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The effect of the Polya strategy in solving chemical problems on the achievementoffourth-class students

Prof. Dr. Mohammed Khalil Ibrahim
Obaidi1965@yahoo.com

Abstract
The aim of the research is to investigate the effect ofPolya's strategy in solving chemical problems on the achievementoffourth-degree students. The researchers tested al-Adhamiya Preparatory School for Girls in a random way because it contained 5 sections, for the fourth scientific class, and Division (A) was selected by random assignment in the fourth scientific class people to represent the experimental group. In the triangle of the (B) division of the control group, the number of female students in the research sample reached (30) students in each division.An achievement test consisting of (20) substantive items was prepared and then the test validity was verified, and 80% agreement was obtained using the apparent validity and content validity, and the test reliability was (0.88) using the Spearman-Brown equation and the appropriate statistical methods were used.The statistical results showed that the average scores of the students of the experimental group of Division (A), which studied according to the Polya strategy, were higher than the average scores of the students of the divergent control group (B), which were studied according to the traditional method and in favor of the experimental group, which indicates the effectiveness of the Polya strategy in increasing and improving the achievement of the students. The experimental group because it adopts directed discovery and provokes the love of learning among the students and increases the intensity of attention, as the students are able to translate the chemical problem in a way that is consistent with their ability to find the appropriate solution to the problem, due to the ability of this strategy to organize the knowledge of the students, which raises their level of achievement in Chemistry .The researchers recommended the necessity of using it in science teaching because of its effective effect in raising the level of achievement, and many suggestions were made in this regard.

Keywords:
Polya strategy, chemical problems, achievement.

Introduction

Despite the development and modernization of the curricula, the teaching methods followed by teachers are still traditional and ineffective, and teachers often do not make good use of the time allocated for the class in teaching a product and effective and address the shortage and weakness of students and how to diagnose and identify its causes, which in turn leads to poor achievement in thematerial and its difficulty . (Trick , 1999: 267-269).

This problem is clearly evident in the solution of chemical issues. Despite the development of this substance, it still suffers from a low level of achievement in it and therefore students' reluctance to this substance, especially the mathematical aspect related to chemical issues and negative trends towards it.

Therefore, it was necessary to use a teaching strategy that addresses the weakness, deficiency and low level that arise among students , and takes into account the individual differences between them, and it must be characterized by flexibility and provide students with the necessary skills to succeed and find appropriate solutions to

problems and raise the level of achievement of students .

In the field of teaching methods development, researchers addressed many strategies that address the problems of poor achievement level and weakness in solving chemical problems, including the Polya Strategy. This strategy has gained great importance as it has proven its effectiveness in raising the level of achievement. It also increases mastery of content learning, increases self-confidence in solving chemical problems, and makes Tabah more optimistic and expectation of success . (Abu ZeinaWaiman, 1985: 43-60)

From this point of view, the two researchers in this research have tried to apply Paulia's strategy in teaching chemistry, especially since it is not used in this field(to the extent that the researchers know), so the problem of the current research is identified in the answer to the following question:

What has been the effect of using Polya's strategy in solving chemical problems on the achievement of fourth-grade scientific students?

The **importance** of the **research:** - The importance of the current research was reflected in the fact that it is an attempt to solve some of the problems facing the learning of chemistry, which the two researchers learned through their visit to some preparatory schools affiliated with the Baghdad Directorate of Education/ Rusafa through reconsideration of the objectives of learning and mastery and the ability to solve chemical problems and use logical thinking methods that contribute to the development of students' ability to confront and keep pace with the development of different fields of life and training on different educational strategies such as(Boliah Strategy), which highlights its importance in helping students to follow clear andsound steps that lead to correct results in solving mathematical problems in chemistry and obtaining good achievement and trying to keep the material meaningful. It is also considered one of the methods used to solve the problems facing the student in finding the right solutions to chemical problems.

Objective of the research and its hypothesis**:** -The current research aims to find out the effect of the use of the Polya strategy in solving chemical problems on the achievement of fourth-grade scientific students.

To achieve the goal of the research, the researchers developed the following hypothesis:

- There is no statistically significant difference at the level of significance (0.05) between the average scores of the students of the experimental group who are studying according to the strategy of Polya and the average scores of the students of the control group who are studying according to the usual method.

Search Limits:

1- Students of the fourth grade of science in the Adhamiya Preparatory School for Girls affiliated with the General Directorate of Baghdad Education/ Rusafa/for the academic year 2016

-201 7.

2- Chapter I and II of the book Chemistry scheduled for the fourth scientific grade (edition 2016).

3- Using Polya's strategy in solving chemical problems.

Term Definition:

2.Issue: - Defined by Al-Thubaini (2011) : It is an obstacle facing students in solving verbal mathematical problems, and it prevents the achievement of the goals of learning to solve these problems. (Al-Thubaini, 2011, 126)

3-Resolution of the issue: Defined by the grooms (2003) : It refers to the process or operations carried out by the individual using the information previously learned, in order to overcome the cessation of a problem previously unfamiliar to him, and he does not have a ready solution. (Grooms, 2003, 28)

4. Problem-solving strategy (Polya Strategy) : Defined by the world (2000) : The method or method used by the learner to facilitate and facilitate the solution of the chemical problem. (World, 2000, 77)

5-**Achievement: -**ArafahFathalla (2006) : It is the amount of scientific curricula that the student receives when studying limited science topics, and it is measured by the achievement test prepared for that . (Fathalla, 2006 : 17)

Chapter Two: -(Theoretical Background and Previous Studies)

Theoretical background: Problem solving : It is a mental performance characterized by the ability to perceive the relationships between the elements of the internal situation, what is given and what is required (problem question) , through the systematic application of the individual's knowledge, thinking and restructuring of the elements involved to identify their relationships , leading the individual to prove what is required and obtain the answer to the question . (Badawi, 2003: 192).

Problem Solving Strategies:The process of forming a plan or strategy to solve the problem is an important process on which the success of solving the problem depends, and that most individuals who stumble in solving problems do not have a clear plan or strategy for the solution, and that the process of solving a problem helps the individual to identify his way of thinking through his knowledge of strategies that help him achieve his goal and others that do not. (Abu Sheikh , 1995: 130).

These strategies include:

PolyaStrategy (Polya 1957) or the search for a solution model: George Polya is one of the pioneers in the field of problem solving , and his proposals in this field are among the most popular books on problem solving, and his strategy in solving problems is one of the most acceptable strategies.

Polya has identified twelve problem solving methods known as scouting techniques and has developed a general problem solving strategy that draws on a set of sequential questions in well-defined steps to guide pupils' thinking paths towards the correct solution to the problem. (Al-Amin, 2001: 249).

The strategies proposed by Paulia differ from the positivist methods of solving problems in that they are not specific steps, stages, or procedures that are sufficient for the learner to follow them step by step and in a certain order in order to reach the right solution, but would call the learner's information and previous knowledge to link them to the elements of the problem or the current situation to discover the solution of the problem himself. (Ahmed, 1984: 111).

The scouting methods that Polya knew were :

1- Partial similarity. 2. Auxiliary elements. 3. Assistive problems. 4. Simplification and re-installation .5.Identification (definition). 6.Dissemination. 7-Extrapolation and mathematical induction.
8. Indirect proof. 9.Allocation. 10.Symmetry. 11.Change of the problem.
12. Analytical work.

The Polya model emphasizes the relationship between strategy processes and problem solving through the premise that studying problem solving processes per se can ensure effective use and process effect transmission. (Badawi , 2003 : 212).

Advantages of Polya's Teaching Strategy:

1- It can be used in other sciences such as chemistry and physics as well as mathematics.
2- It was applied in the field of mathematics and proved TT F Aabove.
3- Simple and easy to train teachers to use in problem solving on which their students have been trained.
4- It has specific milestones. (Al-Amin, 2001 : 248)

The stages of Polya's strategy are : 1- Understand the issue: The student must understand the issue and the teacher must ask him the following questions:

- What 's anonymous?
- What are the data?
- Could the condition be satisfactory?
- Is the condition sufficient to determine the unknown? Or not enough? Or unnecessarily repetitive? Or paradoxical?
- Draw a shape . And get him a proper visa?
- Analyze the situation into various parts, can they be simplified?

2-Creating a solution : The student must find a relationship between thedata and the unknown and be forced to take assistance problems if there is no direct relationship between the data and the unknown and finally must get a plan for the solution :

- Have you ever seen a problem like this before? Or is it similar and slightly different in wording?
- Do you know a related issue to the current issue?
- Do you know a problem or theorem that can be implemented in the solution?
- Look at the unknown , and try to think of an approach problem with the same unknown.
- Take the problem and then solve it relevant to your current issue.
- Can you use the same method in the solution?

- You could enter aids to make it possible to solve.
- Go for identification .
- If you cannot solve the proposed problem, try to solve a problem related to the current problem.
- Can you imagine a more relevant problem to solve? Or more comprehensive? Or something like that?
- Can you solve part of the problem or problem? (Keep a portion and leave the rest).
- Can you derive something useful in solving from the data?
- Can you change the unknown or data , (the unknown and data must be close to each other) .
- Did you use all the data?
- You used all the basic ideas to come up with a solution to the problem .

3-Implementation of the solution plan: The student must implement the plan that he has reached:

- Execute the solution plan and check each step .
- You can select the correct step.
- You can conclude if the move is correct.

4- Solution review: The student must test the solution he has reached:

- Can you check the results?
- Can you derive a different problem?
- Can these laws be used for other matters?

Former studies :

A- Arabic Studies: Al-Badri Study (2019) : The attitudes of physics teachers towards the use of Polya's strategy to solve physical problems in post-basic education in the Sultanate of Oman. To achieve the objectives of the study, a trend scale was built to identify the degree of attitudes of physics teachers towards the use of Polya's strategy, and the scale is in its final form of (34) phrases .

The study sample reached (41) male and female physics teachers with post-basic learning, and the study tools were applied to them, and the results of the study indicated that the average trends of the study sample of physics teachers towards the Polya strategy on the full scale was (3.76), which is located at a high level according to the criterion of performance correction, which is a degree above the level of educationally acceptable (3.5). This is due to the perception of physics teachers of the importance of the Polya strategy in developing the skills of solving physical problems for learners, and the results of the study also indicated the absence of statistically significant differences in the attitudes of physics teachers towards the use of the Polya strategy in solving physical problems with post-basic education according to the variables of gender, scientific qualification and teaching experience.The study recommended the need to pay attention to developing the skills of

physics teachers in using the strategy of Polya with its four steps in teaching and solving physical problems with post-primary learning and continuous work to raise the level of awareness and positive trends among physics teachers towards the strategy of Polya and its importance in the process of solving physical problems.

(Albadri, 2019 19-38)

B- Foreign Studies: A Study (Mastromatteo, 1994) : This study was conducted in the United States of America, and it aimed to find out the effect of using mathematical problem-solving strategies among eighth graders, at Baron Middle School in Ohio.

The sample of the study consisted of (6) divisions of the eighth grade, (3) divisions of which were taught by the researcher and(3) other divisions that were taught by the teacher , and a division of each teacher was selected to be an officer and two experimental divisions, and the teacher's factor was rewarded in terms of: educational qualification , teaching experience and number of years of service .

One of the two experimental groups was taught to each teacher according to the problem-solving method for a period of (5) days per week, while the second experimental group for each teacher was studied for a period of (3) days per week and devoted two days to solving the scheduled problems of the book, while the two groups of teachers studied the officers in the usual way.

The researcher prepared an achievement test and also used the (NTBS) test (National Test of Basic Mathematics Skills). Using variance analysis, it was found that there are :

1. Growth in students' ability to solve mathematics problems.
2. Statistically significant differences between the two experimental groups and in favor of the first experimental group. (Mastromatteo, 1994:182-190)

Chapter Three: (Research Procedures)

1. Experimental Design:-

groups	The independent variable	Dependent variable
Experimental group	Polya Strategy	The test is further away.
Control group	In traditional method,	

Scheme(1) Experimental design adopted in the research

2. Research sample: -Adhamiya Preparatory School for Girls of Baghdad Directorate of Education/ Rusafa I was chosen intentionally to apply the research experiment.

A randomly assigned division (A) was selected from the fourth grade

scientific divisions to complete one-third of the experimental group. While Division B represented the control group . The sample consisted of (30) female students in each division.Table (1)

Table (1) Final distribution of the research sample

groups	Section	Number of students in the division	Teaching Style
Experimental group	A	31	Polya Strategy
Control group	B	31	In traditional method,
Total		62	

3. Equivalence of the two groups :- Equivalence hasbeen made for the experimental and control groups in the variables of chronological age and previous achievement and testing previous experience. The results were equivalent and as in the tables below :

Table (2) Results of the T-test for students of the two research groups in chronological age

group	Number of sample members	Arithmetic mean	Variance	Freedom degree	T value		Significance level
					Calculated	tabular	
Experimental group	30	53.94	19.16	60	1.026	2	Statistically nonfunctional
Control group	30	57,20%	15.64				

Table (3) Results of the T-test of the students of the two research groups in the previous achievement of chemistry

group	Number of sample members	Arithmetic mean	Variance	Freedom degree	T value		Significance level
					Calculated	tabular	

Experimental group	31	7.58	1.62	60	1.98	2.00	Statistically nonfunctional
Control group	31	8.27	2.02				

Table (4) Results of the T-test for the students of the two research groups in the previous experience test

group	Number of sample members	Arithmetic mean	Variance	Freedom degree	T value		Significance level
					Calculated	tabular	
Experimental group	31	27.29	4.78	60	0.465	2.00	Statistically nonfunctional
Control group	31	27.03	4.57				

4. Research requirements:- A-Determination of the scientific material: It was represented in the first chapter and the second chapter of the book of Chemistry scheduled for the fourth scientific year of the academic year 201 6 - 2017, where the chapter identified two topics (gas laws, Boyle's law, Charles' law, Gaylosac law, unified gas law, Avocado's law, ideal gas law, Dalton's law for molecular pressures, the law of spreading for Raham, solving the problems of separation for each law), while the second theme dealt with (kinetic theory of gases , real gases and ideal gases, critical phenomena and gas liquidity, liquid vapor pressure, liquid boiling point, solving the problems of separation for each topic).

B-Determining behavioral purposes: The number of behavioral purposes was (50) behavioral purposes distributed at four levels and were presented to a committee of experts specialized in methods of training, measurement and evaluation[(1)] and in light of their opinions, some

([1]) **Group of Experts**:

1. **Prof.Dr. Ahmed Abdel Zahra (methods of teaching science) .**
2. **Prof. HashimHamza(Methods of Teaching Mathematics) .**
3. **Ms. Khamail Ibrahim (Chemistry School) .**

paragraphs were amended and obtained the percentage of agreement (78%), using a square of K2.
Preparing teaching plans: A teaching plan was prepared according to the strategy of the experimental group and a plan according to the normal method of the control group.

Appendix

Where the teaching of the subject during the trial period was entrusted to the teacher of chemistry / for the fourth stage of science Mrs. (AmiraQasim) to teach the experimental and control groups (after the method of teaching required to be followed from the use of Polya's strategy and its steps in solving chemical problems, training him on these steps, and using the traditional method of control). Teaching was followed by the two researchers , and the teacher was provided with the most far-reaching test applied to the two research groups.
5. Research tool: The current researchrequests include the preparation of an achievement test as one of the various means of evaluation, and a major means of measuring the level of student achievement, and identifying the extent to which the curriculum achieves the goals set for it, and revealing the strengths and weaknesses in that, and the extent of progress made by the school, and in the light of which it is possible to work to improve the educational process and develop them and move it for the better(Abu Jadu, 1998: 325).
The researchers adopted objective tests mainly in the formulation of the paragraphs of the achievement test because they are accurate, objective, comprehensive, and economical at the time. They are also characterized by a high degree of honesty and stability, in addition to being the most types of tests that evaluate the objectives of the article easily and easily despite the great effort exerted in its design .(Samara,1998, p. 59)

An achievement test was prepared consisting of (20) paragraphs , including (10) paragraphs of the type of multiple choice) for the characteristic of this type of test with honesty and consistency, and makes the correction away from the self-corrector, and measures much of the learning outcomes, and(5) paragraphs of the type of the complementarye for their clarity of answer and saving time . (5) Essays where this type of test is characterized by its ability to measure and objectively measure students' mental abilities, and develops their ability to express precisely and clearly the acronym (Muhammad, 1999, p. 17). Appendix(2) , and the search tool was prepared according to the following steps:

ا- Preparation of the test map (specification table) : The specifications table is one of the basic requirements in preparing the achievement tests; because it ensures the selection of a representative sample of questions that measure behavioral goals, ensures the distribution of test items on the basic concepts to be measured, and sets an estimate of the number of questions that the test should consist of and the number of questions that each type of goal needs to achieve in the test (Al-Azawi, 2007, 64). Therefore, a test map was prepared to ensure the comprehensiveness and validity of the distribution of its paragraphs and its representation of the educational material scheduled for research from the book of the fourth scientific and for the first four levels of the cognitive field of the Bloom classification (remember-absorption-application-analysis). The weights of the classroom content were determined based on the opinions of a group of teachers of chemistry, while the weights of the goals were based on the percentage of behavioral goals at each of the four levels according to the contents of each class. The paragraphs of the achievement test were distributed by (20) test items. Table (5)

Table (5) Specifications table (test map)

Contents	Time in minutes	Content Weight	Behavioral objectives				Total
			Knowledge	Comprehension	Applicability	Analysing	
Article One	180	40%	28%	16%	46%	10%	100 %
			2	1	4	1	8
Chapter 2	270	60%	3	2	6	1	12
Total	450	100 %	5	3	10	2	20

* Lesson time is (45) minutes.

B- The validity of the test : Validity (Validity) is one of the basic standard (psychometric) characteristics of the psychological and educational tests and measures that require to be available in the measures before their application is honesty; because validity refers to the ability of the scale to measure what has been prepared to measure it, mM Other standard characteristics can all fall under the characteristic of honesty (Al-Anshi,2007: 32). To verify the validity of the test and its ability to achieve the goals for which it was set, use the following:

1. Apparent validity: -It refers to

the extent to which the test is measured for what has been set out ostensibly, and is reached by the consensus of the estimates of experts and arbitrators on the degree of measurement of the test for the trait, and the apparent validity means the general appearance of the test in terms of vocabulary, how it is formulated, and its clarity, as well as deals with the instructions of the test, its accuracy, clarity, objectivity, and the suitability of the test for the purpose for which it was set (Al-Azawi, 2007: 94).

The test items were presented to a number of specialists in chemistry, teaching methods, measurement and evaluation , and after collecting their opinions, it was found that all the paragraphs are valid for application with a slight amendment to some of them . And I got 80% agreement.

2. Content validity: - The validity of the content means the representation of the test paragraphs of the content of the subject to be measured or the extent to which its paragraphs are related to the content of the purpose that it measures(Ibrahim,1989: 73), and this type of validity suits the achievement tests and is called the validity of the content with comprehensive honesty and is defined as that test whose paragraphs are a representative sample of the field of behavior to be measured, and thus choosing a number of questions that are supposed to represent this field correctly (Al-Dulaimi, and Al-Mahdawi, 2002 :91).

To ensure the validity of the content, the test map (table of specifications) was adopted to find out the extent to which the paragraphs represent the content of the prescribed course and the behavioral objectives Table (5) .

C- The stability of the test : means the accuracy, perfection or consistency with which the test measures the phenomenon for which it was designed. (Allawi,2000, p. 278), i.e., the results of the test do not change if it is reapplied again, and the stability of the achievement test was calculated using the method of halving and this method is one of the fastest and simplest methods in calculating the stability, as the test is applied once in one session, and then the test paragraphs are divided into two halves, one of which includes individual paragraphs, and the other includes even paragraphs, and then the correlation coefficient between the two half of the test is calculated (Apparent,1999, p. 144) and then used by Spearman-Brown equation (Spearman-Brown) and the coefficient of stability of the test reached (0.88).

E- Statistical analysis of the paragraphs: The process of analyzing the test paragraphs is of high importance, because of the benefits it performs that help to come up with effective measurement tools that measure the features accurately, and work to develop the test paragraphs to the extent that they make a significant contribution to what that test measures (Al-Nabhan,2004: 188), after the test was applied to an exploratory sample, the answers were arranged in half (above 50%) and(below 50%) and then found:

1. Difficulty coefficient for test paragraphs:The difficulty coefficient refers to the percentage of students who answered the paragraphs correctly . (Al-Dhahir et al., 1999 : 128), the difficulty coefficients for each of the test paragraphs were calculated based on the difficulty equation and the coefficient values ranged between (0.21 - 0.78) for the substantive paragraphs. As for the article paragraphs, they ranged between (0.29-0.78). Thus, the paragraphs are acceptable as all of the paragraphs are considered to have an appropriate level of difficulty, and (Auda, 1985) considers that the good paragraph is the one whose difficulty coefficient ranges between (0.20 - 0.80) .
2. The discriminatory power of the test paragraphs: It means calculating the extent to which the paragraph is able to distinguish individual differences between students with higher and lower levels in relation to the quality measured by the test. (Imam et al., 1990 : 114), and a discerning force was calculated for each paragraph of the achievement test ranging between (0.25 - 0.56) for the substantive paragraphs, while the article paragraphs ranged between (0.21 - 0.59) and are acceptable if they are more than 30%.
3. Effectiveness of the wrong alternatives: The effectiveness of the incorrect alternatives was calculated for each of the test paragraphs, which ranged between (-0.11) and (-0.26), which means that the incorrect alternatives have attracted a greater number of students in the lower group than the upper group, and accordingly it was decided to keep the incorrect alternatives unchanged .

6 - Application: - A -Experience : The experiment was applied from 15/9/2017 to 20/10/2017 The teaching rate of the two research groups was three sessions for each division 3 weeks.

B- The achievement test was applied on 20/10/2011 to the two research groups simultaneously

after the students of the research sample were informed of the date of the examination in advance and the correction was made according to the form developed by the two researchers.

6- Statistical means: The researcher used the SPSS statistical bag to analyze the data .

Chapter Four :(Research Results and Interpretation)

1. Presentation of the results: - The hypothesiswas verified, which states that (there is no statistically significant difference at the level of significance (0.05) between the average achievement scores of the experimental group students who are studying according to the strategy of Polya and the average scores of the control group students who are studying according to the normal method.

The statistical results showed that the average score in the achievement test for the experimental group is(80.066) and the average score of the control is (72) , and the significance of the difference between the averages of the control and experimental groups was tested using the T-test. The results indicated that the difference is statistically significant at the level of (0.05) and with a degree of freedom (60) in favor of the experimental group, as the calculated T-value was (2, 33) greater than the tabular T-value of (2), and Table (6) shows this .

Table (6) Results of the T-test for the students of the two research groups in the achievement test

group	Number of sample members	Arithmetic mean	Variance	Freedom degree	T value		Significance level
					Calculated	tabular	
Experimental group	31	80.066	160.26	60	2,33	2	statistically function
Control group	31	72	199.53				

2- Interpretation of results: - The results of the research showed the

superiority of the experimental group, which was studied according to the Polya strategy in achieving, because it relies on directed discovery, stimulates the students' love of learning, and increases the degree of attention , where the student can, through the use of this strategy, translate the issue in a manner consistent with his ability to find the appropriate solution to the problem , because of the ability of this strategy to organize the knowledge of the student, which gives him the opportunity to reach the appropriate solution, and thus raises the level of achievement of chemistry.

Conclusions: - The present research has reached the following conclusion:

1. The students who studied according to the strategy of Polya have superiority over the students who studied according to the usual method of achieving chemistry.

4. Recommendations: - Inthe light of the findings and conclusion, some recommendations can be presented:

1. Using Polya's strategy in teaching because of its effect in raising the level of achievement of female students in chemistry.
2. Emphasizing the use of the Boliah strategy in solving problems as it works to activate the role of students, so the role of the teacher is limited to supervision and guidance.
3. Conducting training courses for teachers to familiarize them with various types of teaching methods and strategies, especially the Boliah Strategy.

5- Suggestions: - In light of the results of the current research and as a complement to it, the two researchers propose the following: -

1. Conducting a study on the effect ofPolya's strategy in acquiring and retaining concepts.
2. Conducting a similar study for this study, for other stages of study and for other subjects.
3. Conducting a study of the effect ofPolya's strategy on other variables such as (skill development, development of scientific thinking, orientation towards material).
4. Conducting a study similar to the current study with other strategies (comparative study).

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