penta Gram strategy phases

1- Knowledge phase:

This phase is pivotal for the learner to start reaching the task outcomes, as it provides the background to the subject matter in a way that stimulates learners' motivation for research and learning It aims to present the general context and the outline of the task to be done by learners , starting from defining the idea of searching for information and defining the objectives by laying essential questions for the task , and proceeding of the task by the design used .

2- The planning phase:

The previous knowledge is organized in accordance with the planning, information and data collected previously from the previous phase, in order to help the learners to conceptualize the steps for implementing the course of the plan in the task, and to determine the steps must be followed to answer the questions, previously laid.

3- The decision-making phase:

It is the stage in which the learners choose the best way to do the task, and choose the appropriate icons that ease the task for them to reach the goal effortlessly.

4- Application phase:

It is the stage of implementing the best offers that have been planned and selected, by taking the appropriate decision, and thus the task is applicable, as it is the critical phase for the success of the task where learners engage in activities with the aim of obtaining a solution to the task.

5- Calendar phase:

This phase represents the continuous follow-up and evaluation of what the learners are doing in each of the previous phases, with judging the way and the extent of the task. The teacher must encourage the learners; strengthen their confidence through material and moral reinforcement to reach the required results of the task. (Abdulaziz, 2014: 116)

Critical thinking skills:

After reviewing the literature and critical thinking researches, it was concluded that there are particular references containing lists of different types of critical thinking skills due to the multiple theoretical trends in the study of critical thinking. The researcher found that there is a difference in views among researchers in determining critical thinking skills.

We briefly show some of those critical thinking skills

1- Watson and Glaser defined critical thinking skills as follows:

1- Knowledge of assumptions: This is the ability to examine the facts and data contained in a topic. 2-

Interpretation: It is the ability to conclude a certain result from the assumed facts with a reasonable degree of certainty. 3- Arguments evaluation: It is represented in the ability to perceive important aspects related directly to a specific topic, and to distinguish between relevant strong and weak arguments and the unrelated arguments.

4- Deduction: It is the ability to recognize the relationships between certain facts and judge in the light of this knowledge whether a result is completely derived from these facts or not, regardless of the validity of the facts given ; or the student’s view on them.

5 Conclusion: It is the ability to distinguish between degrees of probability of correctness or error of an outcome, depending on the degree to which it relates to certain facts given to it (Sakhy and others, 2012: 62)

Table (1)

The Previous Studies

Number	Researcher's name and the date of the study	Title of the study	Size and quality of the sample	Type of random design	Independent Variable	Dependent variable	Study tools	Results of the study
1	Omar Syed Saleh Abdul Aziz, Saudi Arabia 2016	The effectiveness of a training program based on the Penta gram strategy to develop creative problem-solving skills among gifted students in light of	32 students	One experimental group	The experimental program based on the Penta gram strategy in light of Therese's Theory	Test problem-solving skills in a creative way	The program is based on the Penta gram strategy, student handbook, teacher's guide, and creative problem-solving test	statistically significant difference was found between the average scores of students in the test of problem-solving skills in creative methods, the pre-college and the students' scores in the

		Therese's theory						<p>test of problem-solving skills in creative ways, the post-college, in favor of the post-test Individual skill (fluency skill, flexibility skill, originality skill), pre and post, in favor of the post application, and this means that the application of the proposed training program had an effective impact on developing problem-solving skills in creative ways in the study sample, which confirms the effectiveness of a training program based on the Penta gram strategy To develop creative problem-solving skills among talented students in light of Therese's theory.</p> <p>The results of the study showed, in general,</p>
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								students excelling in examining problem-solving skills in creative ways, which included the skill of fluency, the skill of flexibility, and the skill of originality
2	Maha Fathallah in Deir Noir, Egypt 2021	The effectiveness of employing a Penta gram strategy in teaching home economics to develop design thinking	42 students	Two groups, experimental and control.	The Strategy of the Penta gram	Learned insufficiencies, Design Thinking, Psychological Prosperity.	Learned Impotence Scale, Design Thinking Test, Psychological Prosperity Scale.	There is a statistically significant difference between the average scores of the experimental group in the pre and post applications of the measure of psychological prosperity as a whole and at each of its components in favor of the post application.
3	Shahad Ahmed Karim Iraq 2016	The effect of Keller's plan on the critical thinking of first-grade intermediate students in mathematics.	60 students	Two groups, experimental and control	Keller Plan	Critical thinking	Critical thinking scale	There was a significant difference at the level of (0.05), statistical significance between the average scores of the experimental and control group, in favor of the experimental group in the test of critical thinking.
4	Hussein Eifan Hassan Iraq 2019	The effect of the Appleton model on the mathematics	67 students	Two groups, experimental and control	Appleton Model	Achievement and critical thinking	Achievement and test critical thinking	There is a difference between the average scores of the students of

		s achievemen t and critical thinking of fifth graders						my group Research experimenta l and control in achievement test and this difference is in the favor of students of the experimenta l group. There is a difference between the average scores of the students of the experimenta l and control groups in the test of critical thinking, and this difference is in the favor of the students of the experimenta .l group
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Research Methodology and Procedures

First: Research methodology and experimental design

Research methodology

It is considered a structured method based on a set of foundations, rules and steps , useful in achieving the objectives of the research (Abdulrahman 2007 : 16). The researchers adopted the experimental method because it is more appropriate to the nature of this research, which enables the researchers to test assumptions related to cause-and-effect relationships (Abdul hafeez and Mustafa2000:107). The experimental method is considered more appropriate to the nature of the human phenomenon, which is characterized by the complexity of the variables affecting it (AL-Assaf 2006: 304).

Experimental design:

A scheme indicates the constructing of an experiment through its planning which includes the number of independent variables, their name and levels. The number and name of the dependent variables, and how the experiment sample is distributed among the processors in order to reach accurate results. Therefore, choosing the appropriate experimental design for the research was of great importance, because it gives the researchers a guarantee of overcoming the difficulties encountered in the phase of statistical analysis. (AL-Mashhadani, 1989: 96)

Table (2)

Research Experimental Design

The group	The groups equivalence	Independent variable	Dependent variable	Post test
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1 Experimental group	-Previous score in mathematics . - Test of previous knowledge in mathematics .	Pent gram strategy	Critical thinking skills	Test of post critical thinking
2 – control group	- Intelligence test . - Test of previous critical thinking skills. - Chronological age counted by months	Ordinary method		

Second: The research community and its sample

The research community: means "all the individuals, things, or people who make up the research problem. It is all the elements related to the study problem that the researcher aims to generalize the results of the study on." (Abbas and others 2012: 217)

Cooperation was made with the Statistics Division in Directorate of Education in Baghdad - Al-Karkh/3 ,to make a survey of for the high schools and secondary schools, as the research community . The research community included students of the fifth scientific (biological) class in secondary and high schools of the schools belong to Baghdad Education Directorate, Al-Karkh/3 for the academic year (2020-2021) . The number of the students was (2514) females students.

Research sample

“It is a selected part of society that is chosen in a way and size through which we can carry out a generalization process.” (Al-Manizel and Al-Atoum, 2010: 101). The two researchers, intentionally chose the (AL-Doha Secondary School for females), affiliated to the Baghdad Education Directorate – AL -Karkh/3, as a sample for their research.

Third: Control procedure.

Table (3)

The statistical results of the two research groups (experimental and control) in the light of variables of (previous achievement, previous knowledge, intelligence, critical thinking skills, chronological age).

Variables	Group	Number of individuals	Mathematical medium	Standard deviation	T – value		Freedom degree	Indication level
					Counted	Tabular		
Previous achievement	Experimental	29	65.90	11.18	0.34	2.00	56	Not significant
	Control	29	65.79	11.83				
Previous knowledge	Experimental	29	11.62	2.24	0.99	2.00	56	Not significant
	Control	29	12.17	2.02				
Intelligence	Experimental	29	23.07	7.09	0.099	2.00	56	Not

	tal							significa nt
	Control	29	23.28	8.70				
Critical thinking skills	Experimen tal	29	12.52	2.10	0.37	2.00	56	Not significa nt
	Control	29	12.72	2.19				
Chronologi cal age	Experimen tal	29	196.07	3.94	0.51	2.00	56	Not significa nt
	Control	29	196.86	7.31				

External safety of the experimental design:

1) Experimental conditions and accompanying accidents:

Accompanying accidents mean the natural accidents occur during the experiment which may hinder the course of the experiment. The experiment in this research was not exposed to any emergency condition or accident that deters its progress.

2) Experimental extinction: means the effect resulting from the leaving or interruption of a number of students of the research sample experiment, (AL -Zobaie, 1981: 95). The two researchers did not face such a problem.

3) Processes related to maturity: They had no effect on the research, as the experiment began on Saturday 5/12/2020, and ended on Wednesday, 17/2/2021.

4) The differences in choosing the two groups:

The two researchers tried, as much as possible, to avoid the effect of this variable by conducting statistical equivalence between the students of the experimental and control groups of the research in five variables, whose interference with the independent variable could have an effect on the dependent variable.

5) Measurement tool: The same measurement tools were used with the students of the two groups to control the differences between the students of the two groups (experimental and control), as the critical thinking skills test was used to apply it to the experimental and control groups.

6) The effect of experimental procedures:

Side effects may occur as a result of the experimental procedures, so the researchers tried to limit some of the effects that may affect the course of the experiment, including;

Confidentiality of the experiment: measures were taken to ensure the confidentiality of the experiment. The two researchers reached to an agreement with the school administration not to inform the students about the nature of the research and its goal, so that the students' activity or their treatment of the experiment do not change, which may affect the safety of the experiment and its results.

Subject: The two groups of the research were taught the same academic content, which includes the three chapters (second,

Third and Fourth) of the mathematics textbook for the fifth scientific (biological) class.

Teacher of the textbook:

The two researchers personally taught the two groups to ensure that the experiment was not affected by a difference of personal characteristics of the school and the methods used.

Teaching Aids: The same educational aids were used for both experimental and control groups.

Location of the experiment: The experiment was carried out in (AL - Doha High School for Females) for the two groups,

In similar classes in terms of lighting, ventilation, space, and seating type.

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Duration of the experiment: The duration of the experiment was equal for the two groups (experimental and control), for a whole semester, which started on 5/12/2020 and ended on 17/2/2021. The experiment lasted for (11) weeks.

The students: The scores of the students from the two groups were excluded statistically.

Allocating the lessons: This factor was controlled by allocating the lessons equally between the two groups. It was twelve lessons. The two researchers agreed with the administration of the school on teaching mathematics to the two groups on the same days, which were divided into a lesson for each group per week, and the other weekdays the teaching was electronically.

Table (4)

Distribution of lessons on the two groups of the research (experimental & control)

Weekdays	Group	Lesson	Time	Group	Lesson	Time		
Saturday Electronic lesson	The experimental group	First	8:00 –	The control group	Second	8:45 –		
			8:45				9:30	
Sunday Electronic lesson		Third	9:45 –			Fourth	10:30 –	
			10:30					11:15
Monday Electronic lesson								
Tuesday Electronic lesson								
Wednesday Attending lesson								
Thursday Electronic lesson								

Fourth: Research requirements

1- Setting the scientific material:

The two researchers set the scientific material, taught for the two groups, (experimental and control), represented by the three chapters (second, third, and fourth) of the mathematics textbook for the fifth scientific (biological) class - for the first semester of the academic year (2020-2021) ,consisting of chapter two (Sequences) Chapter three (Conical Segments) & chapter four (Circular Functions).

2- Formulating of behavioral objectives:

Behavioral objectives are phrases that describe the activity expected to be performed by the learner after having passed through, with specific educational experience, provided that the activity is capable of observation and measurement. (Salameh, 2005: 37)

Therefore, the two researchers translated the content of the scientific material into behavioral purposes of the first six levels

of Bloom's classification of the cognitive domain (remember, comprehend, apply, analyze, synthesize, evaluate) which is measurable and observable. The number of the behavioral objectives was (94). They were presented to a group of arbitrators and experts in education and methods of teaching mathematics to give their views and observations, and find out the objectives appropriate to the level of the goal that is measured, and their coverage for the content of the subject.)

The two researchers adopted the behavioral objectives that obtained an agreement of 80% according to the Cooper's equation. No behavioral objective was omitted, accordingly, the behavioral objectives

were distributed on the cognitive levels of Bloom's classification (remembering, comprehension, application, analysis, synthesis, evaluation) the three chapters were taught in sequence.

Fifth: the search tool

The current research includes one dependent variable and that is the skills of critical thinking to identify the extent to which the research objective and its null hypothesis were achieved.

Test of critical thinking skills

Through the researchers' review of some studies ,literature and researches dealt with critical thinking, they noticed that there was no a suitable test for the research sample and the mathematics subject ,therefore, the two researchers prepared a test to measure critical thinking skills, following the underneath steps:

- Determining the purpose of the test: the aim of this test is to measure the critical thinking skills of fifth scientific (biological) class.

B- Determining Critical Thinking Skills:

Watson Glaser's test for critical thinking skills was chosen, including five main skills (knowledge of assumptions or axioms, interpretation, argument evaluation, deduction, conclusion) to be compatible with the sample of the fifth scientific (biological) class. The research has been based on the theoretical background and some previous studies.

C- Formulating of the test items: the objective pattern was chosen in the formulation of the test items from the multiple choice of quadruple alternatives. The researcher prepared (25) paragraphs of (5) items for each skill, and the following conditions were taken into account in formulating the test items;

1- Linguistic and scientific accuracy. 2- The correct answer corresponds to the proposed alternatives 3- Its relevance to the scientific (biological) nature of the fifth scientific class students, in terms of content, style and language. The following table represents the number of paragraphs for each skill and in conformity to the skill to which it belongs.

Table (5)

Critical thinking skills and number of paragraphs

No.	The skill	Paragraphs number
1	Figuring out assumptions and axioms	5
2	Interpretation	5
3	Arguments evaluation	5
4	Deduction	5
5	Conclusion	5
Total		25

D- Formulation of test instructions:

1- Answer instructions:

Read each paragraph carefully, and then read the answers that follow each paragraph. Choose the answer that you think is correct of the answers given on the examination sheet. Circle the letter indicating the correct answer. Answer all paragraphs without leaving any of them.

2- Correction Instructions:

The two researchers relied on correcting the students' answers on the test items according to the key of the typical answer, as one score is given for the correct answer and zero for the wrong or left answer for each paragraph of the test, and since the test includes (25) items, the test score is limited to (0-25) scores.

E - Apparent validity: To verify the validity of the test, the researchers relied on experts' opinion. The test items were presented to a group of experts and arbitrators to express their views on the test items in terms of adequacy of the test items to the required skill and fitness for the students of fifth scientific

(biological) class, and the scientific and linguistic safety of the test paragraphs, the appropriateness of the alternatives for each of the test paragraphs, and the clarity of the answer instructions. The percentage of experts' agreement on the test paragraphs was greater than (%85) and thus all the test paragraphs were acceptable.

F- The first exploratory sample:

In order to ensure the clarity of the wording of the test paragraphs, instructions and the time taken for the response on the test, the test was applied to an exploratory random sample consisting of (30) female students of fifth scientific (biological) class from AL - Azza High School for females on Tuesday 19.1.2021, after agreeing with the school administrations and the mathematics teachers at the school to conduct the test application. All students were notified a week prior to the date of the test. They were asked to specify everything they find is vague and incomprehensible, whether it is in the test instructions or the test items.

in collaboration with the school administration, the test was applied and it was found that all the paragraphs of the test and its instructions were clear and that is through the absence of questions and inquiries from the students and through the application of the average response time law.

The average time for answering = first student's time + second student's time + ... etc.

The average time for answering the questions was (45) minutes. (Abidat and Suhaila, 2007: 108).

G- The second exploratory sample: The test was applied to an exploratory random sample, consisting of (100) female students of the fifth scientific (biological) class, at AL - Azza High School for females, on Tuesday 26.1.2021, and after reaching an agreement with the school administration and the teachers of mathematics at AL - Azza High School, to conduct the test and to inform all the students one week prior to the date of the test.

The answer sheets were corrected and arranged in descending order according to the students' scores in the test. The highest (%27) of the scores were chosen to represent the upper group and the lowest (%27) of the scores to represent the lower group and the number of students in each group was (27) students. The researcher found the psychometric characteristics.

Sixth: Procedures for implementing the experiment

The two researchers began the experiment on 5.12.2020 and ended on 17.2.2021, at the rate of one lesson per week for each group, and the rest of the weekdays the lessons were taught electronically, and in light of the following procedures:

The content under the current research was taught to the two research groups. The experimental group was taught according to the strategy of (Penta Gram) and the control group was taught according to the ordinary method. After having finished teaching of the two groups, the critical thinking skills test was applied on the students of the two groups on Sunday, 14.2.2021.

Seventh: Statistical tools

Statistical tools were used appropriately in conformity with the nature of the research.

Presentation and interpretation of results

Table (9)

Results of the T-test to test the pre- and post-critical thinking skills of the experimental group

The test	Arithmetic average	Standard deviation	Arithmetic average for differences	Standard deviation for differences	Freedom degree	T value		The level of significant at 0.05
						Counted	Tabular	
The pre test	12.52	2.10	4.00	1.49	28	14.48	2.04	Statistically significant
The post test	16.52	1.96						

Conclusions

- 1- Penta Gram strategy proved its ability to place students at the center of the educational process, and this is in line with the modern vision of education.
2. The teachers use of various educational activities during education contributes to improving the level of critical thinking among high schools students, as it helps to make the teaching process practical and successful.

Recommendations:

- 1- Developing the teacher guide attached to the textbook to include modern teaching strategies, including the Penta Gram strategy.
- 2- Issuing a manual includes the method of teaching critical thinking skills to be distributed to the colleges of education and basic education in the country to have benefit of it.
- 3 – To train teachers of the secondary level, to hold training courses and workshops for them pertaining critical thinking skills among students.

The proposals

- 1- Conducting a study that deals with the effectiveness of using Penta Gram in other variables, such as (background intelligence - cognitive perception - cognitive motivation - attitude - tendency - self-esteem)
- 2 - Conducting a study to find out the effectiveness of Penta Gram strategy that has shown other types of thinking, including (inferential thinking - scientific thinking - creative thinking - systemic thinking)

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