Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 2, 1847 – 1863

# The Effect of a proposed IA-Based Educational Software on Teaching Algorithms and Programming and Measuring Its Efficacy on the Levels of Creative Thinking of 10th-Grade Students in Jordan

**Dr. Mamon Saleem Alzboun[1], Prof. Saleh S. Alshurfat[2]. Dr. Mohammad Faraj Al-Abdallat[3], Dr. Malik Saleem Alzboon[3]**

[1,2]*Al Albayt University*
[3,4]*University of Jordan*
*m.alzboon@yahoo.com*
*m.alzboon@aabu.edu.jo*

## Abstract

The study aims to explore the effect of proposed IA-based educational software on teaching algorithms and programming and measuring its efficacy on the levels of creative thinking of 10th grade students in Jordan. The study sample consists of (49) male and female students from the 10th-grade at the University of Jordan School of the Directorate of Special Education in the University District in the Capital Governorate of Amman in Jordan during the first semester of 2019/2020. Two sections were randomly selected and divided into two groups: an experimental group consisting of (24) male and female students taught using the IA-based educational software, and the other is a control consisting of (25) students taught in the traditional method. To achieve the aim of the study, the Creative Thinking Scale (CTS) of the Verbal Test (A) is used. The study shows that there are statistically significant differences between the arithmetic means of the 10th-grade students' scores in the pre and post-creative thinking test according to the teaching method variable and in favor of the experimental group. The study recommends including artificial intelligence because of its importance in developing thinking skills in general and creative thinking in particular.

**Keywords:** IA-based educational software, 10th-Grade Students, Creative Thinking.

## 1.Introduction

Of the most key challenges facing the educational process at present is the ability to explore effective methods of learning, and being able to design an interactive learning and teaching environment that meets the needs of learners, motivates them, and stimulates their interest to integrate into the learning process. With the availability of various modern technology means, relying on teaching in the traditional method is no longer viable and applicable, and technology must be activated and employed in the appropriate educational learning position to ensure the achievement of positive results. The aim is not to use technology only, but rather to plan to select the appropriate one, depending on the educational situation and the objective of the educational learning process.

Accordingly, the computer has become an effective element in the learning environment in various school subjects. It provides great capabilities for teaching and greatly contributes to developing the mental skills of the learner. At present, computer applications increase for educational purposes on a large scale, especially after the use of the Internet in the educational field of learning, where conferences and meetings are held and calls are made by sound and image to exchange experiences and develop them. (Hila, 2017).

Studies on the outputs of the Fourth Industrial Revolution indicate that artificial intelligence is one of the most prominent of these outputs, and the reason for this is because artificial intelligence is included in most areas of current life such as the medical, economic, industrial,

commercial, agricultural, military, and applied sciences, along with the field of education. There is no doubt that this development and acceleration in the use of artificial intelligence may allow changes like human life, and drive progress and growth in society, This may establish an integrated community of artificial intelligence in all its different fields, as aspirations indicate that this will happen shortly (Nordin & Norman, 2018).

The performance of each learner define the lessons required to enhance strengths and reduce weaknesses, especially concerning the curriculum, as the system also helps teachers to accurately identify students' capabilities and discover their needs in terms of knowledge and experience, which helps in raising student achievement, and this program can also help Teachers in taking tests, determining grades, correcting answers, and informing students of their performance in those tests, which helps them to develop their educational level (Saud, 2017). The role of artificial intelligence comes with its amazing capabilities, faster methods, more efficient and accurate capabilities, and the need to invest these capabilities and capabilities in the educational process to facilitate learners' learning and provide an educational environment in which teachers can teach more easily, develop education and adapt it according to the characteristics and capabilities of each learner, and provide technologies. And educational tools suitable for their needs (Farrani and Hajili, 2020).

## 2. Problem of the Study

The problem of the current study stems from the challenges facing the computer subject teacher in teaching the computer subject in various stages in general and the $10^{th}$-grade in particular. It has been observed for more than (10) years that there is a general weakness of students and a low level of achievement for students in algorithms and programmings, and this difficulty does not depend on students only, but teachers themselves feel the difficulties they will face when teaching algorithms and programming, such as selecting the best method to present the lesson, educational activities, and the proper educational method. Along with the difficulty of learning algorithms and programming, there are other problems such as the process of recognizing the understanding of computer terms and concepts, dealing with them in terms of previous experiences and knowledge that they possess, the ability of students themselves to understand and deal with computer terms and concepts, and the students' lack of experience in understanding and preparing algorithms and using programming languages.

On the other hand, studies indicate that traditional teaching methods are ineffective for teaching basic the $10^{th}$-grade students on programming and algorithms, as most of the traditional methods of teaching focus on presenting facts and concepts to learners and then conducting a question-based test to assess their ability to remember, and this method has proven its success in exposing people to large amounts of information and test their ability to remember. However, sometimes the knowledge and information that the learners want to remember are not well-established in the learner's mind, and the learner may not be able to apply this information properly and when needed, affecting academic achievement (Obeikan and Dahmashi, 2016; Dribi and Aqili, 2017). Against this, the problem of the study is to design proposed IA-based educational software on teaching algorithms and programming and measuring its efficacy on the levels of creative thinking of $10^{th}$-grade students in Jordan.

## 3. Questions of the Study

Due to the nature of the study, the following main and sub-questions are articulated.

1. Are there statistically significant differences at the level of significance ($\alpha = 0.05$) in creative thinking among the $10^{th}$-grade students in basic computer subjects due to the effect of the teaching method using IA-based educational software and the traditional method?

a. Are there statistically significant differences at the level of significance ($\alpha = 0.05$) in the skill of originality on the creative thinking scale of the $10^{th}$- grade students in basic computer subjects due to the effect of the teaching method using IA-based educational software and the traditional method?

b. Are there statistically significant differences at the level of significance ($\alpha = 0.05$) in the skill of fluency on the creative thinking scale of the 10th-grade students in basic computer subjects due to the effect of the teaching method using IA-based educational software and the traditional method?

c. Are there statistically significant differences at the level of significance ($\alpha = 0.05$) in the skill of flexibility on the creative thinking scale of the 10th-grade students in basic computer subjects due to the effect of the teaching method using IA-based educational software and the traditional method?

## 4. Objectives of the Study

The following objective is formulated to answer the question of the study.

- The study aims to explore the effect of proposed IA-based educational software on teaching algorithms and programming and measuring its efficacy on the levels of creative thinking of 10th-grade students in Jordan.

## 5. Significance of the Study

The significance of this theoretical study is highlighted by the importance of addressing IA-based educational software on teaching algorithms and programming and measuring its efficacy on the levels of creative thinking of 10th- grade students in Jordan. The significance of this study is also demonstrated through developing the understanding of algorithm and programming among the 10th-grade students with the computer subject in quick and easy ways compared to the traditional method and presenting the computer subject in a way that takes into account the individual differences between the10th-grade students. It is hoped that this study will be a reference for future studies.

The practical importance of the current study lies in its endeavor to attract the attention of those in charge of the educational process to the importance of paying attention to the effectiveness of designing IA-based educational software to teach algorithms and programming and measure its impact on creative thinking of students. Moreover, it helps those in charge of the educational process to identify some of the variables that affect the compatibility and academic performance of students and their implications in preparing computer-based educational programs to improve their performance.

## 6. Theoretical Framework and Previous Studies

### 6.1 IA-based Educational Software

The spread of the computer and its development has enabled those in charge of the educational process to include a set of data about the learner in the computer, which helps in carrying out the computer analysis of these data that leads to the creation of an evaluation process for the level of the learner on this data, assisting the teacher to correct the path and errors. It can be said that the most important thing provided to the learner is the educational software through which the response processes are controlled and the educational attitudes are corrected, which leads to the occurrence of the self-reliant learning process. In other words, the learner corrects himself until he reaches the required performance and proficiency, and the computer can test and confirm whether or not the learning has occurred (Sharman, 2019).

The vast computer capabilities such as its ability to perform mathematical and logical operations with great speed and high accuracy, save and retrieve information, dialogue and interact with students, and do a drawing, simulation, modeling; problem-solving and other thinking processes make the learner take advantage of these capabilities in education. There are many areas in which the computer is used in the educational process, as it can be used for an educational purpose or as an aid in the educational process or its management, and among the most prominent uses of the educational computer are Computer Assisted Instructions (CAI), Computer Managed Instructions (CMI), and Internet in Learning (Eyadat, 2014).

Many smart technologies based on artificial intelligence have appeared that exceeds the limit in the versatility of their production and the effectiveness of their use, and human minds still try to adapt them to serve the educational sector to advance and develop the educational process (Faris and Ismail, 2017). The use of artificial

intelligence methods in education has begun through using the Scholar program to teach the geography of South America and a geographical knowledge base that is not just pre-recorded texts, and among the new ideas in this program is that it is possible to take the initiative in the dialogue (Qutb, Abu Dina, and Amer, 2017).

The roots of private research in artificial intelligence go back to the forties of the last century with the spread of computer use. In the fifties, research on artificial intelligence has developed and became focused on neural networks. In the sixties, the term artificial intelligence has appeared for the first time during a computer conference held in the United States of America, where a group of researchers has presented a proposal for the first research project in artificial intelligence in the world. In the eighties, research has focused on the representation of knowledge and facts. At the beginning of the nineties, with the advent of the fifth generation computer revolution, there is a big boom in artificial intelligence research (Harbi, 2017).

Artificial intelligence relies on algorithms science to automate tasks by accessing relevant data, as the algorithms rely on neural networks designed by neurons in the brain so that they can learn just like humans and discover the world at the end by themselves. Algorithms can solve problems and perform various tasks, and this new form of intelligence differs from our style, as it perceives the world through its big data perspective (Sarayreh, 2019). Artificial intelligence is defined as a science and technology that combines many sciences such as computer science, languages, cognitive psychology, biology, mathematics, and engineering, and the use of that knowledge to achieve specific goals and tasks through flexible adaptation (Harbi, 2017).

### 6.2 Creative Thinking

The development of higher-order thinking skills in general and creative thinking skills, in particular, has become a basic goal that modern education seeks to achieve. Thus, it has become imperative for those in charge of the educational process to find modern and appropriate approaches to teaching students to help them to achieve their goal and develop students' awareness of concepts and processes so that they can solve problems and increase their ability to infer and communicate, create a learning environment that helps to develop students' athletic strength, prepare them for positive interaction with problems and spread the spirit of exploring ideas in different fields, and then strengthen and develop their athletic strength (Allam, 2019).

The interest in studying creative thinking methods among students is evident as an indicator of the ability to solve problems. Development of thinking and creative thinking skills is the main goal of educational programs in educational institutions and represents the most complex and advanced cognitive activities through the individual's use of higher mental processes when practicing tasks that require a creative solution. The individual works on processing symbols and concepts and using them in solving the problems they encounter in their daily life as the problem-solving style requires mental activity that is reflected in the creative thinking style (Sabra, 2019).

Guilford (1967) defines the creative thinking indicated in (Saadeh, 2015) as open-system thinking in which production is characterized by a unique feature represented in the diversity of the answers produced that are not determined by the information given. Creative thinking skills are measured by the total score obtained by the learner in his performance on the Arabic version of the Torrance Tests of Creative Thinking (TTCT) in the skills of fluency, flexibility, and originality, as indicated by Rida and Amiri (2013).

- Fluency: It refers to the ability to produce multiple ideas, or provide multiple solutions to problems, and unspecified questions, which include the quantitative aspect of creative thinking.
- Flexibility: It refers to the ability to produce various and unexpected ideas.
- Originality: it refers to break away from stereotypes and independence in thinking and uniqueness of ideas.

The importance of creative thinking for individuals is evidenced by the presentation of completely new and different perceptions, and these good perceptions are an effective service for society and solve complex problems in life.

Jarwan (2016) indicates that creative thinking has many important types as follows:

1. Expressive creativity: It refers to the development of ideas regardless of their quality, as is the case in spontaneous drawings in children.

2. Productive creativity: It refers to creativity in artistic and scientific products, as there are strong indications of the availability of some restrictions that control the free performance of individuals.

3. Innovative creativity: It refers to demonstrating proficiency in using materials to develop new uses for them, without having substantial contributions to present basic new ideas.

4. Renewing creativity: It refers to the ability to penetrate fixed intellectual principles, present new perspectives or ideas, as well as make substantial improvements through modifications included in conceptual skills.

5. Imaginary creativity: it refers to reach a theory, principles, and assumptions that can present new schools and research movements.

**6.3 Creative thinking from the viewpoint of behavioral theory**

The theorists of the behavioral theory believe that thinking is a learned behavior that is subject to the laws and principles of learning that govern any other behavior, and they believe that this behavior is supportive and is generalized to other situations based on the results obtained and the amount of reinforcement. The individual uses certain habits and patterns of behavior in a hierarchical form based on the strength of their connection to the situation according to the principle of attempt and error put by Thorndike. Thus, the individual begins using simple behavioral patterns and moves gradually to the most complex to find the most appropriate solution with the discovery of alternative solutions and new associations. It is also seen that there is an interaction between the two factors of genetics and the environment in the occurrence of creativity and believes that creative thinking is a pattern of thinking that receives positive reinforcement or reward, which leads to the possibility of its continuation. Among the pioneers of this theory is the American scientist Watson who believes that communication is made to the creative response by uttering words or expressing them until they reach a new pattern (Abu Jadu, Nofal, 2017).

The behavioral theory considers that creative thinking is associative thinking resulting from the relationship between the stimulus and the response, and the value of creative thinking is determined by the quality of the link between the stimulus and the response. Among the pioneers of this approach are Maltzman & Mednick, where they view creativity as a reorganization of the disintegrating or interconnected elements into new formations that achieve specific purposes. As for Mednick, he indicates that the greater the bonds the individual has of the basic elements, the greater his possibility of reaching a creative solution (Siam, 2013). Based on this, this study believes that creative thinking is a mental process in which unusual thinking takes place, whereby the integration of the individual occurs in solving a specific problem or situation from situations that fall within the training programs creatively. In the beginning, there are several learning attempts, in which the individual reaches the awareness of new formations and through them, the creative response is reached by uttering words and expressing them until they reach new patterns and creative elements as a result of continuous change.

**6.4 Previous Studies**

Several studies are done on the area of using computer-based educational programs on students' achievement. Raad and Fasih (2018) reveal the effect of implementing a computer-based educational program on students' achievement in the computer subject at the Department of Science, College of Basic Education. The study sample consists of (30) students from the College of Basic Education at the Department of Science during the academic year 2017/2018. The students were divided into two equal groups, where the experimental group is taught using computer-based instructional software, while the control group is taught the content traditionally. The results of the study show that there are statistically significant differences at the level of significance (0.01) in favor of the experimental group, which means that students benefit and increase their educational achievement using the modern

application using computers. Among the most prominent recommendations of the study is the necessity to use a computer with the available equipment.

Kaçan & Şahin (2018) investigate the impact of scientific creative thinking skills on practical skills. The study is conducted with (24) candidates for teachers in the control group and (24) candidates for teachers in the experimental group in the second grade of the Department of Science Teaching at a university in Istanbul Province in Turkey. In the experimental group of the above-mentioned study, the laboratory program is designed by researchers based on discussion and scientific research while in the control group; the designed laboratory program is normally applied for the semester. The study data is obtained through a scientific innovation test and is developed by researchers. Among the most prominent findings of the study is the presence of statistically significant differences in the application of the scientific creativity test in favor of the experimental group.

Juwaid and Obeikan (2018) aim to determine the training needs of computer subject teachers to use and teach computational thinking skills. Due to the nature of the study, the descriptive and analytical approach is used. The study population consists of all computer variables for the intermediate and secondary stages in Riyadh, and the random sample has represented 27.31% of the total study population. The study shows that computer subject teachers need to enhance their knowledge in the field of computer thinking according to the framework of knowledge of technological educational content, as the degree of their need for each of the three types of knowledge varies with no differences in their needs due to the two variables of the degree and the number of years of experience where they have a high need in the cognitive domain of computational thinking, while their need is moderate in the skill and teaching areas. The results also show that they are unable to teach new skills without attending training programs for them, and do not have high confidence in their ability to teach computational thinking skills. In light of the previous results, the research recommends establishing training courses for computer teachers that provide knowledge of computational thinking in its scientific names and present realistic examples of it, with a focus on tools and techniques for its application on the ground and preparing workshops to discuss and research the best findings of research in the field of teaching computational thinking, and training female teachers on best practices.

Ghamdi and Ali (2018) reveal the effect of using electronic educational games on achievement and development of creative thinking in the computer subject of intermediate school students. To achieve this goal, the experimental approach is used with a quasi-experimental design based on two groups (control and experimental), and the two study instruments are prepared, namely the achievement test and the creative thinking test. The study is applied to a purposeful sample of (50) middle school students in the Al-Baha region. The sample is equally divided into two groups by the random method, where the first group is the unit of recognizing a student's computer in the computer course using electronic educational games, while the control group is taught the same unit in the traditional method. The results show a statistically significant difference at the level of significance ($\alpha \leq 0.05$) between the mean scores of the students in the post-measurement test of creative thinking at all levels (fluency, flexibility, originality, details) between the experimental and control groups in favor of the experimental group. The study also shows the presence of a statistically significant difference at the level of significance ($\alpha \leq 0.05$) between the mean scores of the students in the post-measurement of the achievement test between the experimental and control groups in favor of the experimental group.

Having reviewed the previous studies and research, it is obvious that none of these studies directly addresses the topic that the study deals with, and to the extent of the researcher's knowledge, none of the studies and their strategies about the research topic has been found. In other words, most studies show the effect of using computer-based educational software and some other studies deal with academic achievement and measure its impact using computer-based educational software, such as (Raad and Fasih, 2018) and (Kaçan & Şahin, 2018). Importantly, what distinguishes the current study from previous studies is that it deals with designing educational software based on artificial intelligence to teach algorithms and programming and measures its impact on

computer subject acquisition, computational thinking, and creative thinking. As far as the researcher knows and is aware that it is the first study, the researcher has designed IA-Based Educational Software, taking into account that it deals with computational thinking and creative thinking.

## 7. Terms of the Study

The following are the terms and definitions of the study.

**Creative thinking:** It is "A complex and purposeful mental activity guided by a strong desire to search for solutions or come up with original products that are previously unknown. Creative thinking consists of a set of skills, namely: fluency, flexibility, and originality" (Jarwan, 2016: 170). Procedurally, it is defined as the ability of the 10th- grade students to find solutions to the problems they face in the computer subject in innovative ways, and it is measured by the total degree that the 10th-grade students obtain in their performance through the Torrance Tests of Creative Thinking (TTCT) of the Verbal Test (A).

**IA-Based Educational Software:** Artificial intelligence is "A term given to the science of computer sciences. This science belongs to the modern generation of computer generations and aims for the computer to simulate the intelligence processes that take place within the human mind so that the computer can solve problems and make decisions in a logical manner and in the same way as the human mind thinking" (Fiqi, 2012: 56). Procedurally, it is defined as software prepared by the researcher consisting of a set of commands and programming levels to understand the problems of the 10th-grade computer textbook and simulate the action of the 10th-grade students and the similar ability of their performance to help achieve the objectives of the educational learning process.

## 8. Limitations of the Study

This study is limited to the male and female students from the 10th grade at the University of the Jordan School of the Directorate of Special Education in the University District in the Capital Governorate of Amman in Jordan during the first semester of 2019/2020. The study is also limited to the Algorithms and Programming Unit in the Computer Textbook.

## 9. Methodology of the Study

To achieve the objectives of the study, the semi-experimental approach is adopted to conduct the study. The study sample consists of two sections of students of the 10th-grade at the grade at the University of Jordan School of the Directorate of Special Education in the University District in the Capital Governorate of Amman in Jordan selected purposely during the first semester of the academic year 2019/2020. The number of study members consists of (49) male and female students randomly divided into two groups, where the experimental group consists of (24) male and female students, and the control group consists of (25) male and female students. The school was purposely selected for several reasons such as the school administration's cooperation with the researcher, availability of the necessary capabilities and tools to implement the study in the school, and the presence of teachers with experience in teaching.

### Study Instrument

### Proposed IA-Based Educational Software to Teach Algorithms and Programming

After reviewing the theoretical literature on designing educational software according to the models, educational software based on the General Model for Education Design is designed, as (ADDIE) is most appropriate for this study. ADDIE is defined as a systematic approach to the education design process that provides the designer for training programs with a procedural framework that ensures that educational products are effective and efficient in achieving goals, which includes five stages: Analysis of the training needs, Design of the training program, Development of the program in detail, Implementation of the program for the target group, and finally the Evaluation phase (Qatami, 2014).

**Torrance Tests of Creative Thinking (TTCT) of the Verbal Test (A)**

To achieve the objective of the study related to measuring a proposed IA-Based Educational Software intelligence to teach algorithms and programming, and to measure its effectiveness in the achievement of computer subject, computational thinking, and creative thinking among the 10th-grade students in Jordan, the Torrance Tests of Creative Thinking (TTCT) of the Verbal Test (A) is used and creative thinking skills measured are also identified (Atoum, et al., 2019). These skills are as follows:

To achieve the goal of the study related to measuring a proposed educational program based on artificial intelligence to teach algorithms and programming, and to measure their effectiveness in the achievement of computer material and computational thinking and creative thinking among tenth-grade students in Jordan, the Torrance test for creative thinking was used Verbal picture (A), and thinking skills were identified Measured creativity (Atoum, et al., 2019):

- Verbal fluency: It refers to the learner's ability to create the largest number of words, expressions, or meanings according to specific determinants.
- Flexibility: It refers to the ability to create various and unexpected ideas, and the change from one type of thought to another when responding to a specific situation, meaning it is the ability to change the state of mind by changing the situation, i.e. it is the opposite of mental stagnation and represents the qualitative aspect of creativity.
- Originality: It refers to the ability to express and produce new ideas more than common and clear ideas. The test includes six questions, which are (asking questions, guessing the reasons, predicting the results, improving production, and making uncommon uses, and assuming that).

**Validity of the Torrance Tests of Creative Thinking (TTCT) of the Verbal Test (A)**

The global standard for creative thinking in verbal test (A) the Arabized form is used as many researchers have applied it to the Jordanian environment, such as (Dolt Cree, 2017) and (Ajlouni and Hamran, 2009).

**Reliability of the Torrance Tests of Creative Thinking (TTCT) of the Verbal Test (A)**

Shanti (1983) indicates that the reliability coefficients for the Torrance Test for Creative Thinking have ranged between (0.71 - 0.93) using the Test-Retest method on a sample of 118 students from fourth, fifth, and sixth grades. Abu Jadu (2003) has pointed out the availability of the reliability coefficient for the Torrance test for creative thinking, where the reliability coefficient for the dimension of fluency is (0.62) for the dimension of fluency, (0.58) for the dimension of flexibility, and (0.70) for the dimension of originality. However, the reliability coefficient for the total degree is (0.67), and these coefficients are statistically significant at the level of significance (a> = 0.01).

To ensure the reliability of the test, it is verified by the Test-Retest method and re-applied after two weeks to a group from outside the study sample consisting of (25) students from the 10$^{th}$-grade students at Al-Balqa Islamic School, and then the Pearson correlation coefficient is calculated between the two applications. The test reliability coefficient values are as shown in Table (1).

Table 1

*Reliability Coefficients for the Creative Thinking Test*

| Creative Thinking and its Dimensions | No. of Students | Reliability Coefficient |
|---|---|---|
| Originality | 25 | 0.65 |

| | | |
|---|---|---|
| Fluency | 25 | 0.68 |
| Flexibility | 25 | 0.62 |
| The test as a whole | 25 | 0.79 |

**** Statistical significance at the level of significance (a = 0.01).**

Based on the results of validity and reliability calculated, it is considered suitable for application in this study.

**Correction of the Creative Thinking Test Verbal Test (A)**

One degree of fluency and one degree of flexibility are estimated for each correct response, while originality is determined based on the degree of frequency and compared according to its estimates in the table of standards for correction of originality as follows:

Table 2

*Originality Correction Criterion*

| Percentage of frequency of correct response | Degree of its Originality |
|---|---|
| Less than 20% | 4 |
| 21% to 40% | 3 |
| 41% to 60% | 2 |
| 61% to 80% | 1 |
| More than 81% | 0 |

**Statistical Processing**

To answer the study questions, descriptive statistics represented by the arithmetic means and standard deviations are used to describe the performance of the members of the experimental and control groups. The analysis of covariance (ANCOVA) is also used to examine the presence of statistically significant differences between the averages of the two experimental and control groups in the creative thinking skills scale as a whole. Multivariate analysis of covariance (MANCOVA) is also to examine the presence of statistically significant differences between the averages of the experimental and control groups in the dimensions of the creative thinking skills scale.

## 10. Results

This section presents the results related to the main question of the study "Are there statistically significant differences at the level of significance ($\alpha = 0.05$) in creative thinking among the 10th-grade students in basic computer subject due to the effect of the teaching method using IA-based educational software and the traditional method?"

The following hypothesis has emerged from this question:

"There are no statistically significant differences at the level of significance ($\alpha = 0.05$) between the mean scores of the $10^{th}$-grade students in the experimental and control groups in the creative thinking post-test among the $10^{th}$-grade students in basic computer subject".

To answer this question and the hypothesis stemming from it, the arithmetic means and standard deviations of the scores of the two study groups are calculated in the pre and post-creative thinking tests.

Table 3

*The Arithmetic Means and Standard Deviations of the Scores of the Two Study Groups in the Pre and Post Creative Thinking Test*

| Test | Group | Number | Pre-Test | | Post-Test | |
|---|---|---|---|---|---|---|
| | | | AM | SD | AM | SD |
| Creative Thinking Test | Experimental | 24 | 29.04 | 4.24 | 41.96 | |
| | Control | 25 | 24.96 | 2.37 | 28.56 | |
| | Total | 49 | 26.96 | 3.96 | 35.12 | |

Table (3) shows the presence of apparent differences between the arithmetic means in the grades of the 10th-grade students in the pre and post creative thinking test according to the variable of the group method, as the experimental group using the IA-based Educational Software has attained arithmetic mean of (29.04), which is higher than the arithmetic mean of the control group using the traditional method which is (24.96). However, to determine whether the differences between the means are statistically significant at the level (a= 0.05), the analysis of variance (ANCOVA) is applied, and the results of the analysis of variance are as shown in Table 4.

Table 4

*Analysis of Variance (ANCOVA) to Find the Significance of the Differences in the Grades of the 10th-Grade Students in the Pre and Post Creative Thinking Test*

| **Source** | **Sum of squares** | **Degrees of freedom** | **Average of squares** | **Value of F** | **Statistical significance** | **(η2) ETA Square** |
|---|---|---|---|---|---|---|
| Creative thinking test | 78.659 | 1 | 78.659 | 8.252 | .006 | .152 |
| Teaching method | 1253.345 | 1 | 1253.345 | 131.492 | .000 | .741 |
| The error | 438.460 | 46 | 9.532 | | | |
| Adjusted total | 2715.265 | 48 | | | | |

**** Statistical significance at the level of significance (a = 0.05).**

Table (4) shows the presence of statistically significant differences at the level of (0.05 =a) in the grades of the 10th-grade students in the creative thinking test according to the variable of the teaching method for the experimental and control groups, where the value of (FP) has reached (131.492) with a level of significance of (0.000). Thus, the null hypothesis is rejected and the alternative hypothesis is accepted, that is, there are statistically significant differences at

the significance level (α = 0.05) between the mean scores of the 10th-grade students in the experimental and control groups in the post creative thinking test. To identify the size of the effect, the ETA square is calculated where it has reached (.741), and this explains (74.1%) of the variance in the grades of the 10th-grade students in the creative thinking test due to the variable of the teaching method for the experimental and control groups, while the remaining is due to other uncontrolled factors. To find out the difference in favor of which of the groups, the adjusted arithmetic means for the scores of the two study groups are calculated in the post creative thinking test as shown in Table (5).

Table 5

*The Post Adjusted Arithmetic Means and Standard Errors of the Tenth Grade Students' Scores in the Creative Thinking Test*

| Test | Group | The Post Adjusted Arithmetic Means | Standard Errors |
|---|---|---|---|
| Creative Thinking Test | Experimental | 41.17 | 0.69 |
| | Control | 29.32 | 0.67 |

Table (5) shows that the adjusted arithmetic means for the grades of the 10th-grade students in the creative thinking test have reached (41.17), which is higher than the creative thinking's adjusted means of the control group, which have reached (29.32). This means that the difference in the students' performance is in favor of the experimental group. To identify the effectiveness of the educational program on the post creative thinking test, the arithmetic means and standard deviations of the scores of the two study groups are calculated in the pre and post creative thinking skills.

Table 5

*The Arithmetic Means and Standard Deviations of the Scores of the Two Study Groups in the Pre and Post Creative Thinking Skills Test*

| Skill | Method | Pre-Test | | Post-Test | |
|---|---|---|---|---|---|
| | | AM | SD | AM | SD |
| Fluency Skill | Experimental | 9.54 | 3.80 | 14.08 | 3.11 |
| | Control | 8.72 | 1.14 | 9.12 | 1.05 |
| | Total | 9.12 | 2.78 | 11.55 | 3.39 |
| Flexibility Skill | Experimental | 9.83 | 1.09 | 12.79 | 2.80 |
| | Control | 8.12 | 1.24 | 9.68 | 1.03 |
| | Total | 8.96 | 1.44 | 11.20 | 2.60 |
| Originality Skill | Experimental | 9.67 | 1.37 | 15.08 | 2.70 |
| | Control | 8.12 | 1.54 | 9.76 | 1.42 |
| | Total | 8.88 | 1.64 | 12.37 | 3.43 |

Table (5) shows the presence of apparent differences between the arithmetic means in the grades of the 10th-grade students in the pre and post-creative thinking skills, depending on the variable of the group method. To determine whether the differences between the means are statistically significant at the level of (= 0.05), the multivariate analysis of covariance (MANCOVA) is applied. The results of the analysis of variance are as shown in Table (6).

Table 6

*Multivariate Analysis of Covariance (MANCOVA) to Find the Significance of the Differences in the Grades of the 10th-Grade Students in the Pre and Post Creative Thinking Skills Test*

** Statistical significance at the level of significance (a = 0.05).

Table (6) indicate the presence of statistically significant differences at the level of significance (0.05 = a) for the performance of the 10th-grade basic students of the post creative thinking skills according to the variable of the teaching method, where the value of Hotelling's Test is (30,500) and with the level of significance of (0.000). However, the value of F calculated in the fluency skill is (18.268) and with the level of significance of (0.001), and the ETA square is (.293), meaning that (29.3%) of the variance in the performance of the 10th-grade students in the basic skill of fluency is due to the teaching method. Also, the value of F calculated in the flexibility skill is (14.182) and with the level of significance (0.000), and the ETA square is (.244), meaning that (24.4%) of the variance in the performance of the 10th-grade students in the basic skill of flexibility is due to the teaching method. Besides, the value of F calculated in the skill of originality is (35,539) and with the level of the significance of (0.000), and the ETA square is (.447), meaning that (44.7%) of the variation in the performance of the 10th-grade students in the skill of originality is due to the teaching method, while the remaining is due to other uncontrolled factors. To find out which groups have attained the difference, the adjusted arithmetic means for the scores of the two study groups are calculated in the post creative thinking test as shown in Table (6).

Table 6

The Post Adjusted Arithmetic Means and Standard Errors of the Tenth Grade Students' Scores in the Creative Thinking Skills Test

Table 6

*The Post Adjusted Arithmetic Means and Standard Errors of the Tenth Grade Students' Scores in the Creative Thinking Skills Test*

| Test | Group | The Post Adjusted Arithmetic Means | Standard Errors |
|---|---|---|---|
| Fluency Skill | Experimental | 13.35 | 0.52 |
| | Control | 9.82 | 0.51 |
| Flexibility Skill | Experimental | 12.78 | 0.52 |
| | Control | 9.70 | 0.50 |
| Originality Skill | Experimental | 14.88 | 0.52 |
| | Control | 9.96 | 0.51 |

Table (6) shows that the adjusted arithmetic means for the scores of the 10th-grade students in the fluency skill of the experimental group has reached (13.35), which is higher than the arithmetic means of the control group, which has reached (9.82). Concerning the flexibility skill, the arithmetic mean of the experimental group is (12.78), which is higher than the arithmetic mean of the control group, which has reached (9.70). Also, in originality skill, the arithmetic mean of the experimental group has reached (14.88), which is higher than the arithmetic mean of the control group, which has reached (9.96), and this means that the difference in the performance of the 10th-grade students in all creative thinking skills is in favor of the experimental group. Table (6) shows that the adjusted arithmetic means for the scores of the 10th-grade students in the fluency skill of the experimental group has reached (13.35), which is higher than the arithmetic means of the control group, which has reached (9.82). Concerning the flexibility skill, the arithmetic mean of the experimental group is (12.78), which is higher than the arithmetic mean of the control group, which has reached (9.70). Also, in originality skill, the arithmetic mean of the experimental group has reached (14.88), which is higher than the arithmetic mean of the control group, which has reached (9.96), and this means that the difference in the performance of the 10th-grade students in all creative thinking skills is in favor of the experimental group.

| **Source** | **Dimensions** | **Sum of squares** | **Degrees of freedom** | **Average of squares** | **Value of F** | **Statistical significance** | **(η2) ETA Square** |
|---|---|---|---|---|---|---|---|
| Pre Fluency | Post fluency | 14.545 | 1 | 14.545 | 3.082 | .086 | .065 |
| Pre Flexibility | Post Flexibility | .383 | 1 | .383 | .083 | .775 | .002 |
| Pre Originality | Post Originality | 2.119 | 1 | 2.119 | .448 | .507 | .010 |
| Group | Fluency skill | 86.225 | 1 | 86.225 | 18.268 | .000* | .293 |
| | Flexibility skill | 65.627 | 1 | 65.627 | 14.182 | .000* | .244 |
| | Originality skill | 168.046 | 1 | 168.046 | 35.539 | .000* | .447 |
| The Error | Fluency skill | 207.674 | 44 | 4.720 | | | |
| | Flexibility skill | 203.614 | 44 | 4.628 | | | |
| | Originality skill | 208.055 | 44 | 4.729 | | | |
| The Total Adjusted Mean | Fluency skill | 550.122 | 48 | | | | |
| | Flexibility skill | 323.959 | 48 | | | | |
| | Originality skill | 563.388 | 48 | | | | |

## 11. Discussion

This section provides the required discussion related to results emerging from the main question of the study "Are there statistically significant differences at the level of significance ($\alpha = 0.05$) in creative thinking among the 10th-grade students in basic computer subject due to the effect of the teaching method using IA-based educational software and the traditional method?"

To answer this question and the hypothesis stemming from it, the arithmetic means and standard deviations of the scores of the two groups of the study are calculated in the pre and post-creative thinking test. It is evident that there are apparent differences between the arithmetic means in the scores of the 10th-grade students in the pre and post-creative thinking test according to the group method variable, as the experimental group using the IA-based educational software has obtained arithmetic mean higher than the arithmetic mean of the control group using traditionally. This indicates that teaching by adopting the IA-based educational software is effective and has a noticeable effect in improving the ability of the experimental sample's members to develop creative thinking skills.

This may be due to the nature of the teaching method used in the current study, which is based on IA-based educational software, as it helps in teaching students to change the traditional thinking patterns, and make their perceptions wider and more comprehensive of the variables and concepts in the computer subject. These results show the development of creative thinking can be done through traditional teaching and evaluation programs and strategies, as the IA-based educational software used on the experimental group gives students a more effective role in the educational learning process because the creative thinking skills in this software have been planned in an orderly way to achieve it. The student's involvement in research and exploration activities and formulating questions have deeply contributed to the understanding of those activities, linking variables to each other, and being familiar with the subject to be studied in the computer subject through collecting data and information related to it and being accurate in presenting and logically analyzing them and evaluating them objectively, as all of this constitutes a fundamental axis for the development of creative thinking skills. In return, the traditional method of teaching is concerned with getting the information and ideas contained in the textbook and directly teaching students without much interest in discussions and activities that could contribute to improving their thinking style.

The study also attributes these positive results to the students of the experimental group regarding high creative thinking to the fact that the IA-based educational software applied to them develops their creative thinking skills, as the teaching methods used in the IA-based educational software develop their different thinking skills, especially the creative thinking. Also, the creative thinking skills are concerned with teaching students to use the maximum of their mental energies and make them more positive and interactive, participate in the learning process, enhance students' ability to touch solutions to problems and make appropriate decisions about them, increase their confidence in themselves, raise the level of their self-esteem, and allow them to develop and innovate. Therefore, this applied IA-based educational software may help in developing the creative thinking skills of students to enhance their skills, raise their intellectual level and their academic achievement in the computer subject. This result is consistent with the results of Ghamdi and Ali (2018), whose results show a statistically significant difference between the mean scores of the students in the post-measurement of creative thinking test at all levels (fluency, flexibility, and originality) between the experimental and control groups in favor of the experimental group.

To determine whether the differences between the means are statistically significant at the level of (= 0.05), the analysis of variance (ANCOVA) is applied. The results of the analysis of variance show the presence of statistically significant differences at the level of (0.05 =) in the scores of the basic 10th-grade students in the creative thinking test according to the variable of the teaching method (experimental and traditional) and with the level of significance (0.000). Thus, the null hypothesis is rejected and the alternative hypothesis is accepted, meaning that there are statistically significant differences at the level of

significance (α = 0.05) between the mean scores of the 10th-grade students in the experimental and control groups in the post-measurement of the creative thinking test. To find out the size of the effect, the ETA square is calculated, as it has reached (74.1%) of the variance in the grades of the 10th-grade students in the creative thinking test due to the variable of the teaching method (experimental, and traditional), while the remaining is due to other uncontrolled factors. To find out which groups have attained the difference, the adjusted arithmetic means for the scores of the two study groups are calculated in the post creative thinking test, and it is found that the adjusted arithmetic means for the scores of the basic 10th-grade students in the creative thinking test are higher than the arithmetic mean of the control group, and that the difference in the students 'performance is in favor of the experimental group.

Importantly, to find out the effectiveness of the educational software on the dimensions of the creative thinking test, the arithmetic means and standard deviations of the scores of the two study groups are calculated in the pre and post-creative thinking skills. The results show apparent differences between the arithmetic means in the scores of the basic 10th-grade students in the skills of pre and post-creative thinking according to the group method variable. The results of the analysis also show statistically significant differences at the level of significance (0.05 =) for the performance of the 10th-grade basic students in the post-creative thinking skills according to the variable of the teaching method, and with the level of significance (0.000). Precisely, "fluency skill" is ranked first with a significance level of (0.001), that is, (29.3%) of the variance in the performance of the 10th-grade students in the basic skill of fluency is due to the teaching method, and the "flexibility skill" is ranked second with a level of significance (0.000), meaning that (44.7%) of the variance in the performance of the 10th-grade students in the basic "skill of originality" is because of the teaching method while the remaining is due to other uncontrolled factors.

More importantly, the results show that the adjusted arithmetic means of the 10th-grade students' scores in the" fluency skill "of the experimental group are higher than the arithmetic means of the control group. In the flexibility skill, the arithmetic mean of the experimental group is higher than the arithmetic mean of the control group, while in the skill of originality, the arithmetic means of the experimental group is higher than the arithmetic means of the control group, and this means that the difference in the performance of the basic 10th-grade students in all creative thinking skills is in favor of the experimental group. This result is consistent with the results of (Kaçan & Şahin, 2018), indicating statistically significant differences in the application of the scientific creativity test and favor of the experimental group in the skill of fluency and the skill of originality.

## 12. Recommendations

In light of the study's results and discussion, several recommendations and suggestions are presented such as activating teaching using IA-based educational software and employing it in the rest of the other educational courses and all grades, investigating the obstacles that limit the possibility of using IA-based educational software, providing training courses for teachers to develop their performance in using IA-based educational software, working to develop and provide the requirements for teaching using IA-based educational software, including artificial intelligence because of its importance in developing thinking skills in general and creative thinking in particular, and studying the relationship between artificial intelligence, creative thinking, and academic achievement in the computer subject.

### References

[1] Abu Jadu, Salih. (2003). The effect of a training program based on the theory of creative problem solving on the development of creative thinking among a sample of tenth-grade students.[Unpublished Ph.D. Thesis]. Amman Arab University for Graduate Studies, Amman, Jordan.

[2] Abu Jadu, Salih. (2017). Educational psychology. Amman: Dar Al-Masirah for Publishing, Distribution, and Printing.

[3] Abu Jadu, Salih, and Nofal, Muhammad. (2017). Teaching theoretical and practical thinking. Amman: House of the March for Publishing and Distribution.

[4] Ajlouni, Khaled and Hamran, Muhammad. (2009). The effect of information and communication technology on the development of creative thinking among students of exploration schools. Journal of Educational and Psychological Sciences, 10(1), 40- 74.

[5] Allam, Salah. (2019). Educational measurement and evaluation in the teaching process. Amman: House of the March for Publishing and Distribution.

[6] Atoum, Adnan, Jarrah, Abdel Nasser, and Beshara, Muwaffaq. (2019). Development of thinking skills, theoretical models, and practical applications. Amman: Dar Al-Masirah for Publishing and Distribution.

[7] Dolt Cree, King. (2017). The effect of using electronic stories on academic achievement in the Arabic language subject and the development of creative thinking skills among eighth-grade basic students in public schools in Jordan. [Unpublished Master Thesis]. The University of Jordan, Jordan.

[8] Dribi, Ohoud and Aqili, Abdulaziz. (2017). Designing a computer-based educational program in the science course for sixth-grade students and measuring its impact on achievement. Specialized Educational Journal, 6(1) 17-28.

[9] Eyadat, Yusef. (2014). Educational computer and its educational applications. Amman: Dar Al-Masirah.

[10] Faris, Naglaa and Ismail, Abdel Raouf. (2017). The use of smart learning systems based on self-organized learning and its impact on the development of computerized thinking skills and computerized self-efficacy of students in educational technology. Educational Journal, 49 (1) 42-68.

[11] Farrani, Lina and Hajili, Samar. (2020). An educational scenario for the use of artificial intelligence in the detection of multiple intelligences in learners. The Arab Foundation for Literature and Human Studies, 11 (1), 73-91.

[12] Fiqi, Abdullah. (2012). Artificial intelligence and expert systems. Amman: Dar Al-Thaqafa for Publishing and Distribution.

[13] Ghamdi, Rehab and Ali, Ahmed. (2018). The effect of electronic educational games in improving creative thinking and achievement in computer subjects among middle school students. Arab Foundation for Scientific Research and Human Development. 3(1),103-165.

[14] Harbi, Fawaz. (2017). The degree of artificial intelligence and its relationship to isolation and curiosity among talented students in the Kingdom of Saudi Arabia. [Unpublished MA Thesis]. Al-Balqa Applied University, Jordan.

[15] Hila, Muhammad. (2017). Design and production of teaching and learning aids. Amman: Dar Al-Masirah for Publishing and Distribution.

[16] Jarwan, Fathy. (2016). Teaching thinking concepts and applications. Amman: Dar Al-Fikr for Publishing and Distribution.

[17] Jarwan, Fathy and Abadi, Zain. (2014). The effect of an educational program based on the strategy of creative problem-solving in developing creative thinking skills for gifted students with learning difficulties. Damascus University Journal, 12(1), 11-43.

[18] Juwaid, Mashael and Obeikan, Reem. (2018). Training needs for computer teachers to use and teach computational thinking skills. International Journal of Educational Research, 42 (3), 35-60.

[19] Kaçan, D. and Şahin, F. (2018).The impact of scientific creative thinking skills on scientific process skills. SHS Web of Conferences. 48(2) 2-9.

[20] Murphy, R. (2019). Artificial intelligence applications to support k–12 teachers and teaching. Report of RAND Corporation perspectives.

[21] Nordin, N. and Norman, H. (2018). Mapping the fourth industrial revolution global transformations on 21st-century education in the context of sustainable development. Journal of Sustainable Development Education and Research (JSDER), 2 (1), 1-7

[22] Obeikan, Reem and Waldhamshi, Noura. (2016). Obstacles to teaching the unit technology and programming of smart devices at the secondary stage in the Kingdom of Saudi Arabia. Journal of Education, 2 (171), 453-478.

[23] Qatami, Yusef and Adas, Abdul-Rahman. (2017). General Psychology. Amman: Dar Al-Fikr for Publishing and Distribution.

[24] Qutb, Maysoon, Abu Dunia, Samar, and Amer, Wissam. (2017). Virtual simulation as an interactive environment and its role in

developing a student's creative thinking. Journal of Architecture, Arts and Humanities, 8 (1) 671-688.

[25] Raad, Shajan and Fasih, Enas. (2018). The effect of implementing computerized educational software on students' achievement in computer science at the Department of Science at the College of Basic Education. The Arab Foundation for Education, Science, and Literature, (1)6.109-118.

[26] Rida, Kazem and Amiri, Maher. (2013). Thinking: An explanatory psychological study. Amman: Sunrise House for Publishing and Distribution.

[27] Saadeh, Jawdat. (2015). Teaching thinking skills with hundreds of applied examples. Amman: Dar Al-Shorouk for Publishing and Distribution.

[28] Saud, Sarah. (2017). Educational Applications of Artificial Intelligence in Social Studies. Suluk Journal, 1(2)133-163.

[29] Shanti, Rashid. (1983). Implications of validity and stability of the Torrance test for creative thinking: A modified image of the Jordanian environment of the verbal test A and the formal test A. [Unpublished MA Thesis]. University of Jordan, Amman, Jordan

[30] Sharman, Atef. (2019). Education design for digital content. Amman: Dar Al-Masirah for Publishing and Distribution.

[31] Sarayreh, Sumaih. (2019). Building a biomechanical model for free throw performance in basketball using some artificial intelligence algorithms for basketball youth in Jordan. [Unpublished MA Thesis]. University of Jordan, Jordan.

[32] Siam, Muhannad. (2013). the effectiveness of a proposed program in light of the principles of TRIZ theory to develop creative thinking in technology subjects for seventh-grade students. Master Thesis, Islamic University, Gaza.