Online Science Education Journal *http://dergipark.gov.tr/ofed*

2023; 8(1): 12 - 21.

ChatGPT - Science Education and Instruction Reshapes Management

M. Said Doğru *, *Kastamonu University, Araç Rafet Vergili Vocational School, Turkey*

*Corresponding Author: msaid.dogru@yahoo.com

To cite this article: Doğru, M. S. (2023). ChatGPT - Science education and instruction reshapes management. *Online Science Education Journal, 8*(1), 12-21.

Article Info

Article History

Received:
18 May 2023

Accepted:
22 June 2023

Keywords
Artificial Intelligence
Science education
Teaching methods
ChatGPT

Abstract

Artificial intelligence has transitioned from being a mere fictional concept depicted in novels and movies to a practical reality. However, its integration into science education and instructional management has been a gradual process. The emergence of chatbots like ChatGPT, powered by extensive training on internet-derived textual data, has revolutionized the way we approach science education. While this technology brings numerous advantages, it is crucial to exercise caution and thoughtful consideration regarding its application.

INTRODUCTION

Over time, Artificial Intelligence (AI) has undergone significant advancements and has transformed into a tangible aspect of our lives. Initially, it was envisioned as a way to replicate and automate human thought processes and logical reasoning. This concept, once considered futuristic and reminiscent of science fiction movies such as 'The Matrix' and 'The Terminator,' has now become a part of our everyday reality. We are currently living in the era of "big data," where the application of AI can be observed in various industries, including technology, banking, marketing, entertainment, and many others. From navigation tools like Google Maps to facial recognition technology and virtual assistants like Siri and Alexa, AI's impact and presence continue to expand and shape our world (Adamopoulou & Moussiades, 2020).

Language processing capabilities, in particular, are advancing rapidly in the realm of AI (Deng & Lin, 2022). Chatbots, such as ChatGPT, Jasperchat, DialoGPT and Replica, along with transcription technologies like Otter.ai, are at the forefront of this progress. Among them, ChatGPT stands out for its remarkable ability to generate high-quality content. Developed by OpenAI, ChatGPT is a large-scale language model that has gained significant recognition (Deng & Lin, 2022).

In essence, AI, particularly in the form of language models like ChatGPT, has emerged as a transformative force. Its potential applications are vast and varied, with implications across

numerous fields. As technology continues to advance, the impact of AI is likely to expand even further (Khan et al., 2023).

Use of Artificial Intelligence in Education

Education is undergoing more and more transformations under the influence of technological advances. An important component of this transformation is the use of artificial intelligence (AI) technologies in educational processes. AI can be defined as a field that allows computer systems to imitate human-like intelligence and learning abilities (Sucu & Ataman, 2020). The use of AI in education offers the potential to increase student achievement, improve teacher performance, and provide more personalized learning experiences (Tapalova & Zhiyenbayeva, 2022). However, it should be noted that this use brings some opportunities and challenges.

Opportunities:

Individualized Learning: AI can offer personalized learning materials tailored to student's needs and learning styles. It can make learning experiences more effective by providing students with tailored feedback and learning roadmaps (Arslan, 2020).

Teacher Support: AI can lighten teachers' workload and provide them with more time and resources. Automatic rating systems and data analytics tools that teachers can use in assessment processes can speed up assessment processes, and provide a more objective assessment.

Student Tracking and Early Intervention: IA can be used to monitor students' progress and intervene early. With data analytics and machine learning algorithms, it may be possible to identify students' learning difficulties or needs and appropriate interventions can be planned accordingly.

Challenges:

Ethical Issues: Significant ethical issues may arise with the use of AI. For example, issues such as student privacy and data security must be properly addressed and protected. Also, concerns that AI systems may lead to prejudice or discrimination should be taken into account (Masters, 2023; Kim & Kwon, 2023).

Teacher-AI Interaction: Rather than literally replacing the teacher, teacher-OR collaboration is an important issue. Proper use of AI systems by teachers still plays a critical role in understanding students' needs and responding appropriately.

Technology Access and Inequality: AI technologies need to provide equal access and reduce the digital divide. All students should have access to AI technologies, and fair policies should be adopted so that technology use does not become a source of inequality (Metin & Bahat, 2020).

The use of artificial intelligence in education brings many opportunities and challenges. When managed properly, AI can improve students' learning experiences, support teachers and help reduce inequalities in education. However, it is important to address challenges such as ethical issues, teacher-artificial intelligence interaction and technology inequality (Çelik, 2023). Therefore, the use of artificial intelligence in education is a process that requires careful planning, cooperation between education stakeholders and compliance with ethical standards.

Discovering the basic principles of science in the minds of students and being able to understand the natural world has made science education a discipline that makes it important. New opportunities in science education have a significant potential to increase learning experiences with the rapid advancement of technology, especially with the development of artificial intelligence (Goralski & Tan, 2020). Artificial intelligence has become an important function in providing a science education at the point of individualizing students, strengthening their interactions and solving problems (Moreno-Guerrero et al., 2020). In this study, the potential and possibilities of using artificial intelligence in science education were examined.

Potentials:
1. Virtual Laboratories and Simulations: Students can find the opportunity to try experiments and activities that they cannot do in real life through virtual laboratories and simulations with artificial intelligence. Thus, scientific concepts can be understood more clearly by students, and progress can be made in scientific thinking skills with the application of experiments.

2. Data Analysis and Prediction: In science education, AI can provide feedback to students and predict science events by analyzing large amounts of data. Based on real-time data, it allows students to analyze their results and conduct data-driven studies in science.

3. Student Monitoring and Personalized Learning: AI can monitor student's progress and provide students with personalized feedback and learning materials. This can increase student success by allowing students to identify their weak areas and work more effectively accordingly (Vorst & Jelicic, 2019).

Facilities:
1. Teacher Support: In science education, artificial intelligence provides important support to educators and teachers, as well as the progress of students on the subject can be monitored carefully with artificial intelligence. Course programs and plans can be arranged according to the subjects that students need. While doing all this, ChatGPT can also give an idea about how teaching materials can be used more efficiently (Chiu et al., 2023).

2. Motivation and Interaction: It is related to the motivation of students towards science subjects in order to learn science subjects and concepts better. Here, artificial intelligence can bring the student's motivation to the highest level by interacting in the context of the subjects. Here, by increasing learning experiences, it can increase interaction in this sense by establishing interactive connections such as rewards and gamification of items (Huang, Lu & Yang, 2023).

3. Teacher Training: Teacher training is very important for the effective delivery of science education. Here, increasing teacher education with artificial intelligence can be used more effectively thanks to these technologies. In order for artificial intelligence applications to be used effectively in the classroom environment, artificial intelligence-based usage skills of such tools can be added. Teacher education can be increased to higher levels by gaining such skills to teachers (Mohammed et al., 2021).

In conclusion, artificial intelligence in science education has the potential to transform learning. Facilities such as virtual labs, data analysis, personalized learning, and teacher support can make science education more interactive, engaging, and student-centered. However, for its successful implementation, educators need to ensure the ethical use and

proper integration of GI (Sijing & Lan, 2018). Artificial intelligence can offer very important opportunities to increase students' interest in science and improve their scientific thinking skills.

Effects of Using ChatGPT in Science Education

The quality of science education is important for the easier understanding of science subjects and concepts and the development of scientific thinking skills. In this sense, it has become an important discipline area. This importance emerges with the rapid development of technology with artificial intelligence. Here, he develops his learning experiences with language models based on artificial intelligence. Thanks to these models, ChatGPT can provide students with information about science topics, answer questions and guide their learning processes by interacting with students. The use of ChatGPT to increase learning and communication in science education reveals new discourses (Alam, 2021).

1. Technology-Student Interaction: As stated above, ChatGPT can communicate with students through a natural language model. Here, students can ask questions to ChatGPT, request information, and request explanations about the subjects. In this way, ChatGPT can interact with users and provide them with positivity at the point of active learning. By doing this, students will be able to learn the subject and concepts better.

2. Question-Answer and Lecture: In this part, answering and explaining questions about science subjects can be done by ChatGPT. Here, students can talk about different topics with ChatGPT and contribute significantly to their learning as they reinforce the concepts and learn more deeply (Ray, 2023).

3. Teacher Support: ChatGPT can also offer support to teachers. Teachers can use ChatGPT in a classroom setting to provide students with additional resources and learning materials. In addition, teachers can provide more interaction and feedback and improve classroom time management with ChatGPT answering students' questions.

4. Customized Learning Experience: ChatGPT has the potential to provide students with a personalized learning experience. Adaptable to students' needs and learning speeds, ChatGPT can provide students with customized guidance and support. Thus, an environment can be created where each student can progress at their own pace and receive additional explanations on the subjects they need (Kasneci, 2023)

The use of language models such as ChatGPT in science education has the potential to support student-teacher interaction and enrich the learning experience. Their ability to answer students' questions, explain topics, and offer customized guidance can make science subjects more understandable and interesting. However, ethical issues regarding the use of ChatGPT and the limitations of the language model must be considered. In order to use ChatGPT successfully in science education, teachers' guidance and correct guidance is important (Cooper, 2023).

The Purpose of Study

The main objective of this article is to explore the transformative effects of artificial intelligence-powered chatbots like ChatGPT on science education and instructional management. It aims to delve into the potential impacts, advantages, and challenges that ChatGPT brings to the realm of science education and teaching administration. Moreover, the article highlights the growing significance of artificial intelligence in education and examines

how the interaction between education experts and artificial intelligence is evolving. Its purpose is to elucidate the advancements of AI-based technologies in science education and instructional approaches, create awareness among teachers and educators in this field, and initiate a discussion on the benefits and challenges associated with these novel technologies.

Using Chatgpt as a Tool in Science Education

The utilization of language-based tools like ChatGPT in science education serves the purpose of facilitating student engagement with scientific topics and enhancing their learning journeys. The incorporation of ChatGPT in science education can be elucidated as follows:

1. Question-Answer Interaction and Information Distribution: ChatGPT plays an important role in answering questions about scientific issues and distributing information about these issues. Here, students can search for ChatGPT's descriptions and definitions using natural language. As a result of these searches, appropriate answers are given by ChatGPT, and students are enlightened on the point of scientific knowledge (Lee, 2023).

2. Detailed Explanation: ChatGPT is of great importance in narration or promotion. In particular, they can explain science subjects and concepts in detail. While making these explanations, it can enable students to learn concepts more deeply with detailed examples. This situation enables students to understand the subjects and concepts better and settle them in their minds. Because of all these, it may be sufficient to express this artificial intelligence application as an important tool in the permanent learning of subjects and concepts in minds (Santos, 2023).

3. Private Guidance: Individual guidance services can be offered to students through ChatGPT. ChatGPT can be used to ask in-depth questions about specific topics and further clarify concepts. Accompanying students throughout their learning journey, necessary additional explanations and support are provided through ChatGPT.

4. Fostering Communication Skills: By engaging with ChatGPT, students are encouraged to enhance their written and verbal communication skills. Through natural language interaction with ChatGPT, students can inquire, express their understanding of concepts, and receive responses. This process aids in strengthening their communication abilities and articulation of science-related topics.

Artificial intelligence tools can also be used as an effective learning tool. The fact that these tools are language-based contributes more to learning. In this context, ChatGPT not only provides information support to students, but also contributes to increasing their communication skills. Teachers can also use it as a resource and support tool. For this reason, ChatGPT can take an important place in a permanent and effective science education.

On the other hand, the artificial intelligence tool ChatGPT can understand and use human language with its unique bilingual feature. Although it does not completely replace the teacher, it is an effective tool in science education. It is a suitable environment for students to present their knowledge subjectively, practice and develop speech-based answers. This potential extends not only to science education but also to the realm of health education (Sallam, 2023; Khan et al., 2023).

ChatGPT provides feedback to students about language use and writing styles, and provides an important gain in terms of improving students' scientific knowledge. This situation can

have a much more beneficial effect, especially on students whose native language is not English, and this situation is expressed in studies (Kohnke, Moorhouse & Zou, 2023). Apart from the field of education, the usability of ChatGPT was discussed in the field of health education, especially within the framework of patient interviews. Here, students can practice concepts such as medical history and symptoms by interacting with the artificial intelligence application (Kung et al., 2023; Seetharaman, 2023).

Better Use of ChatGPT In Science Education

Access to educational information and resources is very easy, especially in the digital age, where online resources are frequently used. Contrary to this ease, misunderstandings and interpretations can be encountered in the learning processes. Students need to make serious efforts to understand science subjects and concepts. In this sense, ChatGPT can be used as an important tool in their own upbringing. Here, ChatGPT can be used as an important teaching strategy for small group assessment (SGA). Students' course materials (books, magazines, etc.) can be increased in terms of source variety through ChatGPT by teachers during the small group assessment process. Thus, it can be ensured that the concepts become more meaningful and permanent in the minds. By emphasizing that students' answers should exceed those provided by ChatGPT, it reinforces the idea that science teachers should always possess superior knowledge compared to an online search engine. Consequently, ChatGPT can serve as a benchmark for students to strive for in their pursuit of science education. By comparing their own responses with those generated by ChatGPT, students can identify any gaps in their understanding and actively work towards bridging them. This scenario is encountered across diverse professional fields and educational contexts (Seetharaman, 2023).

With the feedback feature of ChatGPT, this artificial intelligence application, it can provide significant support in improving students' subjective expressions of scientific knowledge about their writing styles and language use. It is clear that this situation will help students whose mother tongue is not English to define their knowledge and skills and will provide important support in the difficulties encountered (Kohnke, Moorhouse & Zou, 2023). Apart from this, ChatGPT can be used actively to simulate experiments and activities of students. In this way, the interactive practice of knowledge can be realized. ChatGPT plays a valuable role in providing feedback on the comprehensiveness and accuracy of information gathered, assisting students in honing their communication skills and clinical judgment. Beyond its applications in science education, ChatGPT can serve as a tool for evidence-based science education and experimentation. Students can utilize ChatGPT to design experiments and receive suggestions for potential teaching approaches based on existing literature. This nurtures their capacity to interpret and apply scientific research to real-life situations (Cooper, 2023).

Other Areas Where ChatGPT Can Be Used

In science education, ChatGPT offers more than just surpassing the knowledge available through online search engines. Students have the opportunity to utilize ChatGPT to enhance their exam preparation by generating case studies and question papers based on previous year's topics and questions. This approach not only encourages analytical thinking but also facilitates the practical application of acquired knowledge, which are fundamental skills for educators. Moreover, leveraging ChatGPT in this manner enables students to foster critical thinking, problem-solving abilities, and effective communication skills (Kasneci, 2023; Rahman & Watanobe, 2023).

Furthermore, ChatGPT's capabilities can benefit learners in training programs (Rahman & Watanobe, 2023). By leveraging ChatGPT to search for the latest research papers, experiments, and teaching guides, teachers can stay updated and deliver the most effective teaching and learning methods to their students.

While using these effective methods, it also benefits simulation training. Here, it can facilitate the use of virtual laboratories, especially with real-life scenarios. As it is known, virtual laboratories are one of the most important tools that keep students' learning curiosity at the highest level and actively positively affect their learning against the course. ChatGPT provides an important support in transforming simulations into a virtual laboratory for students, revealing participation and realism. Thus, students can learn basic science concepts together with their cognitive skills at the highest level of subjects, concepts and experiments effectively.

Limitations and Disadvantages

While ChatGPT has proven to be a very important tool in science education, it is necessary to consider the limitations and potential disadvantages. One of the major drawbacks here is the risk of student responses being generated via ChatGPT. This situation does not affect students' learning. It leads to a superficial understanding of the subjects. In this sense, it is important for students to understand basic science concepts in order to prevent meaningless learning. Although there is substantial access to current research and development here, the importance of efficient interaction of reasoning in education cannot be fully achieved by ChatGPT. While ChatGPT is thought to help learning significantly, it cannot be expected that this artificial intelligence application should be considered as a tool that replaces human qualities and abilities in education (Lee, 2023).

Moreover, ChatGPT has its limitations in understanding contextual cues and subtle linguistic nuances, which can lead to inaccuracies or misinterpretations in its responses. It is essential to acknowledge that ChatGPT is not a teacher and cannot offer guidance on instructional approaches. Therefore, it is crucial to use ChatGPT as a complementary tool in conjunction with conventional teaching methods rather than a complete replacement. Lastly, the accuracy and dependability of the information provided by ChatGPT can be influenced by the quality of the training data utilized during its development (Seetharaman, 2023).

Measures to Restrict the Use of ChatGPT

With the increase in artificial intelligence applications, their use cases are also considered. Here, in particular, the use of ChatGPT leads to some disadvantages. It may be necessary to take some measures to reduce this use. In particular, to prevent students from using ChatGPT too often, some inputs at the point of using ChatGPT can be limited to subjective expressions of intellectual input. The importance of using ChatGPT as an auxiliary tool by preventing it from replacing books and magazines on the basis of course materials can be explained to students by teachers. It can be perceived as a reference tool. Again, ChatGPT can be transformed into a helpful data set for transforming difficult or obscure concepts into simpler and more understandable expressions. Here, real-life examples can be developed, and ChatGPT can be used for the above purpose. An effective teacher model is important in developing the necessary critical thinking, problem-solving and communication skills. Users or teachers can take advantage of such advantages by making ChatGPT a companion to traditional learning methods by helping the classroom. This situation has also been expressed in different disciplines (health) (Lee, 2023).

Research Ideas for Evaluating the Effectiveness of ChatGPT in Science Education

In addition to the fact that ChatGPT has become a very important tool in science education, there may be some different situations. It is necessary to know that there are limitations and possible disadvantages here. Speaking of these disadvantages, students' high reliance on ChatGPT may lead to deficiencies in learning the subjects, or there may be a lack of in-depth teaching. At this point, it is very important for students to understand basic science concepts. ChatGPT is very important in reasoning and human relations at the point of access to current research and developments. Although mutual empathy and intuitive teaching methods and approaches help ChatGPT at the point of learning, it cannot be expected to function like a human being (Lee, 2023).

Understanding key aspects of ChatGPT language models and responding to some limitations can lead to misunderstandings. Here, it is necessary to accept that this artificial intelligence (ChatGPT) has a guiding role in teaching methods in certain subjects and concepts rather than being a trainer. For all these reasons, it should be seen as a complementary tool that makes an important contribution to the learning of existing teaching methods, not the actual implementer. ChatGPT can be seen as an important tool in order to increase the accuracy and reliability of the information as well as the quality of education data (Seetharaman, 2023). These research ideas can provide a foundation for evaluating the effectiveness of ChatGPT in science education and understanding its advantages. The research can assess various factors such as student achievement, motivation, feedback, teacher perspectives, and deep learning, thereby helping us gain a better understanding of the potential of ChatGPT in science education.

ChatGPT can be used in many different areas. Here, case studies can be used to increase problem-solving, critical thinking and communication skills. Improvements in these skills can take place primarily among students, with various developments taking an active role in ChatGPT. In this way, it is thought that it will make important contributions by playing an active role in the future of science education. The development of these skills may appear as the result of antecedent criteria. As a result, it is thought that ChatGPT, as a product of artificial intelligence, will play an important role in improving the knowledge and skills of users (students) and shaping education.

Insights for Science Education Professionals

Science educators can explore ChatGPT's development of different abilities in students and reveal useful information. While ChatGPT can be useful in enhancing learning and telling, Feners should not ignore its downsides (limitations) and potential risks. Considering these limitations and risks, these subject matter experts and other application researchers can develop artificial intelligence tools that improve subjective learning and narrative abilities without the risks of addiction and science education. Seetharaman (2023) mentioned these in his study with medical students.

These emerging tools may not only provide answers, but may also encourage inquiry, such as revealing the reasoning behind the answer, explaining it, or allowing the user to choose between them. Thus, new artificial intelligence tools can be useful for students to understand the material better and develop their skills effectively and responsibly. This may contribute positively to science education in the future, as well as increase the quality of preparation for teaching and learning. (Cooper, 2023; Lee, 2023; Seetharaman, 2023).

CONCLUSION

The increase in students' objective knowledge as well as other knowledge and skills related to the subject emerges as an important result. Adequate facilities may be required for this. This opportunity is provided with ChatGPT, which is one of the artificial intelligence tools that has reached a certain level in natural language processing and has been developed. Even if ChatGPT is not an expert trainer in a field, it can have a significant impact on increasing basic knowledge and skills in subjects such as questioning thinking and problem-solving. In addition to this, with ChatGPT, it is possible to conduct experiments, learn information and prepare for the exam. In terms of accessing foreign resources, it can help with some features such as speaking and writing, especially in English or other languages. In the development of science education programs, educators or teachers can benefit greatly from the use of ChatGPT. Because of all these, ChatGPT's contribution to the development of science education is great.

REFERENCES

Alam, A. (2021, November). *Possibilities and apprehensions in the landscape of artificial intelligence in education.* In 2021 International Conference on Computational Intelligence and Computing Applications (ICCICA) (pp. 1-8). IEEE.

Arslan, K. (2020). Eğitimde yapay zekâ ve uygulamaları. *Batı Anadolu Eğitim Bilimleri Dergisi, 11*(1), 71-88.

Celik, I. (2023). Towards Intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education. *Computers in Human Behavior, 138*, 107468.

Chiu, T. K., Moorhouse, B. L., Chai, C. S., & Ismailov, M. (2023). Teacher support and student motivation to learn with Artificial Intelligence (AI) based chatbot. *Interactive Learning Environments*, 1-17.

Cooper, G. (2023). Examining science education in ChatGPT: An exploratory study of generative artificial intelligence. *Journal of Science Education and Technology*, *32*, 444-452.

Goralski, M. A., & Tan, T. K. (2020). Artificial intelligence and sustainable development. *The International Journal of Management Education*, *18*(1), 100330.

Huang, A. Y., Lu, O. H., & Yang, S. J. (2023). Effects of artificial Intelligence–Enabled personalized recommendations on learners' learning engagement, motivation, and outcomes in a flipped classroom. *Computers & Education*, *194*, 104684.

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., ... & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, *103*, 102274.

Khan, R. A., Jawaid, M., Khan, A. R., & Sajjad, M. (2023). ChatGPT-Reshaping medical education and clinical management. *Pakistan Journal of Medical Sciences*, *39*(2), 605.

Kim, K., & Kwon, K. (2023). Exploring the AI competencies of elementary school teachers in South Korea. *Computers and Education: Artificial Intelligence*, *4*, 100137.

Kohnke, L., Moorhouse, B. L., & Zou, D. (2023). ChatGPT for Language Teaching and Learning. RELC Journal, 00336882231162868.

Kung, T. H., Cheatham, M., Medenilla, A., Sillos, C., De Leon, L., Elepaño, C., ... & Tseng, V. (2023). Performance of ChatGPT on USMLE: Potential for AI-assisted medical education using large language models. PLoS digital health, 2(2), e0000198.

Lee, H. (2023). The rise of ChatGPT: Exploring its potential in medical education. Anatomical Sciences Education.

Metin, I., & Bahat, İ. (2021). Teknoloji bağlamında eğitimde fırsat eşitsizliği: eğitime erişime yönelik sorunlar ve çözüm önerileri. *Ahi Evran Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 7*(2), 498-517.

Masters, K. (2023). Ethical use of artificial intelligence in health professions education: AMEE Guide No. 158. *Medical Teacher*, 1-11.

Mohammed, A., Ali, R., & Alharbi, A. (2021). The reality of using artificial intelligence techniques in teacher preparation programs in light of the opinions of faculty members: A Case Study in Saudi Qassim University. *Multicultural Education, 7*(1), 5-16.

Moreno-Guerrero, A. J., López-Belmonte, J., Marín-Marín, J. A., & Soler-Costa, R. (2020). Scientific development of educational artificial intelligence in Web of Science. *Future Internet*, *12*(8), 124.

Rahman, M. M., & Watanobe, Y. (2023). Chatgpt for education and research: Opportunities, threats, and strategies. *Applied Sciences, 13*(9), 5783.

Ray, P.P. ChatGPT. (2023). A comprehensive review of the background, applications, key challenges, bias, ethics, limitations, and future scope. *Internet Things Cyber-Phys. Syst. 3*, 121-154.

Santos, R. P. D. (2023). Enhancing Chemistry Learning with ChatGPT and Bing Chat as Agents to Think With A Comparative Case Study. arXiv preprint arXiv:2305.11890.

Seetharaman, R. (2023). Revolutionizing Medical Education: Can ChatGPT Boost Subjective Learning and Expression?. *Journal of Medical Systems, 47*(1), 1-4.

Sijing, L., & Lan, W. (2018, August). *Artificial intelligence education ethical problems and solutions.* In 2018 13th International Conference on Computer Science & Education (ICCSE) (pp. 1-5). IEEE.

Sucu İ, & Ataman E. (2020). Dijital evrenin yeni dünyası olarak yapay zeka ve her filmi üzerine bir çalışma. *Yeni Medya Elektronik Dergisi, 4*(1), 40-52.

Tapalova, O., & Zhiyenbayeva, N. (2022). Artificial Intelligence in Education: AIEd for Personalised Learning Pathways. *Electronic Journal of e-Learning, 20*(5), 639-653.

Van der Vorst, T., & Jelicic, N. (2019). Artificial Intelligence in Education: Can AI bring the full potential of personalized learning to education?