Instructional Design According to the Repulsive Learning Model and its Impact on the Achievement of Chemistry and Lateral Thinking for Third-Grade Intermediate Students

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Abstract—Identify the effect of an educational design according to the repulsive (allosteric) learning model on the achievement of chemistry and lateral thinking. The sample consisted of (59) students from third-grade intermediate students. They were randomly distributed into two groups (experimental and control), and the equivalence was done in (chronological age, previous achievement in chemistry, intelligence, lateral thinking). The (30) students from experimental group was taught according to the instructional design, other 29 students from the (control) group was taught according to the usual method. Two tests done, one of them is an achievement test consisted of (30) items of the type of multiple choice, the other was a lateral thinking test consisted of (26) items, of (multiple choice). Both of the validity and reliability to the two tools were verified. The results revealed the superiority of the experimental group who studied by the instructional design according to the repulsive learning model in achievement and lateral thinking.

Keywords—instructional design, the repulsive (allosteric) learning model, achievement

1 Introduction

The science of instructional-learning design is one of the modern sciences that emerged in the last years of the twentieth century in the field of education, what is known as the science of instructional design, a science that describes the procedures related to the selection of educational material (tools, materials, programs and curricula) to be designed, and analyzed, Organizing, developing, and evaluating them, in order to design educational curricula that help to learn in a better and faster way and help the teacher to follow the best educational methods with least possible time and effort [1, 2]. Instructional design works to translate the principles of learning and teaching through teaching plans and educational activities, and works to organize an educational/learning environment consisting of many stimuli to which the learner responds through a specific behavior that he performs and can be evaluated and judged by its conformity with

the desired behavior [3, 4]. Instructional design takes into account these procedures for the success of the educational process, and from this perspective, we see that the theoretical basis that contributed to building instructional design is learning and teaching theories, communication theories, and system theories, and these theories provide answers and important and multiple question posed by the designer. Teaching about the characteristics of students, how they learn, and the appropriate conditions that facilitate the teaching and learning process [5]. Through the researcher's experience in her field of work and her access to studies and research, including [6], she noticed that there is a lack of interest in employing educational designs based on modern educational theories and models and limiting the use of the usual method of teaching, which depends on memorization, and does not take into account the encouragement of abilities The mentality, which led to boredom and low achievement in chemistry, neglecting their abilities to think, especially lateral thinking, which leads to the students' reluctance to understand and realize the relationships and chemical equations. Based on this, the researcher decided to carry out experimental research that includes building an educational design according to the repulsive (allosteric) learning model, and to identify its impact on students' achievement of chemistry and lateral thinking, perhaps contributing to achieving the planned goals for teaching and learning chemistry in the intermediate stage, and in light of this, the research problem is summarized in: Answer the following questions: What is the effect of an instructional design according to the repulsive (allosteric) learning model on the achievement of chemistry and lateral thinking among third-grade intermediate students?

2 The general framework of the research

2.1 Importance of research

1. Building an instructional design according to the allosteric learning model, which depends on the post-constructivist theory in teaching chemistry, is a response to global trends, which emphasize the need to pay attention to students' thinking and leave the traditional methods and methods adopted in teaching.
2. The instructional design presents a visualization that includes its use according to the allergenic learning model in teaching chemistry.
3. Instructional design is one of the modern trends that go along with teaching chemistry in particular, and employing modern strategies to teach using the repulsive (allosteric) learning model.
4. The importance of the target age group because of its important and essential impact on the student's life, as it is a stage that prepares the student to move from middle school to middle school.
5. The importance of academic achievement, which is one of the most important aims of education and a basic criterion in the progress of students in their studies and making educational decisions.
6. The importance of lateral thinking as it forces the solution of situations in unconventional or seemingly illogical ways, and it is one of the tools of creativity.

7. Chemistry teachers are encouraged to design and organize the lessons of the subject according to one of the theories of post-structural learning, as the design depends on emphasizing the role of the learner in the classroom environment.

2.2 The aim and limitation of the research

To build an instructional design according to the repulsive learning model, and to show its effect on the achievement of chemistry and lateral thinking among third-grade intermediate students. Students of the third intermediate grade in the third general directorate of Karkh education/Baghdad Governorate. The chemistry textbook to be taught for the academic year (2021–2022) and includes the following chapters: Chapter One (the atomic structure of the substance), Chapter Two (Groups I and 2 IA and IIA), Chapter Three (Group IIIA) Chapter Four (Solutions and Expression of Concentration). The first semester of the academic year (2021–2022).

2.3 The research hypotheses

To achieve the aim of the research, the following two null hypotheses were formulated:

1. "There are no statistically significant differences at the level of significance (0.05) between the mean scores of the experimental group students who will study according to the instructional design based on the repulsive learning model, and the scores of the control group students who will study by traditional way in chemistry achievement test."

   H0:X1 = X2 ; H1: X1≠ X2

2. "There are no statistically significant differences at the level of significance (0.05) between the mean scores of the experimental group students who will study according to the instructional design based on the repulsive learning model and the scores of the control group students who will study in the traditional way in the lateral thinking test.

   H0:X1 = X2 ; H1: X1≠ X2

3 The theoretical framework of research

3.1 The concepts of the research

1. Instructional Design is "a set of interrelated stages, which is represented by analyzing the characteristics of learners and the objectives needed to organize, design and

choose educational objectives, strategies, develop and test assessment tools, produce educational materials, and evaluate student performance using learning and teaching theories [7, 8]. The procedural definition is as a logical sequential process for organizing and planning the educational content of the chemistry subject for the third intermediate grade, with a degree of effectiveness and efficiency to facilitate the teaching and learning process and to identify the needs and characteristics of students in order to bring about the desired changes in their behavior in the light of the repulsive learning model.

2. Allosteric (Repulsive) Learning Model; [9] defined it as (describes the mental processes that happen inside the student's mind as well as the external factors that make learning process easier, and creates a highly efficient learning environment that interacts with the student's learning processes according to specific steps) [10].

   The procedural definition of the repulsive learning model: They are intellectual frame-works for creating an interactive post-structural learning environment that describes the mental processes inside the student's mind and present real educational situations that help the third-grade intermediate student to build and modify his cognitive and mental structure according to certain steps, which works to generate responses to various scientific stimuli and activities according to the design prepared according to for the allosteric learning model [11].
3. Achievement is the output of what students learn through direct instruction and is measured by the relationship that students obtain in an achievement test [12]. Procedural definition of Achievement: It is the extent to which students comprehend what they have learned from the experiences and knowledge from the chemistry book for the third intermediate grade, and it is measured by the degree they obtain by answering the test prepared for that.
4. Lateral thinking: It is imaginative creative ways of solving problems that lead to changing the individual's perceptions and concepts about a problem [13, 14]. It is a pattern of thinking patterns that the student uses to practice a variety of skills by creating the largest possible number of solutions and alternatives and by steps to solve problems through learning the study material and reaching scientific solutions for this purpose [15, 16].

3.2 Educational design

Instructional design means translating the principles of learning and teaching through teaching plans and educational activities [17]. As the instructional/learning design plays an important role in the educational process, as it works by translating the concepts derived from educational theories into practical and realistic procedures within the classroom and through clear educational/learning activities and objectives, and it identifies the different techniques that can be used in education to accomplish these activities [18]. The importance of instructional design is that it directs attention towards educational aims, increases the probability of the teacher's success in teaching the educational material, saves effort, time and expenses, facilitates communication

and coordination between participating students, and reduces tension between students that may occur as a result of adopting traditional methods. The teacher guides them on how to work in the classroom [19].

Instructional design stages. The stages of constructing the educational design differed according to the various models of it, but they all share similar stages, which are as follows:

First stage: Analysis; It is the basic stage in building the cornerstone of educational design, and it is the process of determining what must be learned, as it includes analyzing the problem and possible solutions to it, analyzing the needs, analyzing the content, and analyzing the target group. The instructional designer works to answer a number of questions, including the following:

- What are the objectives of the content?
- What outputs will the students show according to the intended aims?
- What is the process by which the outputs are evaluated?
- Who is the target group for education?
- What are the necessary and specific needs of learners?
- How are requirements and needs identified? [20].

Second stage: Preparation or design; here the primary methods and procedures for developing and implementing the teaching and learning process are described, and their outputs include the following:

- Defining general and specific lesson objectives and measurable learning outcomes for each objective.
- Determine the calendar for each goal according to what is appropriate.
- Choosing teaching strategies, models, and methods based on the objectives of the content to be presented to students [21].

Third stage: Implementation; It is an implementation process of educational design, as this stage aims to achieve efficiency and effectiveness in education, and emphasis is placed on the interaction of learners with the educational situation and the absorption of what is presented to them and their mastery of the desired educational goals. The process of applying and conducting pilot testing of materials intended for design and preparation for long-term employment, the use of materials and educational activities prepared for this and various other aspects of support [22].

Fourth stage: Evaluation; It is the process of measuring and estimating the efficiency of the educational processes and the extent to which they achieve goals. This stage includes the formative evaluation, which is applied during the process of constructing the design with the aim of improving and developing the program and providing us with adequate information on the extent of the success of the educational content preparer, the extent to achieves goals, followed by the final evaluation process, which is implemented after Completion and completion of the teaching and learning process, as this type assesses the overall effectiveness of teaching by using it or stopping it [23].

Constructivist and post-constructivist theory. The theory works to clarify how information is built in the individual when he receives this information with his knowledge through the experience and experiences that the individual goes through in order to adapt to the world. In the sense that learning is a process of semi-permanent change in the behavior of the individual, but this theory has faced educators with great obstacles during its application, and there are many criticisms leveled by educators of the constructivist theory by many educators such as [24]. It is that the individual works on building knowledge inside his mind and does not transfer to him in full, as it focused on the students' ideas during the teaching process and did not give any specific role to the teacher, and from [25] point of view, the constructivist theory gradually turned into what is known as the social constructivist theory, after which the concept appeared Post-constructivism, due to the tremendous progress in the era of scientific knowledge, the goal of education is no longer the production of knowledge, but rather how to form knowledge, and use it correctly [26, 27].

3.3 The repulsive (allosteric) learning model

Post-constructivist theory models are considered one of the innovative and new methods that can face changes in the educational process, and the dissociative learning model is one of the post-constructive theory models, which in turn helps students in the deep search for knowledge, building it and preparing it, and it also includes multiple processes that focus on each other. On how to deal with knowledge, others focus on the mental processes that motivate students to master knowledge creatively and critically, and the processes that focus on that are research and investigation, deduction, induction, question generation, knowledge reconstruction, evaluation, problem solving and summarization [28]

Stages of the allosteric science model. The stages of the teaching process are carried out using the allergenic learning model, as defined by [29].

1. The problem stage: here the teacher begins by presenting a set of questions to the students that provoke thought.
2. The reference stage: in which students are able to answer the questions submitted by the teacher and find the relationship between their previous and new knowledge.
3. Mental operations stage: In this stage, students perform all intellectual operations while participating in problem-solving activities, and express the relationships between new and previous knowledge through diagrams, symbols and drawings.
4. Semantic network stage: – It arises from mental processes that were built on the basis of previous knowledge, and is formed as a result of the interaction between relationships, elements and concepts and the formation of a network of meanings.
5. The stage of semantics: It is a set of signs, ideas and symbols necessary to express the concepts and interpretations associated with it. In the repulsive (allosteric) learning model, the teacher works on preparing and processing new knowledge in the form of real-life situations related to the students' lives. He also works on designing knowledge instead of transferring it in a ready-made manner to students, and designs

an interactive learning environment among students, and provides them with a set of various questions that motivate them to think and investigate [30]. They referred to the processes that occur inside the student's mind according to the allegorical learning model, where the student works to manage his own learning, and the occurrence of learning depends on previous knowledge using his own skills, and understanding is achieved by linking the new information that is presented to him and between the previous information to be learning and a full understanding knowledge [31].Through what has been presented, the researcher sees that the learning process occurs according to the repulsive (allosteric) learning model, through what is available from previous information and experiences acquired by the learner, as it works to link the information that is available to him in his knowledge structure and integrate it with what is gained of new information through practicing Mental activities, finding solutions and new and innovative information.

3.4 Lateral thinking

Lateral thinking was known by several names, as the name lateral thinking was mentioned by the scientist "De Bono", and it is more common than the rest of the other names, including lateral thinking, peripheral thinking, as well as the designations of serious creativity, renewed thinking. He has worked on using them as synonyms for lateral thinking in many of his writings, and some scholars believe that lateral thinking is thinking out-side the box, meaning that deviation from the norm as a stereotypical objective thinking for the general public to strange thinking (sort of), but thinking remains in the limits of reason and logic [32, 33]. De bono believes that lateral thinking has skills that a student can practice, which are generating new perceptions; perception here refers to understanding, making a decision, solving problems, judging things, or doing an action [34]. Generating new methods; as de Bono indicated that there are many general methods that the learner tries to achieve, namely: methods and methods with a specific goal that describe the amount of impact on a work, and work on how the work is acquired Its value is [35]. Generating and cultivating new ideas; here new ideas are generated and the idea is something imagined by the mind, as thinking requires creativity and more creative ideas; generating new creations; creativity is working to generate a new event, instead of interpreting and analyzing the old event, and these creations include a specific pattern of lateral thinking patterns [36]. Generating new alternatives; diverse solutions and new ideas are generated rather than progressing in a straight line [37]. Also he believes that it is not required to generate a variety of new creations that may reach a high level of intelligence, and that what you need is a small degree of intelligence [38].The researcher believes that students' practice of lateral thinking skills can only be done after teaching and training students on them by asking many ideas and questions that develop their thinking skills and that work to make the student think outside the boundaries of traditional thinking, by facing problems with new ideas to reach results. They generate an idea through other ideas, and develop habits and creative practices to solve problems raised during the educational process [39].

4 Methodology

Two approaches have been adopted, one of which is the descriptive approach to construct the instructional design, and the other is the experimental approach to apply the design and reach the objectives of the research. The experimental design with partial control was adopted with two groups (experimental and control) with post-test (Table 1).

Table 1. Experimental design

Group	Equivalence	Independent Variable	Dependent Variable	Type of Test
Experimental		Educational programs	Achievement Lateral thinking	Dimension Dimension
Control		Traditional method		

The research community consisted of third-grade intermediate students, as the research sample was determined by random assignment in a school (Al-Bilad Secondary School for Boys). Instructional Design and Division (A) The control group of (29) students will study in the traditional way. The researcher conducted the process of equivalence between the two research groups in several variables that may affect the credibility of the results, namely (chronological age, intelligence, previous academic achievement in chemistry, lateral thinking) as well as controlling the extraneous variables and the results indicated their equivalence.

4.1 Research supplies

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

First-Building the instructional design according to the allosteric learning model. The researcher followed the following steps in constructing the instructional design, as follows:

1. Examining the foundations of constructing instructional design, the constructivist and post-constructivist theoretical principles and assumptions, and the holistic learning model.
2. Seeing the objectives of teaching chemistry in the intermediate stage, and identifying and analyzing the academic content.
3. Analyzing the characteristics of learners and determining their needs by providing a questionnaire to identify the most important educational difficulties.
4. Preparing a scheme for the educational design according to the holistic learning model and presenting it to a group of arbitrators.
5. The formulation of the behavioral objectives of the subject matter was calculated by Bloom's classification of the cognitive domain.
6. Preparing teaching plans according to the instructional design based on the allergenic learning model, and constructing two tests, one for achievement and the other for lateral thinking.
7. Conducting the final evaluation process for the educational design, starting with the formative evaluation and ending with the final evaluation.

Second-The rationale for building instructional design according to the repulsive learning model (Figure 1), the researcher found that most teachers of chemistry follow the traditional method of teaching, which emphasizes that students memorize the subject, and that there is weakness in achievement and lateral thinking skills, which required building an educational design that fits with developments in teaching methods. In order to clarify the stages of building the design, the procedural steps were followed for each stage.

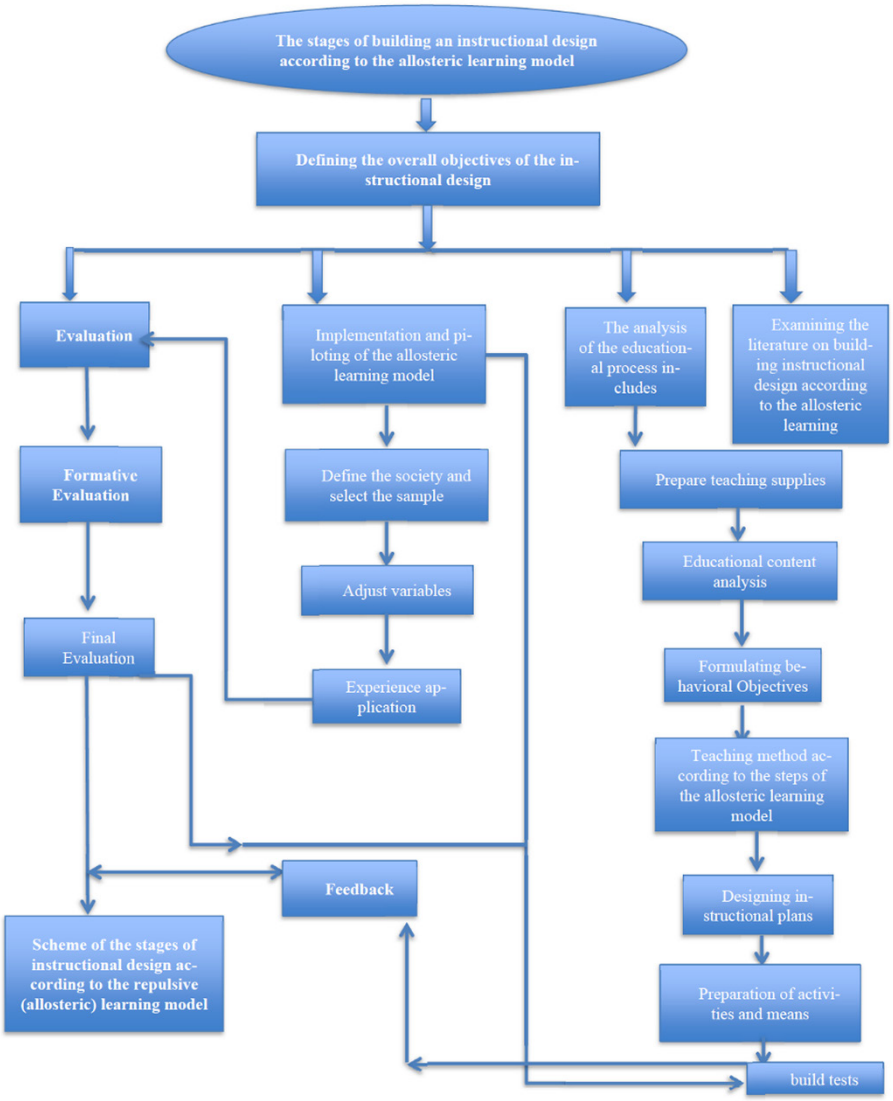

Fig. 1. Stages of instructional design according to the repulsive (allosteric) learning model

4.2 The research tools

The first tool; Achievement test: A multiple-choice achievement test was prepared that amounted to (30) items to measure learning outcomes at cognitive levels (knowledge, understanding, application and analysis) from Bloom's classification.

A specification table has been prepared according to the study material included in chemistry for the third intermediate grade, depending on the number of behavioral goals and their relative importance according to Bloom's classification, as the number of items in the achievement test reached (30) items. The validity of the test; **apparent honesty** which the paragraphs of the achievement test were presented to a group of arbitrators in (Chemistry Teaching Methods), to ensure the validity of the test paragraphs in terms of the integrity of the wording and preparation. **Content validity** where the content validity of the material was verified by preparing a specification table. The exploratory application of the test: The achievement test was applied to a sample of (25) third-grade students in order to verify the clarity of the test and its instructions. The time taken is (30) minutes. Statistical analysis of the achievement test items: The test was applied to a sample of (100) third-grade intermediate students from (Dar Al Salam Intermediate School for Boys), and after correcting the answers, the scores were arranged in descending order, and the percentage was taken at 27% for the upper and lower grades, as The number of students in each group was 27, after which a difficulty coefficient was calculated for each paragraph using the special equation and found that it ranges between (0.39–0.78), as the test is valid and good. Between (0.59–0.78), and thus, all test items are good and valid for application, and the effectiveness of the wrong alternatives was calculated, and it was found that all of their values are negative, so it was decided to keep them without deleting or modifying. Kuder-Richardson's equation 20 for the objective questions was used, and it was found that the reliability coefficient is (0.89), and this indicates that the stability coefficient of the test is good.

The second tool; Lateral thinking test: One of the requirements of the research is to prepare a test for lateral thinking, and after reviewing a set of literature and previous studies related to the lateral thinking test, including the questions and puzzles presented by de Bono in his programs for the development of thinking, I found that most of the tests include questions and puzzles that require answering in an unconventional way. The researcher adopted some test items from Debono in writing (Lateral Thinking is a Breaking of Logical Constraints), and the test items were formulated using the expertise of some specialists. Thus, the test items consisted of (28) items in its initial form in lateral thinking that suits the target age group, the third intermediate grade students. The validity of the test; Apparent honesty: The test was presented in its initial form to a group of arbitrators with the aim of verifying its validity and verifying its sincerity regarding its paragraphs. It has been omitted, and the highest score that a student can get is (26), and the lowest score will be zero. Statistical analysis of test items; The validity of the test was verified by presenting it to a group of arbitrators where all the test items obtained the approval of the arbitrators. Construction validity was verified by applying it to an exploratory sample of (30) students, and the correlation coefficient between the paragraph and the test as a whole was calculated, as the values ranged between (0.36) and (0.73), which are statistically significant values. Test reliability it was calculated using the internal consistency method using the Alpha Cronbach equation, as its value

was (0.82), and this value is good. Procedures for applying the experiment: For the purpose of conducting the application of the research experiment, the following steps were followed for both groups. The researcher visited Al-Bilad Secondary School for Boys and met with the school director and chemistry teacher there, and the purpose of the research was clarified. The researcher provided the chemistry teacher with the teaching plans of the experimental group, which is taught according to the instructional design based on the repulsive learning model, with an emphasis on teaching the control group in the traditional way. The experimental group was taught according to the instructional design, according to the steps of the all-out learning model for educational situations, which are:

- Problem stage; here the teacher asks a set of questions in the form of a problem that can be solved and through the educational reality, as the student observes and experiments and by presenting familiar and unfamiliar ideas to solve the problem and in creative ways. Questions are a driving force for every intellectual activity carried out by the student.
- References stage; the teacher divides the students into groups consisting of four to five students, that is, working in groups, and here the student begins to try to find the relationships between what they possess of previous information and new information.
- Mental operations; here the student works in using all his intellectual operations by participating in solving the problem posed by the teacher, dealing with resources, conducting an investigation, searching for information, and expressing new and previous knowledge through diagrams and symbols.
- Semantic network; the teacher here exchanges questions and information, interacts between students and the teacher, and notes the directions provided by the teacher, as the students work to synthesize his previous information with the information provided, as this process results in a network of meanings.
- Semantics; at this stage, the student arrives in creative ways to solve the problem (the question) and express to us the ideas and signs necessary to express the concept and the explanations associated with it.
- Evaluation; after completing the process of teaching the educational material, the teacher works by asking evaluation questions to ensure that students understand the educational material
- Determining the homework from the prescribed book.

The control group studied according to the usual method, which includes asking the question by the teacher, and answering it by the students. The achievement test was applied after the two groups were taught at Al-Bilad Secondary School for Boys, after the students (the research sample) were notified of the test date. Students' answers to the test were corrected according to the answer key. Calculating their scores, then applying the Lateral Thinking Test, and students' papers were corrected for the purpose of statistically processing, analyzing and interpreting the results in order to reach the research objective. The prepared statistical program for the social sciences, which is known as (SPSS -x) was used to treat the data statistically.

5 Presentation and interpretation of results

The first hypothesis: – the results of the achievement test were compared for the two groups (experimental and control), and it was clear from the Table 2 below that there was a statistically significant difference between the two groups and in favor of the experimental group.

Table 2. The results of the t-test for the two groups in the achievement test

Collection	Sample	Mean	Std. Dev.	Degree Freedom	T-Value		Sig.	Statistical Function
					Cal.	Tab.		
Exp.	**30**	22.13	2.569	57	6.255	2.002	0.000	Sig.
Con.	**29**	17.41	3.202					

In order to calculate the effect size, the researcher adopted the effect size equation, and Table 3 shows this.

Table 3. The value of (η^2) and (d) and the magnitude of the independent variable effect on the achievement variable

Independent Variable	The Follower Variable	T-Value	DF	Values η^2	Values D	The Amount of Impact Size
Instructional Design	achievement	6.255	57	0.407	1.657	Large

It appears from the above table that the effect of the independent variable educational design has reached (1.657) on achievement, which is a significant effect. As it is clear from Table 2 that the calculated t-value (6.255) is greater than the tabular t-value of (2) with a degree of freedom (57) and at a level of significance (0.05), and this indicates the existence of a statistically significant difference in favor of the students of the experimental group, group; thus rejected the null hypothesis The researcher attributes this difference to the fact that teaching according to the instructional design, according to the allusive learning model and during the presentation of the educational material and in a coherent manner in terms of merging knowledge with action, made the students enjoy in presenting ideas, creative solutions among themselves, which led to a focus on solving the problem and building a base Shared knowledge about the problem in the context of presenting allegorical learning for problem solving. Providing real situations for activities such as identifying the problem, formulating hypotheses, and proposing multiple creative solutions, motivating students and participating in group work in practicing real exercises, and this is consistent with the study of [40–47]

The second hypothesis: – t-test for two independent samples were used to find out the significance of the difference between the two averages, it was found that there is a statistically significant difference between the two groups and in favor of the experimental, note the Table 4.

Table 4. Value of the t-test for the two groups in the lateral thinking test

Collection	Sample	Mean Arithmetic	Std. Dev.	DF	T-Value		Sig.	Statistical Function
					Cal.	Tab.		
Exp.	30	18.87	1.889	57	5.517	2.002	0.000	Sig.
Con.	29	14.79	3.559					

Table 5. Value of (η^2) and (d) and the amount of the independent variable effect size in the lateral thinking test

The Independent Variable	Variable The Follower	T-Value	DF	Values η^2	Values D	The Amount of Impact Size
Instructional Design	achievement	5.517	57	0.348	1.461	Large

It appears from the Table 5 that the effect of the independent variable educational design has reached (1.461) in lateral thinking, which is a significant effect. It is also evident from Table 4 that the calculated t-value (5.517) is greater than the tabular t-value of (2), with a degree of freedom (57); at the level of significance (0.05), this indicates the existence of a statistically significant difference in favor of the students of the experimental group in the lateral thinking test. Thus rejected the null hypothesis and accepted the alternative hypothesis, and this difference can be attributed to the fact that the instructional design made the students practice lateral thinking and with different mental abilities among themselves, as they are more active and confident in their thinking when solve a problem that is not yet known. Lateral thinking can help in choosing the starting point and putting it together in a realistic, usable visualization that always produces a large number of ideas, to generate new concepts and perceptions applicable in daily life [48].

6 Conclusion

The superiority of the instructional design built according to the allusive learning model in achievement and lateral thinking and its preference over the traditional method of presenting the educational material in a sequential manner and interconnected with the students' learning style, which led to an increase in the learner's efficiency to learn. Learning according to the instructional design based on the allosteric learning model made the students more attracted to learning by actively participating in the lesson, and this in turn led to stimulating the mental abilities of the learner in searching for information and realizing the relationships between them and linking them to his needs and previous knowledge. The diversity of activities and exercises included in the instructional design helped improve students' learning, and this in turn affected their lateral thinking for the better.

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