A Training Program According to Interactive Teaching Strategies and its Impact on Achievement and Creative Problem Solving for Fourth-Grade Preparatory Students in Chemistry

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Suhad Abdul Ameer Abbood(✉)
College of Education for Pure Science – Ibn Al-Haitham, University of Baghdad, Baghdad, Iraq
sohad.aa.a@ihcoedu.uobaghdad.edu.iq

Abstract—The aim of the research is to know the effect of a training program based on interactive teaching strategies on achievement and creative problem solving among fourth-grade students in chemistry of the directorate of education Rusafa first, the sample was divided into two groups, one experimental and numbering (29) students and the other control group numbering (30) students. The experimental group underwent the training program in the first semester of the year (2021–2022) and the control one studied according to the usual method. Two tools were built, the first being an academic achievement test consisting of (40) multiple-choice items, and the second a test of creative problem-solving skills in a chemistry subject and consisting of (10) essay questions. The results, using the t-test for two independent samples, showed that there was a statistically significant difference at the level (0.05) in favor of the average scores of the students who were applied to the training program which based on interactive teaching strategies.

Keywords—training program, interactive teaching strategies, creative problem solving

1 Introduction

Education is a human process aimed at helping students at all academic levels to acquire forms of knowledge and science in order to achieve a comprehensive and integrated development of their personality, so that it affects all aspects of their growth, including physical and mental, and the competencies of teachers play a major role in achieving this through creating a climate and a sound educational environment and teaching methods, which enhances the learner's self-confidence, stimulates thinking and creativity, and opens the way for him to achieve success [1, 2]. In view of the tremendous developments and rapid changes the world is witnessing in various fields of human knowledge, there has become an urgent need for an active interactive education in which the learner is positive in educational situations [3, 4], meaning that the learner relies on himself in obtaining knowledge, information and acquiring skills,

through the use of teaching strategies [5], interactive and educational programs – learning, enrichment and specialized training that take into account the learner's needs and preparations, and develop his ability to solve problems, attract attention towards the learning process [6]. As these interactive strategies are based on the use of the method of sharing and interaction between the learner and the teacher and between the educational material [7], as these strategies of interactive teaching are applied and implemented in the educational environment through a variety of means and methods, including: brainstorming strategy, hot group strategy, perception strategy, mental stimulants, and others Among the strategies that develop the student's creativity [8, 9]. In order to verify the extent of the use of interactive teaching programs and strategies in teaching chemistry, the two researchers sought to verify the level of achievement of students in chemistry, specifically students of the fourth scientific grade[10], by identifying their grades found a low level of achievement for them, and this was also confirmed by many studies, including [11, 12], and this is considered unacceptable in the midst of the tremendous cognitive development, especially since the chemistry subject for the fourth scientific grade requires a student who is familiar with the skills necessary to solve problems and use thinking skills to reach that, and this will only be achieved through the use of Some modern strategies, including active interactive teaching strategies, which develop the student's creative abilities. Therefore, the two researchers decided to prepare a training program for students to increase their achievement in chemistry and raise their level in solving creative problems, as well as training them to use these strategies. Therefore, the research problem is determined by answering the following question: What is the effectiveness of the training program based on interactive teaching strategies in the achievement of chemistry and solving problems in a creative way for the fourth scientific grade students?

2 The general framework of the research

2.1 Importance of research

This research derives its importance in the need to identify the skills of solving problems in creative ways because of their important role in the development of society and solving its problems [13]. Building a program that may advance the level of students in preparatory education and provide them with information about the creative process and the skills and strategies involved in creative thinking to solve problems that achieve integration between divergent thinking, which shows finding multiple and diverse solutions, and convergent thinking, which is evident from the ability to evaluate and analyze to reach the best possible solutions [14]. Interactive teaching strategies and their role in making the learner active, major participant in the educational process [15]. Chemistry teachers benefit from the teaching plans included in the prepared training program [16]. Providing a creative problem-solving test in chemistry may help teachers to identify the level of creative problem-solving among their students. The program helps to form a positive attitude among subject teachers towards solving creative problems, which makes them feel responsible for the problems they face with their students and helps them in facing various daily challenges.

2.2 The aim and limitation of the research

Building a training program based on interactive teaching strategies for fourth year preparatory students in chemistry. Identifying the effectiveness of a training program based on interactive teaching strategies in the academic achievement of chemistry. Identifying the effectiveness of the training program according to interactive teaching strategies in solving problems in a creative way in chemistry. The research is limited to fourth grade preparatory students in the first Rusafa Education Directorate, and the content of the chemistry textbook, 12th Edition of the year 2021, in the first semester of the academic year (2021–2022).

2.3 The research hypotheses

1. There are no statistically significant differences at the level (0.05) between the mean scores of the students who underwent the training program and the scores of the students who studied according to the usual method in the chemistry achievement test.
2. There is no statistically significant difference at the significance level (0.05) between the mean scores of the students who underwent the training program and the scores of the students who studied according to the usual method in the creative problem-solving test in chemistry.

3 The theoretical framework of research

3.1 The training program

Training program is a practical activity that aims to bring about changes in experiences, information, attitudes, teaching methods and performance of the behavior of the trainees in order to enable them to benefit from the capabilities they possess and their stored abilities in improving their scientific and practical practice in a continuous and continuous manner [17]. So, the procedural definition of the training program: It is the preparation of a set of theoretical and applied lessons that are planned according to a variety of interactive strategies for teaching that work to raise the level of achievement of fourth-grade students in chemistry as much as possible and develop their creative problem-solving skills. It is a detailed set of activities and experiences that are planned and implemented in a specific context and within a specific period of time to achieve desired goals according to a specific purpose [18]. Many believe that the training process has various and multiple methods that are classified and operate according to the methods of their use. The main objective of this integrated program can cover a wide area of the curriculum, which is to employ the experiences of teachers to increase students' ability to solve problems and understand the scientific material and facilitate learning more than being a carrier and conductor of knowledge, some of which are It develops the capabilities and skills of the trainees, including to increase knowledge and information, including what changes their behavior and attitudes [19]. Educational programs employ learning and teaching theories to serve learners in the classroom, and include achieving educational goals in the shortest time and effort and

using teaching methods that organize the content of educational materials on the one hand and teaching on the other hand [20]. The availability of educational programs that are clear in their plans and methods can contribute to changing the role of the teacher and the scholastic task [21, 22].

Steps for preparing the training program are determining the objectives of teaching; analyzing the learning behavior of the learner in small steps; organizing and arranging skills in a coherent and interdependent manner as the previous response leads to the next and gradually from easy to difficult; preparing educational activities related to the academic content to help the learner proceed with the training program; validating the training program after experimenting with a number of learners to prove its safety; conducting a pre- and post-test to check the background of the learners and verify the learner's learning after they have been exposed to the program [23].

3.2 Interactive teaching strategies

Interactive Teaching Strategies are the plans and movements that the teacher follows in the classroom for the purpose of achieving the goals of learning and teaching, which work to stimulate the learner's motivation in order to receive information and knowledge and make the learner active, independent, empowered, who works to employ what he has learned in educational situations and new experiences, interacting with His classmates, his teacher, and the subject [24]. The procedural definition is a set of steps and procedures chosen by the teacher to be used during the implementation of teaching to make the learner able to receive information and achieve the teaching aims as effectively as possible and in the light of the available capabilities [25]. The full integration of the learner into the educational situation requires designing the situation in a way that leads to the participation of all students, physically and mentally, in the activities, procedures and actions planned by the teacher. This means transferring the teaching method from the traditional methods in which the teacher provides the content and transfers it to the students without being there The actual participation of students in this process leads to the participation of students and their integration into learning situations, as this participation varies according to the interactive strategies used by the teacher in the lesson such as role-playing, and group learning, as the educational situation in the lesson is centered around the learner, as the students participate in an integrated manner in the discussion sessions and under supervision and teacher guidance [26]. Accordingly, the two researchers were keen, through the training program prepared for students, to use some of the various interactive strategies, such as the brainstorming strategy, the hot group strategy, the realization strategy, and mental stimulants, according to the appropriate academic content:

1. Brainstorming strategy is one of the forms of problem-solving strategies. It means generating and developing ideas. On this basis, it is called the brainstorming strategy. It means extracting all the ideas in the mind about a specific issue that is intended to be solved, provided that these solutions are intuitive and quick. The teacher writes these ideas or solutions presented by the students on the board, and puts them in categories and each classification is attributed to a group without conducting the

evaluation process on the ideas presented, solutions and choosing the best one after the end the brainstorming session [27, 28].
2. Hot group strategy which its idea based on the principle of a student or teacher-expert in a subject sitting in the lesson in the hot chair among a group of students surrounding him, and the students have to ask him questions conditionally that they are open ended i.e., they are not answered yet [29].
3. Perception strategy and mental stimulants; it works on the learner's memory through the processes that lead to understanding, insight and vision, and then retrieval and remembrance. Among these processes are interpretation, analysis, summarization, conclusion and linking, in the sense that it aims to help learners to absorb new information and increase its meaning, and with this the strategy works to draw the student's attention to the topic of the lesson and important ideas and help him link the new learning with the previous learning [30].

3.3 Creative problem solving

It as a process that includes complex thinking in which both divergent and convergent thinking skills are used, as it requires their abilities together according to specific logical steps aimed at reaching a decision with the best solutions to a problem [31]. The procedural definition of it is an organized process through which productive thinking tools and strategies can be used to understand problems, generate many unusual ideas, and evaluate and implement possible solutions, which is measured by good employment of divergent thinking skills (fluency, flexibility, originality, creativity) with convergence thinking skills (identifying the problem, evaluating and developing solutions, and setting a plan for better implementation), which helps students to overcome problems and distinguish in responding to challenges, and is measured by the degree that the student obtains according to the test prepared for that. It is any effort made by an individual or a group in creative thinking for the purpose of solving a problem. The solution to creative problems is also defined as a creative process with an imaginative approach used by thinkers to generate ideas that have a creative meaning, and this method is used to manage a group of individuals to solve a problem [32]. The creative solution of problems must be placed in the focus of attention of the curricula when designing and teaching them, for the purpose of developing students' ability to discover and be creative, and to use various and stimulating teaching methods to solve problems, reach a creative solution to them, and to provide the opportunity for students to practice various educational activities that develop problem-solving skills which encourages him to reach a creative solution to it, relying on himself and his own capabilities, and to provide him with appropriate feedback [33].

Components of creative problem solving.

1. Understanding the problem, when we want to reach a solution to a problem, we need to give meaning to a specific point where we focus on solving the problem. The focus of attention in this component is on clarifying the understanding of the problem or situation, or defining the path that is heading from the current reality to the future. Understanding the problem includes three basic stages:

A. Mess-Finding; often at this stage, the individual reaches the search for an unclear and vague problem, or situations or challenges that the individual must pay attention to, and until he reaches the main point towards which he directs his activity and focuses his attention on it, and works to propose multiple general ideas for the problem, Or the obstacle that he will focus on in moving to the second stage [34].
B. Data-Finding; which is the pursuit of obtaining the largest amount of information and data that helps clarify the nebulous problem, Mess, and precisely define the problem [35].
C. Problem-Finding; which is extracting a specific formula accurately that helps generate ideas and multiple alternatives to solve the problem and the goal towards which the required activity is directed [36].

2. Generating idea: It includes only one stage, which is idea finding. It is one of the important steps of the model, in which the largest possible number of ideas are recorded, which may be a solution to the existing problem, and through which the largest possible number of effective ideas are developed, and often they are a reason for reaching a distinctive and creative idea; and be the solution to the problem.

As this stage works to help the individual expand his ideas, and overcome the difficulties and complexities that limit his thinking, and where in this component, judgments are not issued on the ideas generated, as they are all taken into consideration without judging their credibility [37].

3. Planning for implementation, at this stage, the individual works on planning, implementing, and finding solutions when he has multiple alternatives, meaning that the individual needs to make a decision in developing a plan in order to reach support for the decision when carrying out the implementation process [38]. It includes two stages: finding the solution – and accepting the plan

A. Solution-Finding: It includes analyzing, checking and improving ideas, focusing on classification and identification, i.e., moving from a large number of ideas to a smaller number, and here requires setting criteria and applying them to the ideas presented and reaching a solution [39].
B. Acceptance-Finding: It is accepting solutions and focusing on actions and procedures, i.e., moving from the current situation to the desired future, and studying the possibility of accepting solutions and making them succeed in reality. Answers in order to achieve the best possible results [40].

3.4 Achievement

It is the amount estimated by the degree that the student obtains from information, experiences, knowledge or skills in the test prepared for that purpose and in a way that can measure the other specific levels [41, 42]. The procedural definition of achievement: It is the amount of information and knowledge that the student obtains, and it is measured according to the achievement test in chemistry for the fourth scientific grade prepared for this purpose [43, 44].

4 Methodology

The researchers adopted two approaches, the first is the descriptive approach to build the training program and the other is the experimental approach to applying the program in order to achieve the desired research goals. The design with partial control of two equal groups adopted the design of the control group, which will be taught according to the usual method, and the experimental group, which will be studied according to the training program prepared according to interactive teaching strategies, and Table 1 illustrates this.

Table 1. Experimental design

Group	Equivalence	Independent Variable	De-Pendent Variable	Type of Test
Experimental		training program	Achievement Creative problem solving	Dimension Dimension
Control		traditional method		

The research community consisted of students in the fourth scientific grade in the First Rusafa Education Directorate/Baghdad Governorate, who numbered (59) students for the academic year (2021–2022). The two researchers randomly selected a sample of the fourth scientific grade students in the Abdullah Ibn Rawaha Preparatory School for Males, which numbered (59) students, and the two samples were drawn randomly to represent the experimental group, which numbered (29) students, and the control group, which numbered (30) students. Both researchers were rewarded with the research sample with variables (previous information in chemistry, intelligence, chronological age, and creative problem-solving) in addition to controlling the extraneous variables, and the results indicated that the two research groups were equal. Experimental group studied according to the steps of the training program prepared according to the interactive teaching strategies prepared by the two researchers, namely – brainstorming – the hot group – the perception strategy and mental stimulants, each according to the steps of the appropriate strategy for the subject and in different ways. – The control group studied using the usual method through question and answer.

4.1 Research requirements

The researchers took major steps to build and control the training program by examining research and educational literature, previous studies and research that dealt with building and preparing training programs, including the study of [24] and other literature for the purpose of identifying on the most important basic steps and procedures followed, as it became clear that most of the studies and literature share certain stages, which were adopted by the two researchers in preparing the training program according to interactive teaching strategies.

The following are the most important several stages in building the training program:

1. The planning stage

A. Determining the objectives of the training program which includes improving the skills of solving problems in a creative way for students of the fourth scientific grade, in addition to the cognitive, skillful and emotional objectives as identify several teaching strategies that work to make the student the center of the educational process, an effective and active one. Identify the learners' characteristics and needs and the elements available in the educational environment. Training students on these strategies, which leads to increasing their motivation and thus motivating them and developing their thinking skills.

B. Analyzing the needs of the learners and their characteristics. This was done by submitting a questionnaire that was presented to them and was answered, through which the training activities were built and the appropriate teaching strategies and evaluation methods were chosen, taking into account the learners' characteristics, preparations and tendencies.

C. Program content: The lessons and the number of classes have been determined, as the content of the subject that will be taught in the first semester of the academic year (2021–2022) has been determined. Within the annual plan prepared for the chemistry book for the fourth grade of science/2021, which consists of three chapters, the study subjects were divided in the weekly classes, at the rate of three classes per week for each of the two research groups and the chapters of the book that will be taught distributed over the lessons and according to the academic year, which can be clarified in the following Table 2.

Table 2. Distribution of classes according to the academic content

Number of Servings	Study Content	Sequence
9	The basic concepts in chemistry	Chapter one
14	Gases	Chapter two
11	nuclear chemistry	Chapter three

D. Formulation of behavioral objectives: After examining the subjects in the chemistry book for the fourth scientific grade, (198) behavioral objectives were developed, distributed according to six levels in the field of knowledge, namely: (knowledge, comprehension, application, analysis, synthesis, and evaluation). After presenting the behavioral objectives to a group of arbitrators in the field of Education and Teaching Methods of Chemistry In the light of their opinions and suggestions, an agreement rate of more than (85%) was adopted.

E. Preparing teaching plans: (29) teaching plans were prepared according to the behavioral purposes, the content of the study material, and the steps of the specific strategy, and after presenting a model of those plans to a group of experts and specialists in teaching methods, and in the light of their opinions and observations, they were modified with an agreement of 85%.

F. Showing a preliminary copy of the program to a group of experts in order to make amendments to it.

2. Application of the training program: The training program was applied to an exploratory sample of students in the fourth grade of middle school, other than the main research sample, which numbered (29) students for four consecutive days, based on teaching plans that were built according to interactive teaching strategies and according to building the steps of the training program in order to investigate the possibility of its application.

3. Evaluation process: The evaluation process for the training program was carried out, as the introductory evaluation of the program was conducted by presenting it to a group of experts and arbitrators in chemistry, as well as applying it to the exploratory sample. Conducting the final evaluation of the program at the end of the experiment.

4. Program implementation: This is done by applying all the procedures followed in the training program and the time period specified for teaching the educational material according to specific methodological procedures, including the implementation of study plans and the application of research tools on the research sample before and after in order to identify the effectiveness of the training program, and this was done under the supervision of the two researchers.

4.2 The tools

1. Achievement test: According to the variables of the current research, it is required to prepare an achievement test to identify the level of academic achievement of students in the content of the chemistry book for the fourth grade of middle school, according to the behavioral purposes and its six cognitive levels (remembering, understanding, applying, analyzing, synthesizing, and evaluating). The process of preparing the achievement test included determining the objective of the test; the test aims to measure the achievement of the fourth-grade middle school students in the chemistry subject to be taught to the fourth-grade middle school students in the training program. Then determining the academic subject which includes the classes taught in the first course of the academic year (first, second and fifth semesters) for the academic year 2021–2022. The behavioral goals were determined according to the six levels of Bloom's classification of the cognitive domain, which are remembering, understanding, applying, analyzing, synthesizing, and evaluating, as there were (198) behavioral aims. Preparing a specification table (optional map). After determining the educational material and the behavioral objectives of the chemistry content, the total number of questions and the number of questions for each cell were determined as in Table 3. The achievement test items were prepared and built, consisting of (40) multiple-choice items, in front of each item 3 wrong alternatives and one correct. After verifying the validity and stability of the test items, calculating the paragraph difficulty coefficient, the strength of its distinction, and the effectiveness of the wrong alternatives, the achievement test consisted of (40) objective items of multiple-choice type, and thus became ready for application.

Table 3. Specification table according to behavioral aims

Content	No. of Pages	Content Weight	Remember 28%	Understanding 24%	Application 18%	Analysis 14%	Synthesis 9%	Evaluation 7%	Sum
Chapter One (Basic Concepts in Chemistry)	25	30%	3	3	2	2	1	1	12
Chapter Two (gases)	31	38%	4	4	3	2	1	1	15
Chapter Five	26	32%	4	3	2	2	1	1	13
Nuclear chemistry	82	100%	11	10	7	6	3	3	40

2. Creative problem-solving test: After the two researchers reviewed the literature and previous studies that identified problem-solving skills in creative ways, a test was constructed consisting of (10) questions of the type of essay questions in chemistry, which included the three components understanding the problem, including (the fuzzy problem, collecting data, defining the problem); generating ideas and includes (fluency, originality, flexibility); planning for implementation and includes (reaching for solutions and acceptance).

5 Presentation and interpretation of results

The two researchers present the results that were reached according to the research objectives. The first aim to build a training program according to interactive teaching strategies in teaching chemistry for the fourth scientific grade, and this has been achieved according to the research procedures as mentioned previously. The second objective for the purpose of verifying the validity of the first hypothesis. The t-test equation was used for two independent samples, and the results were as in Table 4.

Table 4. The arithmetic mean, standard deviation, and the value of (t-Test) for the post achievement test for the two research groups

Collection	Sample	Mean	Std. Dev.	Degree Freedom	T-Value		Sig.	Statistical Function
					Cal.	Tab.		
Exp.	**29**	31.03	4.814	57	4.655	2.002	0.000	Sig.
Con.	**30**	23.67	7.708					

From the table above, it is clear that there is a statistically significant difference between the mean scores of the experimental group and the control group at the level of significance (0.05) and in favor of the group that studied according to the training program (the experimental group) in choosing the achievement of chemistry. Through this, the null hypothesis is rejected and the alternative hypothesis is accepted, and this agrees with [45–53]. In order to identify the effect size that focuses on the differences through the equation (d) and ETA square, and since the effect size completes and interprets the statistical hypotheses, as it was found that the effect size of the independent variable in

the achievement dependent is very large, the following is a Table 5 that shows the effect size depending on the values of (d) and the square of eta:

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

The Dependent Variable	η2 Value Squared eta	Values D	Effect Size
Academic achievement	0275	1.233	Very Large

The third objective; for the purpose of verifying the second null hypothesis: the arithmetic mean and standard deviation of the scores of the students of the experimental and control groups were calculated in solving creative problems, and by adopting the t-test for two independent samples, then finding the calculated t-value as in Table 6.

Table 6. The arithmetic mean, standard deviation, and (t-test) value of the creative problem-solving test for the research sample

Collection	Sample no.	Mean Arithmetic	Std. Dev.	DF	T value		Sig.	Statistical Function
					Cal.	Tab.		
Experimental	29	21.52	2.370	57	5.770	2.002	0.001	Statistic
Control	30	16.43	4.133					

In order to identify the effect size that focuses on the differences through the (d) equation and the eta square, and since the effect size completes and explains the statistical hypotheses, the following Table 7 shows the effect size depending on the values of (d) and the eta square.

Table 7. The size of the impact of the training program on solving creative problems

The Dependent Variable	η2 Value Squared eta	D	Effect Size
Creative problem solving	0.369	1.529	very large

It appears from the above table that the effect size of the independent variable the training program has reached (1.529) in solving creative problems, which is a very large effect.

5.1 Interpretation of results

According to the results of the research, which were reached, the students of the experimental group who studied according to the training program based on interactive teaching strategies excelled in the achievement tests of chemistry and creative problem-solving skills for the many reasons. The effective role of the training program, which contains a variety of interactive teaching strategies focused on the effective role of the learner in learning and training, and his actual practice in the lesson. Encouraging students to discuss and dialogue, activate group work, and exchange experiences and ideas through teaching strategies that stimulate students' motivation and push them

to continue thinking to find appropriate solutions in solving the problems at hand. The active role of students during teaching and their interaction in presenting and presenting the lesson led to enhancing self-confidence in how to deal with various situations and training in problem-solving. The training program helped students to deal positively with new situations and problems by training them to discover new relationships between variables and elevate them to higher mental levels. Providing a learning environment rich in educational requirements and providing a safe educational climate that helped the freedom of presenting ideas and freedom of movement, which led to an increase in their ability to learn and think.

6 Conclusion

Raising the scientific and cultural level and academic achievement in chemistry for fourth grade students through a training program prepared according to interactive teaching strategies, which had a significant impact on that. The training program has a positive and effective effect in solving problems in a creative way among fourth-grade students in chemistry. Students' need for training programs to increase their self-confidence and develop their creative problem-solving skills.

7 Recommendations

Adopting the training program according to interactive teaching strategies in teaching chemistry for different stages of study, due to its apparent effectiveness in raising the level of academic achievement and solving problems in creative ways. Include interactive teaching strategies within the vocabulary of the fourth-grade science chemistry guide. Introducing male and female chemistry teachers in training courses for the purpose of training them to use the training program prepared according to interactive teaching strategies in teaching chemistry for the various educational levels.

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9 Author

Suhad Abdul Ameer Abbood: She is presently Assistant Professor Dr. and one of the faculty members in the College of Education for Pure Science/Ibn Al-Haitham, Chemistry Department, University of Baghdad, Iraq. Her current research interests include methods of teaching and strategies and supervising postgraduate student's research. She has number of published articles. E-mail: sohad.aa.a@ihcoedu.uobaghdad.edu.iq

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