The Impact of Teaching Artificial Intelligence Concepts and Tools in Improving Creative Thinking Skills Among Talented Students

Mohammed F. Abu Owda, Assma H. Abu Mousa, Mahmoud D. Shakfa, and Dawood A. Al-Hidabi

1 Introduction

The world today is moving toward preparing students with twenty-first-century skills that revolve around four important skills: creative, critical thinking skills, cooperation, and communication (4C skills). These skills are the concentration of keeping pace with the technical acceleration and the explosion of knowledge. Creative thinking comes among these four main skills and receives wide attention by educators. According to Crumpler (2021), creative thinking involves some actions like transforming a concept into fresh information to discover novel and improved items. The International Encyclopedia of the Social and Behavioral Sciences (2015) states that creative thinking is more likely when there is the right quantity of information available – more knowledge isn't necessarily better – and when the person is aware of how to use the information. It is also defined as the collection of abilities that allow a person to generate original ideas and evaluate them in a distinctive way. These abilities need continual practice to stay sharp and focused, as well as the use of different thinking strategies to improve the mentality necessary for the generation of novel and creative ideas (Tabieh et al., 2021).

Addressing the problem is the first step in the scientific activities that make up the creative thinking process, followed by gathering information about it. Then, the next steps are identifying different alternatives to the solution, testing alternatives to produce new knowledge by combining concepts and finally evaluating ideas and making decisions.

M. F. Abu Owda (✉) · A. H. Abu Mousa
Islamic University of Gaza, Gaza, Palestine
e-mail: modaa@iugaza.edu.ps

M. D. Shakfa · D. A. Al-Hidabi
International Islamic University Malaysia, Kuala Lumpur, Malaysia

M. Al Mubarak, A. Hamdan (eds.), *Technological Sustainability and Business Competitive Advantage*, Internet of Things,
https://doi.org/10.1007/978-3-031-35525-7_16

One of the most important components and indicators of creative thinking is a person's skills of fluency, flexibility and originality. In light of this, creative thinking can be defined as a complex cognitive process aimed to improving ideas or producing new ideas. This study defines creative thinking as the ability to produce new solutions to problems, namely, how to think about the issue from different angles, using the right tools to evaluate them and make decisions, measured by the creative thinking skills test.

Since creative thinking has been considered the driving force behind all human progress (Saggar et al., 2017), the relationship between creativity and innovation is important. This means that curriculum developers must work to develop creativity by promoting curricula with fourth industrial revolution innovations such as the big data and artificial intelligence. This study focused on artificial intelligence, concepts and tools, to examine the impact of its teaching on the development of creative thinking skills, especially fluency, flexibility and originality.

John McCarthy coined the phrase "artificial intelligence" in 1956, and since then many theoretical concepts of artificial intelligence have emerged. Baker and Smith (2019) defined artificial intelligence as follows: Cognitive computing refers to machines that do tasks that are typically associated with human minds but that do not notably learn or solve problems. In order to emulate human intelligence, AI research and development have initially concentrated on the concepts of encoding human thought, and subsequently on "expert systems," which simulate expert procedural decision-making based on specific knowledge rules (Williamson & Eynon, 2020).

After 2010, artificial intelligence gradually returned to a new model that emerged, not as human intelligence, simulation software or expert systems, but as data processing systems that could learn and predict a particular classification. In addition, they can link huge amounts of big data and calculations including data analytics, machine learning, neural networks, and deep learning, and enhanced learning focuses not on creating (super-intelligence) but on developing machines that can learn from their own experience, adapting to improve its performance and creating a new decision-making algorithm (Williamson & Eynon, 2020).

According to this study, artificial intelligence (AI) refers to computerized systems that are capable of thinking like humans do, including learning, adapting, classifying, self-correcting, and using data for complex processing tasks that typically call for human intelligence, like visual perception. Zawacki-Richter et al. (2019) suggests that some important foundations have been laid to classify the field of artificial intelligence into three key types: basic artificial intelligence, with the aim of exploring computational techniques to simulate intelligent behavior, and applied artificial intelligence. This is interested in using current AI techniques to build products for use in the real world, and cognitive science, focusing on studying human or animal intelligence through different means.

The importance of the study lies in the fact that it provides a general framework for teaching basic artificial intelligence its concepts and tools at the core stage, which may benefit technology teachers, curriculum designers and developers.

The study links creative thinking skills to artificial intelligence in the fourth era of industry and education, fostering talented and programmatically superior programs.

2 Literature Review

2.1 Artificial Intelligence

The concept of artificial intelligence can be customized to systems that automatically perform tasks that are pre-trained and originally programmed to accomplish them. Also, these systems implement different algorithms in achieving their goals. We can define artificial intelligence (AI) as computing systems capable of engaging in human-like processes such as learning, adaptation, synthesis, self-correction and data use for complex processing tasks (Popenici & Kerr, 2017). Machine learning and deep learning have made it possible for artificial intelligence to learn on its own from large data sets (Aggarwal, 2018). Algorithms, machine learning and artificial neural networks are thus the three most crucial terms in artificial intelligence. The idea of algorithms initially came to an end in 1996, while the Google founders were still Stanford University students (Holmes et al., 2019). Recently, several trends have emerged in the search for artificial intelligence technologies and their applications on the one hand and AI concepts and related concepts on the other, such as studying the impact of artificial intelligence AI on teaching and learning. It is worth mentioning that higher education reveals the progress of AI capabilities to replace teachers with machines (Chassignol et al., 2018).

A study by Panigrahi and Joshi (2020) aimed to understand the extent to which AI is used in education and its expected benefits. He also provided examples of the use of artificial intelligence in education. This explores India as one of the developing countries, where education for all is seen as one of the sustainable development goals. Qian and Feng (2020) study stated that the great development of deep learning makes machine performance brain-like. The integration of artificial intelligence and education has become an inevitable trend for development. Hence the idea of the current study to study the impact of teaching AI concepts and tools in developing skills creative thinking for ninth graders as the first daughter in integrating AI into education. Seren and Ozcan (2021) aim to uncover methods that can contribute to increasing the efficiency of distance education and whether human education can be left to machines. Several studies discussed the type of attitudes that would be faced if such a system was used, and the results indicated that the use of AI-based education must be thoroughly considered by all parties involved and must be done so for the benefit of people.

Additionally, Bonami et al. (2020) aimed to provide definitions and discussions on artificial intelligence, big data from an academic point of view, or through what international organizations have published. The examination of education through

the development of twenty-first-century skills and the influence of AI in the platform age is proposed in this study, subject to three systematic considerations: research, application, and assessment. As the same point, Popenici and Kerr (2017) explore the use of artificial intelligence in teaching and learning in higher education and also examine the educational implications of new technologies on the way students learn. In addition, we investigate how institutions teach and develop in their employment and how modern technological developments are explored. Apparently, the growing rate at which new technologies are incorporated into higher education in order to forecast how higher education would develop in a setting where artificial intelligence is ingrained in universities. The study identified some of the challenges facing higher education institutions and educated students in adopting these techniques to teach, learn, and support students and management.

In the same regard, Azid and Md-Ali (2020) conducted an experimental investigation utilizing mixed analysis to investigate the efficacy of the successful AI unit (SIIM) that employs thinking abilities. Additionally, University Utara Malaysia students' analytical, practical, and creative thinking skills were to be improved through the development of this interactive unit. The qualitative research methodology was utilized to attain this aim by posing an open question to a sample of professors in order to discuss the prospective effects of AI on higher education at Prince Sattam Bin Abdul Aziz University (Aldosari, 2020). The findings indicated a decline in knowledge of the methods used to use AI and the need to further spread knowledge about the potential applications of AI in education in Saudi Arabia.

In light of the results of previous studies, the current study relies on a training program designed by the researchers that aimed at spreading the culture of AI and integrating it into education. The program provides training in AI concepts such as machine learning, deep learning, features, patterns, data sets, and decision-making and on tools to apply these concepts: machine learning for kids, coinmates, and Google's teachable machine.

2.2 Creative Thinking Skills

With global variables, the world is moving toward preparing twenty-first-century students with the necessary knowledge and skills. Creative thinking and criticism are the most important features of a student's personality for the twenty-first century. These lead us as teachers to think about how to enhance teaching practices with thinking skills. In addition, when we understand that young learners are already active in the learning process before entering school, the use of creative and critical thinking skills as part of learning instructions becomes necessary (Netto-Shek, 2017). These thinking skills are at the heart of the education field, with many studies on how to develop these skills and how to improve students' attitude according to thinking skills. In the same regard, Wijayati et al. (2019) aim to improve the ability to think creatively, make thermodynamics devices, and make fuel oil from

plastic waste. This study is a hands-on, classroom study that was carried out in three cycles, each of which had four stages: observation, process, re-observation, and reflection. Moreover, Netto-Shek (2017) argued for teaching thinking to young learners, especially in English lessons, to be educated in the twenty-first century. This paper explained how thinking skills should be contextual in authentic children's literature as a means of modeling thinking frameworks and good thinking. Furthermore, Putri et al. (2019) aimed to study improving the creative thinking skills of elementary school students in science through project-based learning (PBL). Use this quasi-experimental research with the design of an unequal control group. The study included (45) fifth graders at a public elementary school in Karawang, West Java.

In the light of these studies, this study seeks to combine the novelty of the field of artificial intelligence in its teaching among students of general education schools with the authenticity of thinking skills in terms of refinement and development. It aims to examine the impact of teaching the program on the concepts and tools of artificial intelligence on the development of creative thinking skills in line with studies that have studied several programs and strategies to develop these skills.

3 Study Objectives

- Detecting the impact of teaching artificial intelligence concepts and tools on creative thinking skills among talented students
- Identifying the significant differences between the talented students in the test of creative thinking skills

4 Study Importance

- It offers a broad framework for instruction. Artificial intelligence concepts and tools at the basic stage that benefit technology teachers, curriculum designers, and developers.
- The study presents a test to measure creative thinking skills that benefits interested and researchers in graduate studies.

5 Study Limitations

The research was carried out during the academic year (2020–2021), on a group of (25) ninth-grade talented students from three education directorates: West Gaza, East Gaza, and East Khan Younis.

6 Study Terms

- *Artificial intelligence concepts*: AI is related to concepts of intelligence agents, machine learning, deep learning, machine training, information, decision-making, and programming principles, which used to design the unit.
- *Creative thinking skills*: In this study, fluency, flexibility, and originality skills are intended for the student to be able to produce the largest number of ideas, adapting them to reality and the uniqueness of these ideas measured by creative thinking skills test.

7 Research Methodology

7.1 Research Aim

With the requirements of the twenty-first-century students with critical and creative thinking skills, it becomes a challenge in the field of education to prepare students with the knowledge and skills necessary to actively engage in their communities to keep pace with the new development in the fourth technical revolution and develop its concepts and tools in the hands of students to enable them to employ them effectively in solving their problems and those of their communities; in this context comes to link creative thinking skills as the most prominent skills of the twenty-first century with the most important innovations of the fourth technical revolution, namely, artificial intelligence. By examining the impact of teaching AI concepts and tools on the development of creative thinking skills among talented students, the problem was presented in the following major question:

What is the impact of teaching artificial intelligence concepts and tools on improving creative thinking skills among talented students?

It has the following sub-questions:

- Are there statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean score of the creative thinking skills of the experimental group students in the pre- and post-applications of the creative thinking test?
- Are there statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the creative thinking skills of the male and female students in the post-applications of the creative thinking test?

7.2 Study Hypotheses

- There were no statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the scientific of the experimental group students in the pre- and post-applications of the creative thinking test.

- There were no statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the creative thinking of the male and female students in applications of the creative thinking test.

7.3 Study Design

The research employed a descriptive and quasi-experimental methodology (the design of one group pre-post). The study's training program for teaching artificial intelligence concepts and tools was built using a descriptive approach, while the research experiment was designed according to the quasi-experimental approach for one experimental group of 25 ninth-grade talented students distributed among three education areas (West Gaza, East Gaza, and East Khan Younis). Students were selected intentionally based on their GPA and programming skills examined by the Programming Skills Test.

7.4 Data Collection

Reviewing literature and studies to assess creative thinking skills. The tested skills were determined by fluency, flexibility, and originality, the test was made of seven questions, and after the test was processed in its final form, it was adjusted and applied to the experimental group before the application of the program designed according to task-based learning (TBL) and applied remotely via Zoom and Google classroom and after the implementation of the program. The results were compared (pretest with post-test) to determine the impact of teaching the AI concepts and tools program on the development of creative thinking skills among students of the experimental group.

7.5 Validity and Reliability

To verify the validity of the test, the test was presented to a group of curriculum professors and methods of teaching science and technology to adjust the test and make the necessary adjustments. To confirm the internal consistency of the test, the researchers calculated the correlation factor between the paragraph grades and the overall degree of the test, and the results came as follows (0.851, 0.741, 601, 0.700, 0.829, 0.770, 0.455); all correlation transactions were statistically significant at the semantic levels (0.01, 0.05) and to verify reliability, the researchers calculated Cronbach's alpha coefficient, which was worth (0.786) as a result of the researchers' finding that the test was valid and reliable.

7.6 Analysis of Data

The data collected through the study tools was analyzed using the SPSS Statistical Package for the Social Sciences Version (23):

- The Kolmogorov-Smirnov test was examined to verify the natural distribution of the data, and the test showed that the population sampled was usually distributed.
- To evaluate whether the difference between the pre- and post-test was significant, a paired sample *t*-test was performed, and the value of η^2 was computed to determine the effect volume of teaching artificial intelligence concepts and tools. The independent sample *t*-test was conducted to determine if the difference between the female students' results and male students' results was significant.

8 Results and Discussion

8.1 Results

8.1.1 Results of Question 1

Are there statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the creative thinking skills of the experimental group students in the pre- and post-application of the creative thinking test? The hypothesis is as follows: There were no statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the scientific of the experimental group students in the pre- and post-applications of the creative thinking test.

In the creative thinking skills test, students pre- and post-test results varied significantly at level ($\alpha = 0.01$) as shown in Table 1. Pre experiment, the average student score was (30.04) after teaching the artificial intelligence unit using the (TBL) technique, average students score it increased to (57.40), to determine the effect size the value of η^2 was computed as shown in Table 2. The values of η^2 for all the

Table 1 Paired sample *t*-test between the pre- and post-test results

Scientific practices	d*f*	Test	Means	S. D	*t*-test	sig
Fluency	24	Pre	14.04	4.523	12.001	0.001
		Post	27.92	4.636		
Flexibility	24	Pre	9.76	2.204	10.067	0.001
		Post	16.52	2.874		
Authenticity	24	Pre	6.24	2.666	11.440	0.001
		Post	12.96	1.904		
Total degree	24	Pre	30.04	8.956	12.144	0.001
		Post	57.40	8.958		

Table 2 Effect size η^2 of teaching AI concepts and tools in improving creative thinking skills

Scientific practices	*t*-test value	t^2	d*f*	η^2
Fluency	12.001	144.024	24	0.85716
Flexibility	10.067	101.3445	24	0.80852
Authenticity	11.440	130.8736	24	0.84503
Total degree	12.144	147.4767	24	0.86003

Table 3 Independent sample t-test between males' and females' pretest results

Scientific practices	d*f*	Test	Means	SD	*t*-test	sig
Fluency	14	M	13.07	2.702	-1.220	0.235
	10	F	15.27	6.051		
Flexibility	14	M	9.57	1.604	-0.475	0.639
	10	F	10.00	2.864		
Authenticity	14	M	5.36	1.985	-1.978	0.060
	10	F	7.36	3.075		
Total degree	14	M	28.00	5.588	-1.303	0.205
	10	F	32.64	11.775		

creative thinking skills measured were all more than (0.14) with total effect size (0.85). This implies that teaching artificial intelligence concepts and tools has a significant impact among talented ninth-grade students' ability to think creatively.

8.1.2 Results of Question 2

Are there statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the creative thinking of the male and female students in the post-applications of the creative thinking test? The hypothesis is as follows: There were no statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the creative thinking of the male and female students in the post-applications of the creative thinking test.

To examine this hypothesis, the experimental group is divided into males and females, and the pretest results were compared. This is to verify the equality of the two groups, as indicated in Table 3. There were no significant variations between the average scores of the male and female students in the pre-application of the creative thinking test. Also, there were no significant variations in the average scores of each skill between male and female students, to examine the impact of the program interaction with gender. The results of post-test were compared, as shown in Table 4 that there were no significant variations between the average grades of the two groups, which means that the program has an effective impact in improving creative thinking skills among male and female students with the same effect.

Table 4 Independent sample t-test between males' and females' post-test results

Scientific Practices	*df*	Test	Means	S. D	*t*-test	sig
Fluency	14	M	27.64	5.372	−0.331	0.744
	10	F	28.27	3.717		
Flexibility	14	M	16.21	3.191	−0.592	0.560
	10	F	16.91	2.508		
Authenticity	14	M	12.71	2.431	−0.721	0.478
	10	F	13.27	0.905		
Total degree	14	M	56.57	10.545	−0.514	0.612
	10	F	58.45	6.773		

8.2 Discussion

This study discussed the impacts of educating artificial intelligence concepts and tools among talented ninth graders' ability to think creatively. The study findings indicated that teaching an artificial intelligence concepts and tools unit has a favorable effect on boosting the average score of gifted students' capacity for creative thought. The findings of the study that creative thinking abilities can be enhanced are consistent with research. Wijayati et al. (2019) demonstrated that students' typical modes of thought are increasing significantly in terms of both fluency and elaboration, and Putri et al. (2019) study findings that demonstrated that students in the experimental group had better creative thinking abilities than those in the control group. It may be concluded that project-based learning (PBL) can successfully boost creative thinking skill of primary school pupils in science class. The Connecting, Organizing, Reflecting and Extending (CORE) learning paradigm is helpful in fostering students' capacity for creative thought. In addition to Saregar et al. (2021) study which showed that the (Connecting, Organizing, Reflecting, and Extending) CORE learning model, is effective in enhancing students' creative thinking skills with Effect Size (0.48), which is in the medium category. Meanwhile, a study by Aytaç and Kula (2020) found that (SCA) is a significant variable that has a good impact on pupils' capacity for creative thought (CTS). The project brief has a positive impact on creative thinking abilities, according to Habibi et al.'s (2020) study. When compared to the lecture strategy, the fluency indicator has the largest average effect, which is (15.7), as well as the average of (9.89) and the lowest on the originality indicator. According to Tabieh et al. (2021), the experimental group students' learning of fluency, one of the three creative thinking skills was impacted by the narrative technique. While the research of Rumahlatu et al. (2021) demonstrated that the resource-based learning design thinking (RBLDT) learning model has an impact on creative thinking abilities, idea acquiring, and digital literacy of students in the class (XI) senior high school on the topic of animal tissue ($p < 0.05$). The (RBLDT) learning model syntax can enhance students' conceptual learning, critical thinking, and digital literacy more effectively than RBL or DT used alone.

According to this study, the improvement of creative thinking skills may be attributed to the nature of content in the first place, which is considered attractive

content belonging to the world of digital students and falls within the areas of their curiosity and interest. Additionally, the design of instruction with learning based on tasks puts students in a constant state of thought and frees up space for them to express and share their ideas with their peers. Researchers found no significant differences in students' learning abilities or curiosity towards acquiring and employing new knowledge in the digital world. While their abilities vary in technology, the passion for artificial intelligence in both teams is in similar proportions.

9 Conclusion

Artificial intelligence is one of the most important sciences that resulted from the Fourth Industrial Revolution. This study aimed to verify the impacts of teaching artificial intelligence its concepts and tools on their thinking skills and creativity in particular. Results showed the positive impact of teaching artificial intelligence concepts and tools on the creative thinking skills of the targeted students. Study tool's pre- and post-applications favor post-applications. Results also showed that there are no gender-based disparities in how the program affects pupils' ability to think creatively. Considering the findings, the study is considered an important study in introducing the concepts of artificial intelligence and its tools among students and examining their impact in improving some variables due to the novelty of artificial intelligence on the one hand and the specificity of the target group on the other hand.

10 Recommendations

1. Integration of artificial intelligence concepts and tools in school curricula for all stages
2. Training teachers on teaching artificial intelligence concepts and tools
3. Designing content with spiral width for the concepts of artificial intelligence and teaching it using active methods

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