The Implementation of Artificial Intelligence in STEM-Based Creative Learning in the Society 5.0 Era

Junia Melya Sari*, Edi Purwanta

Department of Guidance and Counseling, Universitas Negeri Yogyakarta, Indonesia

Abstract: This research aimed at utilizing artificial intelligence in STEM-based creative learning in the society 5.0 era. The researchers investigated how an educator can utilize artificial intelligence and optimize it into a STEM-based learning process. STEM stands for Science, Technology, Engineering, and Math. The United States initiated it to combine the four disciplines integrated into a problem-based learning method and everyday contextual events. Artificial intelligence is an intelligence added to a system managed in a scientific context. Artificial intelligence is created and put into a machine (computer) to do work like humans. Several fields that use artificial intelligence include expert systems, computer games (games), fuzzy logic, artificial neural networks, and robotics. The researchers employed the literature review or library research by reviewing the results of various studies and collecting data from assorted references and sources. In conclusion, implementing artificial intelligence in STEM-based creative learning can be an alternative for an educator in the learning process. Artificial intelligence (AI) is expected to help educators in the creative learning process by implementing long-life education and showing behavioral changes in a better direction cognitively, affectively, and psychometrically, especially in the era of society 5.0.

INTRODUCTION

The COVID-19 pandemic certainly causes various rapid changes. Integrating technology into the educational process is the most important learning policy, especially distance learning during the pandemic (Akhvlediani et al., 2020; Arifa, 2020; Kemdikbud, 2020). The dynamics and changes of 21st-century educational direction are one of the focuses of national policy-making, apart from the 4th Sustainable Development Goals in 2025.

The future education roadmap will make the hybrid learning model (a mixture of face-to-face and virtual classes) the best choice. It is believed to optimize higher-order thinking skills and make students the center of learning activities (Aristika et al., 2021). The workforce's minimum ability orientation within five years will experience many shifts due to technological disruption, such as the use of artificial intelligence (artificial intelligence integrated into computer systems) in the education process. Therefore, STEM-based creative learning in the era of society 5.0 is very necessary (Sirajudin et al., 2021).

Digital creative learning is an alternative to classroom learning, especially artificial intelligence, in the learning process (Chouyluan, et al., 2021). Therefore, STEM-based creative learning is an alternative for teachers to

implement the classroom learning process (Suherman et al., 2021). STEM is a modern approach that has an impact on the learning process (Jawad et al., 2021)

Therefore, the researchers tried to explain the implementation of STEM-based creative learning, especially in society 5.0. It is an era characterized by a shift in patterns and systems of people's lives that try to solve and answer various complex social problems through the use of various innovations that emerged in the industrial revolution 4.0 era, such as the Internet of Things (IoT), Artificial Intelligence (AI), Big Data, and Robots. The objectives are to improve the individual quality of life (Nugraha & Aminur Rahman, 2021).

Educator basic data or Dapodik Kemdikbud in April 2020 stated that more than 68 million students from 543,630 educational units (from early childhood education to higher education, including those studying in courses/training/ and community education) had implemented distance learning using digital platforms. Furthermore, more than 4 million teachers in Indonesia instantly change.

New teaching strategies may not have been done before (Dapodik, 2018). Based on the PISA evaluation in 2018, students who utilize ICT in learning have higher achievements than those who do not (OECD, 2018). Therefore, school teachers should start making ICT and AI important parts of the learning processes.

The Ministry of Education and Culture designs several changes that can improve the quality of achievements, namely using Information and Communication Technology (ICT) tools, involving students in reading, improving reading aloud strategies, summarizing instead of copying, enriching the reading types, and cultivating reading habit (Rezania et al., 2016). Artificial intelligence is included in the digitization process. AI is a valuable tool, especially in helping and managing an effective educational process so that AI will be optimal in the education process and learning strategies based on student's abilities and needs (Dilmurod & Fazliddin, 2021).

Education aims to improve students' skills needed by society and prepare them for the future. Therefore, basic thinking skills are very important, especially in using artificial intelligence (AI) (Touretzky et al., 2019). It should be noted that well-known industrialized countries, such as China, South Korea, and the United States, are preparing and planning for the future of their AI-based education systems and patterns (Shin, 2019). Seeing the importance of AI in education, the researchers tried to describe the implementation of artificial intelligence in STEM-based creative learning in the era of society 5.0 to be an alternative in the learning process and strategy.

METHOD

The researchers employed the literature review or library research by reviewing the results of various studies and collecting data from various references and sources related to the implementation of artificial intelligence in STEM-based creative learning in the era of society 5.0. A systematic literature review is important because it can be a valuable basis and will help in other research (Collins et al., 2021).

Research-based on literature reviews obtained from journals, books, and several other sources tries to analyze any data collected from various sources. It also tries to connect or correlate each data with aspects and indicators (Bhakti & Rahman, 2020).

The literature review search process was performed online and offline. In this study, the researchers searched documents using Google Scholar by inputting keywords, namely artificial intelligence (AI), Creative Learning, STEM, and Era Society 5.0. The scopes of the literature review process are contained in Table .1

Table 1. The Scope of Research & Operational Definition

No	The Scope of Research	Operational Definition
1	Artificial Intelligence	In the current era, information and technology play an increasingly crucial role and function, whether through networks, digital, artificial intelligence (AI), or other technologies in education. They will even become part of the future delivery process to students (Flogie & Aberšek, 2021).
2	Creative Learning	Creative learning is a form of creative expression in the academic domain and the learning process. It combines existing knowledge with new learning stimuli and contributions in the form of new ideas, insights, perspectives, and understandings for oneself and others (Beghetto, 2021).
3	STEM	The STEM-based learning approach integrates science, technology, engineering, and mathematics. It aims to create individuals who think critically, logically, systematically, objectively and increase students' interest in learning at school (Thahir et al., 2020)
4	Era Society 5.0	The era of society 5.0 is an era that provides opportunities for every individual to have more ability to access information in the digital era. It is a vision of a new society integrated with technology and human-centered (Fukuda, 2020).

This research employed secondary data consisting of various national-scale data related to artificial intelligence, creative learning, STEM learning, and various other supporting data. Apart from descriptive data, this research also included various information from various kinds of literature (scientific journals, national and international reports compiled from several sources, and theories relevant to this research).

RESULT AND DISCUSSION

The society 5.0 era makes various aspects of people's lives more comfortable and sustainable concerning cost and time. Human Resources (HR) is the key to facing the era of digital transformation. Industrial revolution era 4.0 and society era 5.0 rely on technological developments. They require Indonesia to prepare for developing reliable resources, such as artificial intelligence. Artificial intelligence (AI) is one of the new technologies that continue to develop and can also be used to improve the qualifications and competencies of human resources in Indonesia (Devianto & Dwiasnati, 2020).

Artificial intelligence (AI) is part of digitalized computer science that represents knowledge using symbols rather than numbers and processes information according to several rules (Swarnkar & Swarnkar, 2020).

Artificial intelligence technology does not necessarily replace the role of humans in the educational process. Rather, it supports humans in the educational process. Integrating artificial intelligence in creative learning is an alternative for educators in the learning process and becomes part of a renewable strategy.

Artificial intelligence that is integrated into the creative education process will run effectively. It is characterized by various collaborations over a long and complex period (Yang & Bai, 2020). The researchers compiled a table related to the implementation of artificial intelligence in the STEM-based creative learning process. The following is a description of artificial intelligence in the STEM-based creative learning process.

Table 2. AI in STEM-Based Creative Learning Process

		Innovation Process	
		Develop Ideas	**Generate Ideas**
Barriers to Innovation	**Information Processing Constraints**	a. Artificial Intelligence (AI) system can identify dan evaluate more information that can be used to develop ideas. b. Developing ideas and identifying more information will be very helpful in the STEM-based creative learning process. Thus, teachers will find it easier to access any ideas or support information.	a. Artificial Intelligence (AI) systems can recognize more problems, opportunities, and threats that may be used to generate new ideas. b. In STEM-based creative learning through artificial intelligence (AI), an educator in the classroom will explore more strengths, problems, opportunities, or threats to generate new ideas in alleviating problems.
	Ineffective or Local Search Routines	a. Artificial Intelligence (AI) can identify and evaluate more creative and exploratory ideas. b. In the creative learning process, identifying and evaluating are required. They will become assessments of STEM-based creative learning.	a. Artificial Intelligence (AI) systems can recognize and create more creative and exploratory problems, opportunities, and threats to generate new ideas. b. Artificial intelligence will certainly support teachers and students more in the STEM-based creative learning process. It will help them in the process of finding, exploring, or creating new strengths, problems, opportunities, minimizing threats.

(Haefner et al., 2021)

Several studies have stated that the implementation of artificial intelligence in the learning process is encouraging in improving student performance and academics and supporting educators in shaping learning designs and complements to perfect learning strategies (Luan et al., 2020).

Integrating artificial intelligence in the STEM-based creative learning process can effectively solve problems in the educational process and help students in the learning process. Also, artificial intelligence prioritizes cognitive processes to solve problems in education. In other words, artificial intelligence is a type of learning that consists of memorizing information, understanding relationships, and applying specific and general skills (Puratep & Chaijaroen, 2020).

In the process of using AI in the learning process, several skills can be applied by students—first, memorizing information which consists of three aspects, namely approaches, courses, and modules—second, understanding the relationship that consists of example-decision, Problem-implications, develop-involved, computer-students, and integrated-complex. Third, skills consist of science, solution, development, and algorithms. Lastly, there are results, projects, and challenges. Therefore, AI in learning is a part of creative learning. Here is how to design the framework of artificial intelligence in education.

Table 3. Type of Artificial Intelligence (AI) in The Creative Learning Process (Shin, 2021)

Memorize Information	Apply Skills	Understand Relationships	Apply Generic Skills
Approaches	Science	Example-Decision	Result
Course	Solution	Problem-Implications	Projects
Module	Development	Develop-Involved	Challenge
	Algorithms	Computer-Students	
		Integrated-Complex	

Integrating STEM into creative learning through artificial intelligence has complex challenges in the implementation process. Therefore, the following is an overview of including STEM in the creative learning process to help students in higher-order thinking processes and communicating thoughts and ideas.

Table 4. Overview of How to Include STEM in the Creative Learning Process (Exchange, 2015)

No	Creative Learning-Based STEM
1	Use recognize and analyze models
2	Communicate effectively
3	Focus on inquiry and investigation while working in teams
4	Understand multiple contents area
5	Gain knowledge of contemporary issues and appreciate personal and social content
6	Understand plant, act, evaluate
7	Use technology and math, and apply abstract and quantitative reasoning

Table 4 shows that STEM-based creative learning consists of various aspects that an educator can do. The first is how to use, recognize, and analyze models. The second is to communicate effectively because there needs to be effective communication, such as discussions about a problem. The third is to focus on inquiry and investigation while working in teams. Teachers and students need to focus on problems that arise and work in teams or collaborations.

The fourth is to understand multiple content areas because students need to understand various learning topics. The fifth is to gain knowledge of contemporary issues and appreciate personal and social contexts to respect each individual. The sixth is to understand, plan, act, and evaluate. Educators need to have learning patterns, lesson plans, implementation, and evaluation as important capitals in the creative learning process. The last is technology and math, and apply abstract and quantitative reasoning. An educator needs to understand implementing technology into a learning process to support STEM-based creative learning.

STEM-based creative learning has several advantages in the implementation process. The advantages are (Pentury, 2017) creating fun and supportive atmospheres, interactive class, and interactive, active, and pro-active students. Teachers can stimulate and enjoy things that happen in the classroom. They can stimulate and support students by giving interesting and challanging assignments. The teacher participates, elaborates, and collaborates in the learning process with students. The students are more inspired and motivated to learn more naturally by using authentic materials. It prepares students for life experiences to succeed in the future. Besides, it fosters good cooperation among students and teachers.

Students are encouraged to be more independent in experimenting and exploring extraordinary things to develop knowledge and psychomotor abilities. Their language skills are getting better through collaboration with technology. Students and teachers can develop their talents. Teachers and students can develop language skills and apply them communicatively and productively.

CONCLUSION

Artificial intelligence in STEM-based creative learning can be an alternative for teachers in the learning process. Various literature studies have stated that artificial intelligence does not act as a teacher's substitute. Rather, it supports creative learning activities and helps teachers implement STEM-based learning. It is certainly in line with the era of society 5.0 that integrates the role of humans and digital technology.

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