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Research Article

Identification of instructional learning design by Alan Hoffer's model and its effect on students' creative thinking in mathematics

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Abstract

This study aimed to know the effect of using instructional learning designs by Alan Hoffer's model on students' creative thinking at the second stage of mathematic department in axiomatic system and engineering. The experimental design was created by a post-test divided into two groups in the academic year 2018-2019. The sample of experimental design was 86 male and female students divided into 43 students for the experimental group by the instructional learning design and 43 for the control group by traditional teaching methods. Two variables used in this study; an age, and the total average points of the experimental students of the previous stage (first stage). The researcher used 100 behavioral goals according to Bloom's classification in the field of knowledge of levels (knowledge, understanding, application, analysis, composition, evaluation), these behavioral goals based on the content of the scientific subject, and it has been presented it to a reviewer to determine the extent of their suitability in the preparation of study plans. A creative thinking test consisting of 21 items. The results of the study indicated that there wert significant differences between teaching methods and instructional learning designs based on Alan Hoffer's model on students' creative thinking tests. This study concluded to use Alan Hoffer's model by teachers lead to developing a student's creative thinking in mathematics and recommended for apply Allan Hoffer's model in teaching, especially in engineering subjects in order to increase student's creative thinking abilities, and provided the mathematic books of the students at schools with many activities in order to motivate students to complete learning and develop their mathematical thinking level.

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Introduction

The teaching and learning process are confused caused of science and information technology development. Basically, to overcome this important problem by changing the traditional teaching methods that are indoctrinated with activating methods and developing the learners' minds which can make them creative, imaginative, and able to infer new information. As a result, many researchers began to focus on conduct experiment studies on various instructional learning designs aimed at finding results and recommendations that support activating the learner's role thinking mind. Additionally, these studies are appropriate with the principles and standards issued by the National Council for Mathematics Teaching in the United States of America (NCTM, 1989, 1995, 2000), they discovered that there was no unified teaching plan managed by fixed rules can be fit in all circumstances. Teaching and learning preparation is a fundamental aspect of academic staff's position. The operations involved are not carried out in a vacuum, but rather in accordance with the institution's existence. Academic workers may fairly be required to understand the institution's community under which they operate: the organization's mission and vision; goals, ethos, and values. Inevitably the institution's history and values affect the program. Whether we conceptualize the curriculum and curriculum design is relevant due to the effect of these concepts on the way we think about teaching and learning. It in effect affects how we organize the learning opportunities we place at our students' fingertips (Stefani, 2008).

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The teacher has a role in building and designing learning instruction:

- Determine the behavioral objectives associate with general objectives.
- Determine pre-learning and the fundamental requirements of teaching behavioral objectives.
- Plan the learning experiences and activities associate with the objectives and levels of the learner thinking to reach the goals.
- Encourage learners and provide them with a good psychological environment.
- Assess the learning process and learners in order to achieve the goals.
- Adopt the system of reward and punishment (Merhi, 1983: 153)

Engineering is one criterion of important content. Additionally, it represents the big part of physical mathematics dissimilar other mathematic branches which are totally abstract. A large amount of engineering subjects is uncomplicated to express and learn if the teachers choose the right Strategies which simplify learning (Abu- Lum, 2007). In fact, for the students Engineering skills connect with Alan Hoffer's Model, where he determines it by five basic fields which are: Visual, Verbal, drawing skills, logical, and applied as below:

Visual Skills; the ability to distinguish the different geometric shapes without knowing their characteristics, observe the parts of a particular form, relationships between them and different shapes, classify shapes base on their characteristics, use the information of an engineering firm to conclude other, use mathematical systems to imagine geometric models by the given information.

Verbal or Descriptive Skills; name the geometric given shapes, characterize an engineering form, describe different relationships between them, distinguish the data and requirements of an engineering problem, identify the logic structure of engineering problem, and construct general abstract phrases.

Drawing Skills; change the oral information into an image, draw many forms during a given form, add practical supporting elements to a specific form, and deduce how to draw or construct particular form geometric models by using mathematical systems tools.

Logical Skills; distinguish geometric shapes by similarities and dissimilarities, categorize them in line with their characteristics, use the properties to determine whether one of the forms is its content in another category, use logic rules to develop proofs and infer logic phrases from given information toward the preference of engineering proofs, know the role and limits of the inference curricula and when axiomatizable system is absolute, stable and independent.

Applied Skills; distinguish geometric shapes in nature, construct models of physical forms, identify its properties during models, identify its benefits in situations, and develop mathematical models to describe Engineering forms. (Hoffer,1981)

Recently, mathematics teaching trends try to develop students' higher thinking skills as creative thinking to create new original ideas, link the causes to the consequences of the problems (Al-Aisra, 2011) .Creative thinking needs complex and sophisticated mental processes Such as attention, cognition, organization, remember the pre experiences and link the old with new, encoding the individual experience (Coding) and recording it in the brain. Comprehension it by adding personal character and put it into individual knowledge and repair when they face new experiences. It's good to find a background to be creative where the students create ideas and solve if they understand, then find relationships between them to link the causes (Abdul Aziz, 2009).

Creative Thinking; is a deferent form of thinking and everyone have it but in varying degrees, some of them are special in a specific field but not in another. Creative thinking cannot happen without a good climate, to get individuals creative energies and discover new ideas to solve problems that learners face.

Components of Creative Thinking; most psychologists like Gilford (1956) agree that there are three creative thinking components: fluency, flexibility, originality.

Fluency; is a mental skill uses to generate sequences of thoughts, the ability to create many ideas as possible. It is the ability to give a number of similar ideas (Padget, 2012). The components of fluency the learner as below:

Symbols or Vocabularies Fluency: produce words and synonyms base on specific criteria such as produce words start with a letter or end with definite word and there is fluency in numbers. *Meaning and Thou*ghts a specific *Fluency (Thinking Fluency):* Produce many ideas relate to a limited situation that the learner is able to understand. *Expressive Fluency:* thinking quickly to form coherent and cohesion speech and make unique language structure. *Association or Defending Fluency:* learners produce a number of words that have specific conditions of meaning. *Shapes Fluency:* draw a number of examples to answer an optical thriller, or produce examples, illustrations, and structures depend on given form or descriptive stimuli (Runco, 1986). *Flexibility:* change mind state with many situations. Flexibility measures by different categories of learner's responses where he takes one score for each idea. There two types of flexibility: *Automatic Flexibility:* the learners must transfer responses from one part to another *Adaptive Flexibility:* learner changes his previous interpretations into modern to use them (Harris, 2004). *Originality:* produce original responses not repetition in the statistical sense of the group that the learner belongs. Idea is authentic if it is less common (Rich & Weisberg, 2004).

The Importance of the Study

Discussing the five stages of Alan Hoffer's Model, which may simplify the Axiomatic system and engineering furthermore, develop students' creative thinking at the second stage in the mathematic department.

- Creative thinking is an important topic in global education which is not applied to develop the local education, especially in engineering (limit to researcher's knowledge).
- To help the mathematic curricula planners and developers to put many practical activities and exercises base on the principles of the Alan Hoffer's Model.
- The study makes attention to officials' programmers of preparing teachers to employ the Alan Hoffer's Model in their teaching performance to high learning levels of their students.
- The importance of engineering as a real link of theoretical mathematics with the life.
- Provide math teachers with an organizing guide of subjects to help them organize and teach engineering for many stages.

Conceptual Framework

Nasr (1998) conducted a study aimed to design a program to develop engineering thinking levels at secondary school in the light of Alan Hoffer's Model. The results showed there is a statistically significant difference between the experimental and the control groups in engineering thinking tests to the experimental group, and the proposed program is characterized by a good degree of efficiency. Al-Ali study deals with the variables of this study (Al-Ali, 2010) the effect of using Alan Hoffer's Model in teaching engineering at the higher basic stage in Jordan, where the results showed the experimental group is higher than the control group in academic achievement and engineering proof skills due to the advantages of the model in arranging content and activities that push learners to think and able of engineering styles proof. Alwan (2018) his study entitled the effect of Alan Hoffer's Model and in solving the engineering issue and its impact on mental motivation, the experimental group is higher than the control group because of the use of the student's senses in learning, which increases the achievement and motivation towards learning. While Al-Ghamdi (2018), identify the effectiveness of Alan Hoffer Model in developing Van Hiele levels of geometric thinking and reducing the anxiety of mathematics, the results show that the experimental group is better than the control group. Rossa (1996) examines the effects of three strategies for developing creative thinking skills, but the researcher uses three strategies: visualization, computer, and creative problem solving, to develop verbal, formal fluency, and flexibility. The study results show an 80 % increase in verbal skills, formal fluency, and originality which represent the effect of the program. Zayyadi et al. (2020) explained the content and pedagogical knowledge skills in learning mathematics from a cognitive perspective based on the teacher's view. The students do teaching and recording by video recordings. Teaching with video recordings is to find out educational abilities and content knowledge from the teacher's perspective. The numerical ability is one of the elements that must be mastered in mathematics; the Team Assisted Individualization (TAI) is a learning model that gives a good influence on students about numeracy skills (Haspani et al. 2020). Juniati & Budayasa (2020) investigate male and female undergraduate students of mathematics about working memory capacity and mathematic anxiety. The results showed that the working memory capacity of male students was greater than female students. The working memory capacity of first-year students was greater than the and the third-year students. While the working memory capacity of male students is greater than female students, while there is no difference in mathematical learning seen from the sex of the students and their level. The study of Abu Atra & Afana (2010) deals with the effect of (express-plans-people strategy) in teaching mathematics and developing creative thinking, whilst Abdul Azim (2011) studied the impact of a proposed program according to learning theory based on the brain in developing both achievement and creative thinking.

The Aim and Hypotheses

This study aims to determine the effect of instructional learning design based on Alan Hoffer's Model for second-level students of the mathematics departments who are studying creative thinking.

- There is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught with instructional learning design according to Alan Hoffer's Model, and the control group who are taught with the traditional method in creative thinking test H_°:μ_1≠μ_2 ، H_°:μ_1=μ_2
- There is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught with instructional learning design according to Alan Hoffer's Model, and the control group who are taught by the traditional method in fluency in creative thinking test H_°:μ_1≠μ_2 ،H_°:μ_1=μ_2
- There is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught with instructional learning design according to Alan Hoffer's Model, and the control group who are taught with the traditional method in flexibility in creative thinking test H_°:μ_1≠μ_2 H_°:μ_1=μ_2
- There is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught with instructional learning design according to Alan Hoffer's Model, and the control group who are taught with the traditional method in originality in creative thinking test H_°:μ_1≠μ_2 ، H_°:μ_1=μ_2
- There is no statistically significant effect at (0.05) for the program according to ETA equation in the variable studies.

Research Problem

For many years, the researcher observed that There is weaknesses in thinking of second-level students in the mathematics department in Axiomatic System and Engineering, they are not able to distinguish geometric shapes, identify similarities and differences between their characteristics, methods of engineering proof and others. In general, worthless students' performance in learning engineering is not due to their lack of knowledge, but to their inability to plan, organize, and control what they already know (Al-Kubisi, 2008).

In the national council of mathematic teachers in the United States of America (NCTM, 1989, 2000), ensure to develop many forms of thinking, such as creative thinking to introduce mathematically as a tool of thinking and connections to make students' intellectual not just recipients. In this regard, Rossman (1997) sees the importance of preparing mathematicians as a skill to train students' thinking and build their experiences. Therefore, students' experience cannot be achieved easily but they must have a lot of education, but by submitting learner to multiple education situations and activities aim to develop many thinking levels (Ylink, 1998).

The students must complete all opportunities to develop new forms of thinking and develop all tools both mathematical curriculum and the material following the teaching and evaluation method. From the explanation above, the research question is What is the effect of using instructional learning design according to Alan Hoffer's in Axiomatic System and Engineering towards students who learn to think creatively in Mathematic Department.

The main problem of low-level creative thinking for the second stage student in the Department of Mathematics, College of Education.

Sub-problem 1: Diminishing of personal creative thinking skill with the specific sample which affects engineering proof skills.

Sub-problem 2: Students' incompetence in thinking creatively in engineering proofs due to a lack of mastery of creative thinking skills in general.

Method

Research Model

This study is a quantitative research method with pre-test and post-test control-experimental group design. This research design is provided a very powerful test of existing theories by the process of analytical generalization and to test the theories. Below, the components of the research design are shown in Table 1.

Table 1.

Experimental Design of Study Sample

Group	Equivalence	Independent variable	Dependent Variable
Experimental	Age Total average	Alan Hoffer's Model	Creative Thinking Skills
Control	Age Total average	-----	Creative Thinking Skills

Participants

This data was obtained from all second stage students in the Department of Mathematics, College of Education, University of Misan.

Classes were chosen randomly as follows:

(A) Class is an experimental group which consists of 43 students taught with Alan Hoffer's Model.

(B) Class is the control group that consists of 43 students taught with the traditional method.

Equivalence of the Groups Process was done two variables; an age which was taken from the registration unit of the college and confirmed by the students, and the total average points of the experimental students of the previous stage (first stage).

The mean average and standard deviation of equivalence variables are calculated in two groups to show the significant differences between them, using T-test independent samples, as described in Table2.

Table 2.

The Mean, Standard Deviation, and T–Value for the Equivalence Variables

Variables	Group	No.	Mean	Std. deviation	Df	C. t-Value	T. t-Value	p
Age	Experimental	43	247.33	5.121	84	0.504	1.99	.299
	Control	43	247.79	3.226				
Total average	Experimental	43	75.77	10.454		1.232		
	Control	43	72.65	12.88				

Procedure

Behavioral objectives; The research used 100 behavioral goals based on the content of the knowledge material at the level of scientific material according to Bloom's taxonomy at the level of knowledge, understanding, application, analysis, synthesis, evaluation, that have been distributed to experts. To determine the validity of the study plan, some changes have been made which depends on suggestion and modification.

Lessons plans; the researcher prepared two kinds of lessons plans for the two groups, the first according to Alan Hoffer's Model for the experimental group, and the second type according to the traditional method of the control group, and these plans are distributed to experts to obtain their opinions, observation, and improvement of the formulation. Some changes are also made depending on suggestions and modifications.

Educational materials; prepared after reading a number of previous studies in this field, choosing (Al-Ali, 2010; Alwan, 2018) by the following steps:

- Select the "first, second, third and fourth" units, which prescribed to the students of the second stage/ mathematics department in the first semester because of the classrooms contain many concepts, geometric, and numerical matrixes for different Axiomatic systems and there is a difficult for students to understand the subject when the researcher uses the traditional method.
- Analyze the content of concept, generalization, and skill into an element of mathematic content.
- The teaching strategy adopted is based on Alan Hoffer's Model (5 stages); view stage: students learn the geometric forms and determine the relationships between them. Verbal formulation stage: it describes the geometric forms, formulates definition, and recognizes logical structures orally. Drawing stage: The ability to draw numerical shapes and rows according to the systems of axioms. Logical conclusions and proof stage: the ability to prove and use inference. Application and Problem Solving Stage; the ability to use engineering models to solve issues.
- Teaching materials
- Homework
- Working sheets of five stages of Alan Hoffer's Model
- Showing lessons samples after designing them

The operational stages of Alan Hoffer's Model in the lesson in Figure 1;

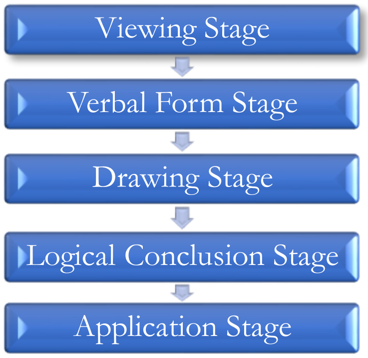

Figure 1.
Instructional Design of Alan Hoffer's Model

This model stages are viewing; the researcher presents different geometric shapes or parts of this problem or numerical organizing, and arranging rows relates to levels of Axiomatic systems to students in order to identify these shapes, determine the relationships between them while she listens for students' answers. Verbal form stage; after viewing the shapes and discussing their forms, students reach to form definition, concept, and mental rule that can be distinguished. Drawing stage; after form definition, students are able to draw shapes based on Axiomatic systems and determine its parts. Logical conclusion stage; the researcher exposes shapes and asks questions again to the students about them, where she reaches a rule and or relationship, then the researcher divides the students into groups, each group consists of (6-5) students, then asks them a question of what has been concluded in order to use cooperation learning to solve problems. Application stage; the researcher presents models of systems or examples of different engineering forms and asks students to solve them, this stage considered as evaluation.

Data Collection Tools

Behavioral goals: The researcher used 100 behavioral goals according to Bloom's classification in the field of knowledge of levels (knowledge, understanding, application, analysis, composition, evaluation), these behavioral goals based on the content of the scientific subject, and it has been presented it to a reviewer to determine the extent of their suitability in the preparation of study plans, and some proposed changes have been made to some goals, according to what the reviewer approved.

Lessons Plans: The researcher conducted the two type of teaching forms for the two research groups, first according to the "Allen Hoffer" for the experimental group, and the second according to the traditional method for the control group, and these plans forms were presented to a group of a reviewer to improve the forms of those plans, which makes them guarantee the success of the experiment, and some proposed changes have been made to some goals, according to what the reviewer approved.

Construct Creative Test: This test tends to measure the ability of creative thinking of second-level students in the mathematics department at the College of education in Axiomatic systems. Construct Test Items: the researcher construct (21) items distributed depend on Creative thinking skills that included: fluency; *fluency of forms*, f*luency of symbols*, *fluency of words*, *fluency of meanings*, *fluency of thoughts*, and *Brainstorming*, flexibility; consists automatic and adaptive, originality; unique in thought. Three Paragraphs for Each sub-skill is clear and suitable for students' level.

Test correction; the researcher follows procedures of Abu Jado and Muhammad (2007) to correct the creative test, after applying test she prepares models correction and scoring for objectivity, the final score has taken after collecting all marks of each skill. The degree of fluency was determined by the total number of the answer which belongs to the correct in the light of the specific requirements of each skill after the deletion of any answer that does not belong to the test, while the degree of flexibility is given according to the number of categories on which the answers were distributed for the question, by one score per idea not giving and the duplicate idea more than a degree. As for determining the degree of originality in each of test activities, it was done by omitting the students' answers on special models, extracting the percentage of students who had repeated answers, and the number of answers that were repeated was 5% or less originality and the degree was given full, and excluded answers that increased the percentage repeat it for 5% (Abu Jado, Muhammad, 2007).

Items Analysis; the researcher distributed the test which consists of (21) question items to a group of mathematicians and teaching methods to express their opinions on the extent to which items are suitable for the goal. After receiving an agreement (90%), and to confirm its statistical significance, the Chi-square formula (x2) was used, where the Computed greater than tabulated at (0.05) and the degree of freedom (1) i.e. it is a statistical, as shown in Table 3.

Table 3.
Specialists Agreements about Creative Test

Items	Agreements		Disagreements		Chi- square		p
	Frequency	Percentage	Frequency	Percentage	Computed	Tabulated	
1,6,5,4,3,2,1, 7,7,14,10,9,8,16	10	100%	_	0%	10	3.841	.011*
15,10,11,13,12,21, 20,19,18,17	9	90%	1	10%	6.400	3.841	

Applying the test to pilot sample: In order to ensure the clarity of the test items and the answer time as well as to conduct statistical analysis of the test, the researcher applied the test to a pilot sample of (100) students from the second stage section Mathematics in the Faculty of Education evening study, it was found that the test items are clear, and the time to answer is (60) minutes.

Data Analysis

The Data analysis of test items may not accurately reveal their validity or validity (Ebel & Frisbie 1972). Therefore, it is necessary to perform statistical analysis of its paragraphs and to know the psychometric properties of it, as specialists in measurement and evaluation indicate that These characteristics, such as validity and Reliability, are of great importance in determining the ability of the test to measure what was actually measured for it and does not measure anything else as a substitute or addition to it (Holden et al. 1985).

Validity Test; to be sure that the test has the face validity it was exposed to a jury of ten members who are asked to give their agreement, modification, or any additional realties to the test. It is valid because the items get 90% agreement.

Reliability Test; The equation (Alpha-Cronbach) is used to calculate the test reliability, that measured internal consistency i.e. homogeneity that contains objective items. Hence, the test applied only one time.

The results if showed that the value of the test reliability coefficient (0.82) is good reliability for educational and social sciences. For this statistical analysis that SPSS has been used in this study.

Results

The result of the first null hypothesis**:** there is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught by instructional learning design according to Alan Hoffer's Model, and the control group who are taught by the traditional method in creative thinking T-test. The T-test used can be seen in Table 4.

Table 4.
Means and Standard Deviations of the Two Groups in Creative Thinking Test

Group	No.	Mean	Std. deviation	Df	Computed t. Value	Tabulated t. Value	p
Experimental	43	70.67	4.56	84	21.031	1.99	.003*
Control	43	44.33	6.834				

There is a statistically significant difference between two groups therefore, an alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected. It means that "there is a significant effect of instructional learning design according to Alan Hoffer's Model on students' creative thinking.

The results of the second null hypothesis: there is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught by instructional learning design according to Alan Hoffer's Model, and the control group who are taught by the traditional method in fluency component. The T-test used can be seen in Table 5.

Table 5.
Means and Standard Deviations of the Two Groups in All Fluency Components

Components	Group	No	Mean	S.D.	Df	T- Value		p
						Computed t. Value	Tabulated t. Value	
Symbols	Experimental	43	10.86	1.302	84	12.082	1.99	.001*
	Control	43	6.07	2.251				
Meaning	Experimental	43	9.81	1.468	84	7.606	1.99	.001*
	Control	43	6.65	2.298				
Defending	Experimental	43	10.44	1.201	84	8.829	1.99	.000*
	Control	43	5.77	3.257				
Shapes	Experimental	43	16.21	3.516	84	7.678	1.99	.005*
	Control	43	11.23	2.389				
Total Fluency	Experimental	43	47.33	4.127	84	14.5	1.99	.002*
	Control	43	29.72	6.808				

There is a statistically significant difference between two groups therefore, an alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected. It means that "there is a significant effect of instructional learning design according to Alan Hoffer's Model on students' Fluency components.

The results of the third null hypothesis: there is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught by instructional learning design according to Alan Hoffer's Model, and the control group who are taught by the traditional method in flexibility components). T-test used can be seen in Table 6.

Table 6.
Means and Standard Deviations of the Two Groups in all Flexibility Components

Components	Group	No	Mean	Std. deviation	Df	t- Value		p
						Computed t. Value	Tabulated t. Value	
Automatic	Experimental	43	10.16	1.271	84	9.812	1.99	.007*
	Control	43	6.81	1.842				
Adaptive	Experimental	43	2.65	0.813		4.276		.874
	Control	43	1.88	0.851				
Total flexibility	Experimental	43	12.81	1.239		10.775		.000*
	Control	43	8.7	2.177				

There is a statistically significant difference between two groups therefore, an alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected. It means that "there is a significant effect of instructional learning design according to Alan Hoffer's Model on students' flexibility components.

The results of the fourth null hypothesis: there is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught by instructional learning design according to Alan Hoffer's Model, and the control group who are taught by the traditional method in originality component. T-test used can be seen in Table 7.

Table 7.
Means and Standard Deviations of the Two Groups in All Originality Component

Component	Group	No	Mean	Std. deviation	Df	T- Value		p
						Computed t. Value	Tabulated t. Value	
Originality	**Experimental**	43	10.53	1.202	84	14.256	1.99	.012*
	Control	43	5.91	1.757				

There is a statistically significant difference between the two groups: therefore, an alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected. It means that "there is a significant effect of instructional learning design according to Alan Hoffer's Model on students' originality component.

The results of the fifth null hypothesis: there is no statistically significant effect at (0.05) for the program according to the ETA equation in the study variable. The size of the effect of instructional learning design according to Alan Hoffer's Model on students' creative thinking after calculating the value (T-test) with calculating the ETA square:

$\eta^2 = (\frac{t^2}{t^{2}+df}) = \frac{(70.67)^2}{(70.67)^2+84} = 0.983$ Then change η^2 to d by relationship $d = \frac{\eta^2}{\sqrt{1-\eta^2}} = \frac{0.983}{\sqrt{1-(0.983)2}} =$ 5.429

Discussion and Conclusion

The result of the first null hypothesis, there is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught by instructional learning design according to Alan Hoffer's Model, and the control group who are taught by the traditional method in creative thinking test t-test is used. There is a statistically significant difference between the two groups: therefore, an alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected. It means that "there is a significant effect of instructional learning design according to Alan Hoffer's Model on students' creative thinking.

The results of the second null hypothesis, there is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught by instructional learning design according to Alan Hoffer's Model, and the control group who are taught by the traditional method in fluency component.

The results of the third null hypothesis, there is no statistically significant difference at (0.05) between the mean score of the experimental group who are taught by instructional learning design according to Alan Hoffer's Model, and the control group who are taught by the traditional method in flexibility components. There is a statistically significant difference between two groups therefore, an alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected. It means that "there is a significant effect of instructional learning design according to Alan Hoffer's Model on students' originality component.

The results of the fourth null hypothesis, there is a statistically significant difference at (0.05) between the mean score of the experimental group who are taught by instructional learning design according to Alan Hoffer's Model, and the control group who are taught by the traditional method in originality component Due to it depends on participating in discussion, activities, and worksheets that through a gradual transition from one stage to another which leads to an increase in mental focus that provides a level of creative thinking.

The results of the fifth null hypothesis, there is no statistically significant effect at (0.05) for the program according to the ETA equation in the study variable. The size of the effect of instructional learning design according to Alan Hoffer's Model on students' creative thinking after calculating the value (t-test) with calculating the ETA square. By using this design it was concluded that most of the students' creativity related items (visual, oral, movement, and thinking) have a positive impact on creative thinking. This positive effect was created after introducing education material. Additionally, educational material has an unexpected effect on students as making them more active in class and as a consequence increases their creative thinking. This in line with some studies that reported the increase of students' creative thinking in the classroom (Brookfield, 2020; Chen & Lo, 2019; González & Deal, 2019; Kristanti et al. 2018; Schoevers, Leseman, Slot, Bakker, Keijzer & Kroesbergen, 2019). Using this design will increase logic conclusions, which improve the higher thinking levels and make students more active in learning with having feedback (Deeley & Bovill, 2017; Dickson, Harvey, & Blackwood, 2019; Suryani et al., 2020; Tan, Whipp, Gagné & Van Quaquebeke, 2019; Van Popta, Kral, Camp, Martens, & Simons, 2017). Additionally, it helps them in understanding engineering subjects.

Activate students' sense to make mathematics and engineering meaningful in their life through (expressing, watching, drawing, concluding, and Appling) then improve their skills in creative thinking. Students' meaningful understanding can develop their thinking and reasoning (Cavallo, 1996; Clarke & Roche, 2018; Ellis, Özgür & Reiten, 2019; Rofiki et al. 2018). This design focuses on activating learners' role in the learning process individually or in a group. Showing the material in a sequence way helps all students from different learning levels develop themselves in creative thinking. This design makes students familiar with cooperative learning and takes them responsibilities. The positive effect of using Alan Hoffer's Model as a teaching method in increasing creative engineering thinking for students at the second stage at the college of Education in the mathematic department.

Using Alan Hoffer's Model encourages learners to interact with the teacher like asking freely and positively participating which can arouse their motivation for learning to think creatively. Teaching procedures in this model are modern in making learners basic in education process and experience (Choi-Koh, 2000; Erdogan, Akkaya & Celebi Akkaya, 2009; Whitman et al. 1997). Teaching by using Alan Hoffer's model provides a good education environment that encourages students to think, to improve their ability to understand engineering concepts, to evaluate information during learning, and to use it in many educational situations.

Recommendations

Teachers can use Alan Hoffer's model to develop a student's creative thinking in mathematics by providing examples of facts, concepts, and information. Mathematic teachers can also apply Allan Hoffer's model, especially in engineering subjects in order to increase student's creative thinking abilities.

The Central Curriculum Preparation Committee in Iraq must be provided the mathematic books of the students at schools with many activities in order to motivate students to complete learning and develop their mathematical thinking level.

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References

Abdul Azim, S. (2011). A Proposed Program in Mathematics Depends on Learning brain Theory to develop achievement and creative thinking for preparatory students. *Journal of Education Collage in Suez*, *1*(4), 12-55.

Abdul Aziz, S. (2009). *Teaching Thinking Skills*, (1st Ed), Dar Al- Thaqufa Publishing, Amman, Jordan.

Abu Atra & Ali. M. (2010). *The effect of the "express-plans-evaluate" strategy in teaching of mathematics on developing creative thinking among students in the seventh grade in Gaza*, M.A Thesis, College of Education, Islamic University of Gaza.

Abu Jado & Mohammed, S. (2007). Teaching theoretical thinking and practice, (1st Ed), Dar Almassira publishing, Amman, Jordan.

Abu Lum, K. (2007). *Methods and Strategies of Teaching Engineering* (2nd Ed). Dar Almassira publishing, Amman, Jordan.

A-l Ali, O. (2010). The *Effect of Teaching mathematics according to Alan Hoffer model in achievement and engineering proof skills on higher primary level in Jordan*. Published PhD Thesis, Arab University of Amman, https://search.mandumahm.com/Record/637087

Al-Ayasra, R. (2011). Probe and Creative Thinking. Dar Osama Publishing, Amman, Jordan.

Al-Ghamdi, M. (2018). The Effect of Alan Hoffer model in developing van Hel's levels of Engineering Thinking and Reducing the Anxiety of Mathematics among First-Grade Female Students in Riyadh. *Dirasat: Educational Sciences, 45*(2), 11-42.

Al-Kubaisi, W (2008). *Methods of Teaching Mathematics and Its Styles (Examples and Discussions)*, (1st Ed), Library of Arab Society, Amman.

Alwan, H. (2018). The Effect of Alan Hoffer model in Solving Engineering Issues of First Intermediate Female Students on Their motivation, Collage of Basic Education/Maysan University.

Brookfield, S. (2020). Teaching for critical thinking. In *Handbook of Research on Ethical Challenges in Higher Education Leadership and Administration* (pp. 229-245). IGI Global.

Cavallo, A.M. (1996). Meaningful learning, reasoning ability, and students' understanding and problem solving of topics in genetics. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *33*(6), 625-656.

Chen, C.W.J., & Lo, K.M.J. (2019). From Teacher-Designer to Student-Researcher: a Study of Attitude Change Regarding Creativity in STEAM Education by Using Makey Makey as a Platform for Human-Centred Design Instrument. *Journal for STEM Education Research*, *2*(1), 75-91.

Choi-Koh, S. S. (2000). The activities based on van Hiele model using computer as a tool. *Journal of the Korea Society of Mathematical Education Series D: Research in Mathematical Education*, *4*(2), 63-77.

Clarke, D., & Roche, A. (2018). Using contextualized tasks to engage students in meaningful and worthwhile mathematics learning. *The Journal of Mathematical Behavior*, *51*, 95-108.

Deeley, S.J., & Bovill, C. (2017). Staff student partnership in assessment: enhancing assessment literacy through democratic practices. *Assessment & Evaluation in Higher Education*, *42*(3), 463-477.

Dickson, H., Harvey, J., & Blackwood, N. (2019). Feedback, feedforward: evaluating the effectiveness of an oral peer review exercise amongst postgraduate students. *Assessment & Evaluation in Higher Education*, *44*(5), 692-704.

Ebel, R.L., & Frisbie, D.A. (1972). Essentials of educational measurement (pp. 492-494). Englewood Cliffs, NJ: Prentice-Hall.

Ellis, A., Özgür, Z., & Reiten, L. (2019). Teacher moves for supporting student reasoning. *Mathematics Education Research Journal*, *31*(2), 107-132.

Erdogan, T., Akkaya, R., & Celebi Akkaya, S. (2009). The Effect of the Van Hiele Model Based Instruction on the Creative Thinking Levels of 6th Grade Primary School Students. *Educational Sciences: Theory and Practice*, *9*(1), 181-194.

González, G., & Deal, J. T. (2019). Using a creativity framework to promote teacher learning in lesson study. *Thinking Skills and Creativity*, *32*, 114-128.

Guilford, J. P. (1956). The structure of intellect. *Psychological Bulletin, 53*(4), 267-293.

Harris, R. (2004). *Creative problem solving: Step by step approach*. Los Angeles: Pyrczak Publishing.

Hoffer, A. (1981). Geometry is more than proof. *Mathematics Teacher*, *74*(1), 11-18.

Holden, R.R., Fekken, G.C., & Jackson, D.N. (1985). Structured personality test item characteristics and validity. *Journal of Research in Personality, 19*(4), 386-394.

Kristanti, F., Ainy, C., Shoffa, S., Khabibah, S., & Amin, S. M. (2018). Developing creative-problem-solving-based student worksheets for transformation geometry course. *International Journal on Teaching and Learning Mathematics*, *1*(1), 13–23. https://doi.org/10.18860/ijtlm.v1i1.5581

Merhi, A. (1983). *Unique Education*. First edition, Dar al-Fikr, Amman.

Nasr, H. (1998). *A Proposed Program for Developing Engineering Thinking for Intermediate School in the light of the Alan Hoffer model.* Unpublished M.A Thesis, University of Assiut.

National Counil of Teachers of Mathematics (NCTM) (2000). Principles and standards for school mathematics Reston, Va. NCTM.

Odeh, S. (1999). Educational Assessment and Evaluation in Teaching Processes, Third edition, Dar Al- Amal Publishing, Amman.

Padget, S. (2012). Summer, creativity and critical thinking for teachers in training. (2nd ed) Routledge, 3, P61.

Rich, J. D., & Weisberg, R. W. (2004). Creating all in the family: A case study in creative thinking. *Creativity Research Journal*, *16*(2-3), 247-259.

Rofiki, I., Nusantara, T., Subanji, & Chandra, T. D. (2018). Exploring local plausible reasoning: The case of inequality tasks. *Journal of Physics: Conference Series*, *943*(1), 012002. https://doi.org/10.1088/1742-6596/943/1/012002

Runco, M.A. (1986). Flexibility and originality in children's divergent thinking. *The Journal of Psychology*, *120*(4), 345-352.

Rossa, P.I.E. (1996). Teaching Young children to think: The Effect of specific instructional program. Elsevier science ltd.

Schoevers, E. M., Leseman, P. P., Slot, E. M., Bakker, A., Keijzer, R., & Kroesbergen, E. H. (2019). Promoting pupils' creative thinking in primary school mathematics: A case study. *Thinking Skills and Creativity*, *31*, 323-334.

Stefani, L. (2008). Planning teaching and learning: Curriculum design and development. In A handbook for teaching and learning in higher education (pp. 58-75). Routledge.

Suryani, A. I., Anwar, Hajidin, & Rofiki, I. (2020). The practicality of mathematics learning module on triangles using GeoGebra. *Journal of Physics: Conference Series*, *1470*(1), 012079. https://doi.org/10.1088/1742-6596/1470/1/012079

Tan, F. D., Whipp, P. R., Gagné, M., & Van Quaquebeke, N. (2019). Students' perception of teachers' two-way feedback interactions that impact learning. *Social Psychology of Education*, *22*(1), 169-187.

Turner, J.C., Styers, K.R., & Daggs, D.G. (1997). Encouraging Mathematical Thinking. *Mathematics Teaching in the middle School*, *3*(1), 66-72.

Van Popta, E., Kral, M., Camp, G., Martens, R. L., & Simons, P.R.J. (2017). Exploring the value of peer feedback in online learning for the provider. *Educational Research Review*, *20*, 24-34.

Whitman, N. C., Nohda, N., Lai, M. K., Hashimoto, Y., Iijima, Y., Isoda, M., & Hoffer, A. (1997). Mathematics education: A cross-cultural study. *Peabody Journal of Education*, *72*(1), 215-232.

Ylink, M. (1998). Mathematical Thinking (In-A-T.I.) Translation by the Institute of Education. Amman. Department of Education, UNRWA/UNESCO.