A Review of Artificial Intelligence and Its Use in Education[1]

Betül Altundal[2]

Abstract: Artificial intelligence has the potential to lead to great changes in the field of education as well as in many other fields. In the literature, the number of studies on how to use artificial intelligence in education is increasing. Studies also raise expectations about artificial intelligence. In this study, the issue of artificial intelligence and education is examined. In the study, firstly, a brief history of artificial intelligence is given, and definitions related to artificial intelligence are mentioned. Then, examples of studies on artificial intelligence in the field of education are given. Finally, some of the artificial intelligence applications that can be used in education are mentioned.

Keywords: Artificial intelligence, education, chatbots

Introduction

The most discussed digital transformation of recent years is artificial intelligence. Artificial intelligence, which creates a question mark in many people with its positive and negative aspects, has been in human life for a long time in many ways (Alanoğlu & Karabatak, 2021). Technological innovations such as autonomous driving, intelligent virtual assistants (Apple's Siri, Amazon's Alexa, Google Assistant), medical imaging diagnosis, text-to-text language translation, speech-to-text applications, and chatbots are prominent examples of success in this field (Murphy, 2018; Syed & Zoga, 2018). Artificial intelligence is closely related to many disciplines, such as medicine, engineering, industry, banking, agriculture, education, and even psychology. Artificial intelligence operates within a framework developed by the needs of each discipline (Arslan, 2020).

The concept of artificial intelligence has been included in sources with various definitions since the first moment it was introduced. According to Popenici and Kerr (2017), artificial intelligence is a technology model in which certain skills are taught and developed by humans, and these taught skills are then presented to humans. Arslan (2020) defines artificial intelligence as the ability of a computer to use high-level cognitive skills such as human-like behavior, reasoning, problem-solving, inference, and generalization. Similarly, according to Nabiyev and Erümit (2023), this technology can exhibit human-like behaviors and movements. It is expressed as computer-controlled technology used to perform human-like behaviors such as feeling, thinking, decision-making, reasoning, and learning. Definitions of artificial intelligence are not limited to these but can be encountered with different definitions according to different disciplines (Bayındır, 2023).

The fact that countries make large investments in the field of artificial intelligence (Castro & McLaughlin, 2021), create strategy plans, include it in their education curricula, and create various ecosystems (TÜBİTAK, 2023; OECD, 2023; Türkiye Yapay Zeka İnisiyatifi, 2017) makes us curious about artificial intelligence, which we frequently use in daily life but do not realize its importance. This change in the field of technology is reflected in various sectors and can quickly affect people's

[2] altndl96@gmail.com, Ministry of National Education of Türkiye, Kars, Türkiye, ORCID: https://orcid.org/0009-0001-4353-3689

daily lives, learning, communication skills, and social skills (Günay & Şişman, 2020). It is possible to see that this interaction is also reflected in the education. Artificial intelligence seems to have the potential to create great changes in terms of students, teachers, and the functioning of the education system (Kış, 2019).

When these interactions are considered together, it is a necessity to have enough knowledge about the field, to improve oneself, and to train people for this field or by using this field. While studies on artificial intelligence are increasing around the world, educators need to develop and update themselves in the field (İşler & Kılıç, 2021). In this study, firstly, a brief history of artificial intelligence was mentioned. Then, the studies on artificial intelligence in the field of education in the literature were mentioned. Finally, information on which artificial intelligence applications are available in the field of education and where they can be used is mentioned.

Artificial Intelligence from Past to Present

The concrete emergence and development of artificial intelligence can be considered parallel to the mechanization of the Industrial Revolution. The great revolution of mechanization at that time brought the concept of "thinking machines," whose philosophical foundations were laid long ago, back to the surface. Automated machines opened the doors to computers and computer technologies (Öztemel, 2020; Nabiyev & Erümit, 2023).

The philosophical foundations and first steps of artificial intelligence date back to the 17th century. In this period, especially among the rulers and aristocratic class, efforts to build automatic machines that mimic human and animal behavior began. These efforts were also reflected in the philosophical thinking of that period. For example, the famous philosopher Descartes put forward ideas suggesting that he saw the world as a mechanism and made mechanical philosophy a subject of discussion with other philosophers (Nabiyev & Erümit, 2023).

Following the first digital computer, mechanization and automation accelerated gradually. Since 1940, studies that could be a serious stepping stone to artificial intelligence have become the turning point of digital transformation in a short time. In 1943, McCulloch and Pitts developed the "Boolean Circuit Model of the Brain." This is accepted as a mathematical theory of neurons in the brain. This theory formed the basis of artificial intelligence using the principles of brain functioning. In 1948, Shannon suggested that computers could be used to prove complex mathematical theorems and play chess (Arslan, 2020). Alan Turing made a significant contribution to the debates on computers, machines, and intelligence with his paper in 1950. Turing's paper addressed the question of whether a machine can be conscious and have the ability to think. Turing predicted that machines could think and designed a famous experiment to evaluate these abilities (O'Regan, 2016). Despite all these years of studies and ideas, the name artificial intelligence was first mentioned by John McCarthy at the Dartmouth conference in 1956. Marwin Minsky, Allen Newell, Herbert Simon, and John McCharty were considered the founders fathers of artificial intelligence (Nabiyev & Erümit, 2023). Moreover, this is not only because they were present at the conference and gave names, but also because they established leading research centers that greatly developed the concept of artificial intelligence (Wang, 2019).

In 1956, studies continued after the concept of artificial intelligence was officially used. The natural language processing program ELIZA was generated, and the features of computers to store and process information started to come to the fore. While all these studies were continuing, some problems led to low financial support and a decrease in interest. The period in history when this interest and support decreased is called the "Winter of Artificial Intelligence." Although studies continued in these years, support and positive results decreased. After 1993, interest started to increase again (Arslan, 2022; Nabiyev & Erümit, 2023).

While throughout history the concept of artificial intelligence has aimed to produce robots that work in the same way as the human brain (Özmerkez, 2020), it has been accepted over time that this will not be possible and the human brain has not yet been fully solved Efforts have been made to analyze how the human brain works and to create similar systems (Nabiyev & Erümit, 2023; Wang, 2019). However, the things targeted by artificial intelligence have also started to change. It is now aimed at

creating intelligent programs that imitate human intelligence instead of human-copy robots (Altun, 2019; Öztemel, 2020).

The fields of study of artificial intelligence have an ever-expanding range. Artificial intelligence consists of expert systems, fuzzy logic, artificial neural networks, machine learning, and genetic algorithms (Öztürk & Şahin, 2018). The topics covered by artificial intelligence can be classified under headings such as problem solving, modeling games, modeling information, automatic theorem proving, expert systems, natural language processing, audio processing, pattern recognition, computer creativity, and robotics (Nabiyev & Erümit, 2023).

The phases of artificial intelligence are analyzed under three headings. These are narrow artificial intelligence, general artificial intelligence, and super artificial intelligence. Narrow artificial intelligence refers to a system that has been trained and developed in only one area. Narrow artificial intelligence applications cannot show any other action other than the work they are trained for. Examples include a chatbot that responds to a customer's question or application algorithms that predict probability (Demir, 2019; Murphy, 2018). General artificial intelligence includes systems that are developing more actively today. It has functions closer to the human mind. It is used in areas such as natural language processing, image processing, and productive artificial intelligence. Super-artificial intelligence refers to the most advanced of these systems. Although it is still far from the target, its creative functions algorithmically foresee working with the most comprehensive functions of the human brain (Nabiyev & Erümit, 2023).

Artificial intelligence is based on the ability to learn. It develops and maintains learning skills with algorithms and artificial neural networks similar to the neural networks in the human brain. Unlike the human brain, artificial intelligence can learn much faster and reach outputs (Öztürk & Şahin, 2018). Artificial intelligence has a form that mimics the human brain, and there are multiple ways to train it: machine learning, artificial neural networks, deep learning, etc. (Kış, 2019). Machine learning is a general term that refers to the learning of algorithms from data, while deep learning is a subset of these algorithms that includes complex structures such as multi-layered artificial neural networks. Neural networks are one of the basic building blocks of deep learning and provide a mathematical model for processing and learning information. Artificial neural networks are recognized as the best in machine learning (Arslan, 2020; Nabiyev & Erümit, 2023; Öztemel, 2020; Öztürk & Şahin, 2018).

Considering the position of artificial intelligence in society, its development in history, and the point it has reached now, it is possible to say that the areas it affects are very comprehensive. It is important to form qualified human resources trained in this field and to revise the fields of profession and education accordingly (Demir, 2019; Özgeldi, 2019).

Artifical Intelligence in Education

With the four industrial revolutions that humanity has seen, the speed of adaptation of each period and what it brings to society differ. While the speed of change has reached its fastest point in the 4th industrial revolution, some developments herald the 5th industrial revolution. The Internet of Things, cyber-physical systems, autonomous robots, simulation, and big data concepts are accepted as the technological components of the 4th industrial revolution. Those who will not succumb to these digital revolution components will undoubtedly be those who make their investments around knowledge and innovation (Öğretir Özçelik, 2020; Öztemel, 2020; Tuğluk & Gök Çolak, 2020). Innovation is based on creativity, using, and synthesizing knowledge. It is defined as introducing new ideas or applying new processes. Considering the development and usage areas of today's technological components, innovation skills must continue to maintain their importance and continue to be developed through education and lifelong learning (Öğretir Özçelik, 2020).

Especially with the acceleration of the development of computer technologies, the innovation revolution and 21st-century skills are at the center of our lives as a concept. Nowadays, information is much more easily accessible. Skills such as the availability of information, digital literacy, digital citizenship, information fluency, and innovative thinking gain importance in this process. The rapid development of artificial intelligence systems is parallel to the development of these skills (Günay & Şişman, 2020; Özçelik, 2020).

Artificial intelligence, which emerged with the rapid development and self-renewal of technology, is at the center of life. The use of artificial intelligence, which expands from daily life to many professional fields, is rapidly gaining a place in the policies and education systems of states. Artificial intelligence draws its working system from knowledge and learning. It analyzes complex data faster than the human brain and presents it to us (Öztürk & Şahin, 2018). Not only using this fast data analysis system in our daily lives but also integrating it into many professions allows the transformation to accelerate and different needs to emerge. The education system is one of the key points of these needs. Considering the stakeholders in the education system, the aim is both to raise individuals who know, learn, and develop artificial intelligence and to increase the effectiveness of education and training (Arslan, 2020; Kış, 2019).

Education is the most important tool that is directly related to the welfare level of societies and is the pioneer of innovations in generation transfer. Individuals are shaped by education, and societies are shaped by individuals. Everything that is in the policy of the states is aimed at being transferred to society in the education and training process. In this direction, the things included in the scope of education and training should be in a position to keep up to date and guide future periods from today (Aydın, 2019; Öğretir Özçelik, 2020). With the inclusion of artificial intelligence in the education system, it is aimed to serve many purposes, such as finding well-equipped individuals, expanding the areas of use by turning them into advantages, increasing effectiveness by pushing the boundaries of the traditional education system, and producing value on a global scale (Altun, 2019; Digital Transformation Office of the Presidency of the Republic of Turkey, 2021).

Education stakeholders are affected by every change in the system. Students, teachers, educational environment and parents are the main characters of the education system. The educational philosophies of states are shaped on these characters and aim to achieve positive results (Çetin & Aktaş, 2021).

Artificial intelligence in education refers to artificial intelligence technologies used in educational environments to facilitate teaching, learning, and decision-making. These technologies can make inferences, judgments, and predictions using computer systems, mimicking human intelligence. One of the most important goals of artificial intelligence in education is to provide personalized guidance, support, and feedback to students. In the traditional education system, it does not always seem possible to create individual learning environments for each student. Artificial intelligence methods that provide big data analysis will provide support in matters such as creating an individual environment, providing rapid feedback, and creating personalized designs. Technologies such as smart learning systems, adaptive learning materials, and virtual reality increase the potential to provide students with a customized and effective learning experience. These technologies allow students not only to learn information but also to discover their potential (Hwang et al., 2020; Karaca and Telli, 2019; Somyürek, 2009). The advancement of artificial intelligence and technology shows that education is possible, independent of time and place. With the integration of artificial intelligence into education systems, it is used more widely in areas such as distance education, online learning, virtual reality, and augmented reality (Tuğluk and Gök Çolak, 2020). This situation also centers on the concept of lifelong learning and offers individuals individual learning environments (Korucu and Biçer, 2023).

Artificial intelligence in education appears in different ways and systems. Techniques such as expert systems, intelligent tutor systems, dialogue-based systems, data mining, and natural language processing are generally used in education. Machine learning is an umbrella concept and can be used simultaneously with many techniques (Arslan, 2020; Korucu and Biçer, 2023). For instance, data mining and machine learning are interrelated techniques. Data mining, which is used in the analysis of big data, is used in similar areas to machine learning with its analysis and prediction functions. It can be used in areas such as predicting success in education, evaluating, and giving feedback. Natural language processing and image processing are the techniques underlying the applications we use frequently today. In this way, it is supportive in areas such as language translations, spelling error corrections, language learning, and graphic interpretations. There are applications for these techniques and areas of use, the examples of which can be increased. Applications such as Coursera, Aleks, Udemy, Evernote, and Chatbot are applications that undertake multiple roles of education with individualized learning content and are equipped with different artificial intelligence techniques that

accompany lifelong learning (Korucu and Biçer, 2023). Artificial intelligence techniques used in education and the applications created can be classified into many sub-fields, but the rapid development of artificial intelligence makes this classification difficult (İşler and Kılıç, 2021).

Many fields and studies support learning with artificial intelligence in education. Other artificial intelligence applications, such as chatbots, which are especially actively used in foreign language learning, are entering the education system by appealing to all ages. In these applications, factors such as adaptable learning environments and personalized course content, people being able to receive instant feedback, and rapid evaluations increase the quality of learning (Rusmiyanto et al., 2023). Chen et al. (2020) examined the effectiveness of chatbots and other online applications through articles and conference reports. As a result of the content analysis, they observed that the instant feedback-evaluation system and personalized course content in these applications increased retention among students. It has also been stated that it provides convenience for educators in matters such as classroom management, reviewing work, and adapting students. Chatbots, which are fully compatible with the concept of education, are considered tools that support language teaching anytime and anywhere. These robots provide an effective language teaching experience by offering opportunities such as material suggestions, correcting grammatical errors, supporting the student with feedback, and improving and evaluating vocabulary. At the same time, it allows students to individually experience situations they may encounter in real life. This also supports students in overcoming anxiety and staying motivated (Akkaya and Şengül, 2023).

At the same time, prediction studies are conducted based on many factors, such as students' socioeconomic level, cultural characteristics, and demographic characteristics. The literature indicates that positive and significant results have been achieved in prediction studies using artificial intelligence systems such as artificial neural networks and decision trees. As a result of these studies, predicting academic success or failure allows for necessary revisions for both the students and the educators. In this way, teachers can make decisions based on existing data and transform the curriculum. The student, on the other hand, has the opportunity to set realistic goals for himself (Akgün et al., 2023; Başer, 2022).

The potential benefits in areas where artificial intelligence is used in education and where artificial intelligence can be used can be listed as follows (Akkaya and Şengül, 2023; Çinici, 2023; Gordon and Breazeal, 2015; Korucu and Biçer, 2023; Nabiyev and Erümit, 2023):

•   Personalized learning opportunity
•   Instant feedback-evaluation
•   Monitor student behavior
•   Content creation and editing
•   Graphic interpretation, statistical calculation
•   Analytical forecasting
•   Development of language skills
•   Lifelong learning
•   Virtual reality environments
•   Specific learning difficulties

The literature indicates that it is possible to see that these benefits are discussed concretely. Akdeniz (2019), for instance, aimed to support students' concept development with a preschool toy based on artificial intelligence. Students were observed throughout the use of the toy. In the following process, parent and teacher opinions were also considered as the findings of the study. At the end of the study, it was concluded that the developed toy was successful in supporting students' concept development, provided motivation with its interesting aspect, and could be used in individualized education.

Çelik (2020) emphasizes the importance of identifying possible problems in advance by modeling the reading difficulties of primary school students with artificial intelligence. MATLAB, an artificial intelligence program, was used in the study. 10 different models were being developed with artificial neural networks, including the reading problems experienced by students and their reasons. This modeling aimed to predict and classify possible problems in advance and develop solutions.

Uçar (2007) developed artificial intelligence-based software modules to increase and facilitate educational effectiveness for special education students. These modules were aimed at helping the education of children with articulation disorders, autism, or mental disabilities. As a result, positive and significant differences were observed in the learning percentages and comprehension rates of the experimental group compared to the control group.

Artificial intelligence not only supports learning but also strengthens educational institutions in terms of management. For example, while artificial intelligence provides a direct impact on school administration in areas such as course and personnel programs, examination systems, facility management, security, and cyber security, it also indirectly contributes to efficiency in education (Arslan, 2020). Meço and Coştu (2022) examined 21 studies using the keywords "artificial intelligence in education" between 2017 and 2021 in Türkiye. According to the results of the study, 13.6% of the studies mentioned the advantages of artificial intelligence. These advantages indicated that artificial intelligence facilitates individual learning, saves teachers' time when preparing materials, and opens collaborative learning paths for students. In the training, its effectiveness in data collection and analysis processes was also indirectly stated.

Artificial Intelligence Applications for Educators

There are different ways to convey information to individuals in educational environments. The use of materials is inevitable in educational approaches that have changed and developed over the years. Teaching materials are needed to concretize knowledge during the learning process, turn it into experience, and increase the effectiveness of learning. With the development of technology, the materials used in education have also changed, and some materials have become unusable (Öngöz, 2023). Today, applications equipped with various artificial intelligence software affect the education process with gamification techniques, virtual environments, and individualized environments. These materials attract the attention of the student, save time and space for the educator, and facilitate learning (Gündüz and Akkoyunlu, 2020; Korucu and Biçer, 2023).

Although artificial intelligence studies in the use of materials in education have become popular recently, it is known that the first application based on intelligent teaching systems was made in 1970. The application called SCHOLAR is a system that provides dialogue with the user. In this application, based on geography education, a smart lesson system with instructional dialogues was created (Carnobell, 1970). The system guides students step by step by determining learning materials and activities according to the student's performance. Difficulty levels, tips, and explanations are constantly updated according to the student's needs. The goal is to ensure that the student learns the subject effectively (Arslan, 2020).

These systems have been developed and transformed from their first applications to the present day. Öngöz (2023) classifies artificial intelligence-equipped materials under nine headings. These are educational software, digital books, web materials, museum applications, interface agents, assistants, avatars, teaching robots, and robot teachers. These materials are multi-media environments that guide students, analyze and evaluate their knowledge, and offer simulated experiences by working with systems based on intelligent teaching systems and adaptive environments. In these environments, students feel freer and breathe in a teaching atmosphere parallel to the current one, apart from traditional education. At the same time, it provides convenience for teachers in many areas, such as using additional resources, saving time, and tracking students (Altun, 2023).

Educators who are unfamiliar with these practices will refrain from using the materials. At this stage of the study, some artificial intelligence-supported materials will be introduced. For instance, Storyjumper, an e-book application, has already reached a large audience. Individuals can write their own stories in the application, which enables student, teacher, and parent cooperation. In the virtual environment here, they have the opportunity to freely create the characters they want with the drawings they want, turn them into reading aloud, or communicate with other writers. If people wish, they can create a common library with their parents, or their teachers can continue storywriting lessons in virtual classrooms with the support of Google Classroom. In many digital book applications similar to this, students now take on the role of producers rather than readers. In this way, people increase

interaction, enjoy the pleasure of creating permanent works, and provide support to the educator with educational materials used in and out of class (Öngöz, 2023).

The EBA platform, which has been in practice for a while by the Ministry of National Education of Tükriye, is an application that offers virtual classroom opportunities, facilitates course follow-up, and has very rich content, such as virtual museums and interactive course content. Especially since the pandemic period, the use of EBA has increased significantly (Aydın and Atasoy, 2023). With the EBA system, which is at the center of the distance education process, students continue their education and continue their learning outside of school. The EBA ADES system, which has been accessible since 2020, offers an artificial intelligence-supported environment. With a system that emphasizes personal learning experiences, course contents and lesson plans are created according to the individual's level. This artificial intelligence-supported system is currently accessible to 11th and 12th grade students (https://www.eba.gov.tr/). In the study by Aydın and Atasoy (2023) examining the effect of using EBA ADES on course success, it was found that there was a significant difference between the course success of the experimental group that used EBA ADES and the control group that did not use it. The use of EBA ADES had a positive impact on the course success of the experimental group.

The Quizizz application is an artificial intelligence-supported application that can be used in classes. In this easy-to-access application with its rich content, existing course content added by users can be used, or one can create their own course content. Artificial intelligence support can be utilized when creating course content. With the robot created with artificial intelligence support, lesson plans, lectures, or questions in various styles can be created on the desired subject. It is aimed at saving significant time by providing additional resources to the teacher during the lesson. In this application, the teacher can instantly prepare and diversify his questions in the course content and present them to his students with different gamification techniques. It provides the opportunity to evaluate the students' situation together with the students through instant feedback for the analysis of the questions. If one wishes, he can turn in the questions or lecture content for which he has prepared a worksheet. By creating a virtual classroom school for extracurricular learning, you can start live lessons, assign and track homework, and provide feedback to students by obtaining regular reports.

Flashcards can be created with the Slay School application. It provides the opportunity to create personalized notes by analyzing many documents with its artificial intelligence content. Many contents, including YouTube links and web content, can be used in this application. Especially the fact that it supports content such as videos in addition to documents is a great advantage. The created flashcards or tests can also be transferred to other artificial intelligence-supported applications, such as Quizlet and Anki.

Kahoot is an application where teachers can create quizzes, surveys, games, and combined content. It provides support for educational environments through opportunities such as gamified lessons, receiving instant feedback, reporting, and access from anywhere. In their study, Gündüz and Akkoyunlu (2020) evaluated the use of the Kahoot application from the perspective of students. In the study conducted with 53 undergraduate students, the Kahoot application was used in the course along with flipped learning techniques. The students' opinions were investigated, and, as a result, they stated that the application made the course interesting. At the same time, they stated that their negative thoughts towards the course evolved into positive ones, and their motivation towards the course increased.

Conclusions

Artificial intelligence technology leads to transformations in the field of education as well as in many other fields. Studies on this subject show that artificial intelligence applications may help both individual learning and teachers' workload (Çam et al., 2021; Çınar Yağcı & Aydın Yıldız, 2023; Demir Dülger & Gümüşeli, 2023; Şenocak, 2020; Şenyaman, 2023; Yalçın -Çelik & Çoban, 2023). The emphasis on technology competence draws attention to studies on what the qualifications of teachers should be. For example, Göker (2021) emphasizes that teachers should be able to diversify learning with digital applications, design digital applications and games, and use digital systems effectively. Since teachers' workload is very high, artificial intelligence will inevitably help them in this regard. Similarly, it is vital that students can use artificial intelligence to learn on their own. As a

result, artificial intelligence is expected to provide significant advantages in education. In this regard, education stakeholders need to follow the developments regarding artificial intelligence and benefit from the opportunities offered by artificial intelligence.

Acknowledgement

References

Akdeniz, M. (2019). *Okul öncesi çocuklarına yönelik yapay zeka tabanlı akıllı oyuncaklar: tasarım tabanlı bir çalışma* [Doctoral dissertation, Afyon Kocatepe University]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/

Akgün, E., Salman, B. Y., Ayvaz, S. & Karadeniz Oran, Ş. (2023). Makine öğrenmesi ile tahmin: akademik başarı örneği. In V. Nabiyev & A. K. Erümit (Eds.), *Eğitimde Yapay Zekâ Kuramdan Uygulamaya* (pp. 284-303). Pegem Akademi.

Akkaya, Ş. & Şengül, L. (2023). Sohbet robotları (chatbots) ve yabancı dil eğitimi. *Buca Eğitim Fakültesi Dergisi,* (58), 2988-2999

Alanoğlu, M., & Karabatak, S. (2020). Eğitimde yapay zekâ. In F. Güçlü Yılmaz & M. Naillioğlu Kaymak (Eds.), *Eğitim Araştırmaları-2020* (pp. 175-185). Eyuder.

Altun, D. (2019). Sanal gerçeklik ve yapay zekâ. In G. Telli (Ed.), *Yapay zekâ ve gelecek* (pp. 139-157). Doğu Kitabevi.

Altun, M. (2023). Yapay zekâ okuryazarlığı. In U. Tecir (Ed.), *Ortaokul ve liseler için yapay zekâ uygulamaları el kitabı* (pp.14-35). Ministry of National Education.

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

Aydın, A. (2019). Devlet erkinin ve yönetim paradigmasının yapay zekâ bağlamında dönüşümü. In G. Telli (Ed.), *Yapay zekâ ve gelecek* (pp. 65-87). Doğu Kitabevi.

Aydın, Ü. Y. & Atasoy, B. (2023). COVID-19 salgını sürecinde EBA platformu üzerinden gerçekleştirilen uzaktan eğitimlere ilişkin ilkokul öğretmenlerinin görüşleri. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi*, *43*(3), 1687-1714.

Başer, H. E. (2022). *LGS inkılap tarihi ve Atatürkçülük alt testi doğru sayılarının yapay zekâ yöntemleriyle tahmin edilmesi* [Doctoral dissertation, Dumlupınar University]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Bayındır, E. (2023). *Eğitim alanında yapılan yapay zekâ çalışmalarının sosyal ağ analizi ile incelenmesi* [Master thesis, Bahçeşehir Üniversitesi]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Carbonell, J. (1970). AI in CAI: An artificial intelligence approach to computer aided instruction. *Science, 167*,190-202.

Castro, D. & McLaughlin. (January, 2021). *Who is winning the AI race: China, the EU, or the United States?- 2021 update.* Center for Data Information. https://datainnovation.org/2021/01/who-is-winning-the-ai-race-china-the-eu-or-the-united-states-2021-update/

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *Ieee Access*, *8*, 75264-75278.

Çam, M. B., Çelik, N., Turan Güntepe, E., & Durukan, Ü. G. (2021). Öğretmen adaylarının yapay zekâ teknolojileri ile ilgili farkındalıklarının belirlenmesi. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *18*(48), 263–285.

Çelik, C. (2020). *3. sınıf öğrencilerinin yaşadığı okuma güçlüklerinin sebeplerinin yapay zekâ yöntemi ile modellenmesi* [Master thesis, Bursa Uludağ University]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Çetin, M., & Aktaş, A. (2021). Yapay zekâ ve eğitimde gelecek senaryoları. *OPUS International Journal of Society Researches*, *18*(Eğitim Bilimleri Özel Sayısı), 4225-4268.

Çınar Yağcı, Ş., & Aydın Yıldız, T. (2023). Is ChatGPT the foreign language student's trusted artificial intelligence chat buddy? *RumeliDE Journal of Language and Literature Studies*, *37*, 1315–1333. https://doi.org/10.29000/rumelide.1407539

Çinici, M., A., (2023, May 3-5). *Öğrenme yönetim sisteminde yapay zekâ kullanımı* [Conference presentation]. Ufuk University 2nd International Congress on Social Sciences, Ankara, Türkiye. https://usbk.ufuk.edu.tr/wp-content/uploads/2023/10/Tam-Metin-Kitabi.pdf

Demir, O. (2019). Sürdürülebilir kalkınma için yapay zekâ. In G. Telli (Ed.), *Yapay zekâ ve gelecek* içinde (pp. 44-64). Doğu Kitabevi.

Demir Dülger, E., & Gümüşeli, A. İ. (2023). Views of school principals and teachers on using artificial intelligence in education. *ISPEC International Journal of Social Sciences & Humanities*, *7*(1), 133–153. https://doi.org/10.5281/zenodo.7766578

Gordon, G., and Breazeal, C. (2015). Bayesian active learning-based robot tutor for children's word-reading skills [Conference presentation]. 29th AAAI Conference on Artificial Intelligence.

Göker, S. D. (2021, September 8-12). Eğitim 4.0 temelinde tanımlanan yeni öğretmenlik yetkinlik alanları [Conference presentation]. *EYFOR-XII Uluslararası Eğitim Yönetimi Forumu "Okula Dönüş"*. Ankara, Türkiye.

Günay, D. & Şişman, B. (2020). Bilgi ve iletişim teknolojileri okuryazarlığı. In A.D. Öğretir Özçelik ve M. N. Tuğluk (Ed.), *Eğitimde ve endüstride 21. Yüzyıl becerileri* (pp.257-273). Pegem Akademi.

Gündüz, A. Y., & Akkoyunlu, B. (2020). Sınıf cevap sistemleri için oyunlaştırma aracı: Kahoot!. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 35*(3), 480-488. doi:10.16986/HUJE.2019052870

Hwang, G.-J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of artificial ıntelligence in education. *Computers and Education: Artificial Intelligence*, *1*, 100001. https://doi.org/10.1016/j.caeai.2020.100001

İşler, B., and Kılıç, M. (2021). Eğitimde yapay zekâ kullanımı ve gelişmi. *Yeni Medya Elektronik Dergisi*, *5*(1), 1-11.

Karaca, B. ve Telli, G. (2019). Yapay zekânın çeşitli süreçlerdeki rolü ve tahminleme fonksiyonu. In G. Telli (Ed.). *Yapay zekâ ve gelecek* (pp. 170-185). Doğu Kitabevi.

Kış, A. (2019, May 2-4). *Eğitimde yapay zekâ* [Conference presentation]. 14th International Congress on Educational Administration. İzmir, Türkiye.

Korucu, A.T. & Biçer, H. (2023). Eğitimde yapay zekânın rolleri ve eğitsel yapay zekâ uygulamaları. In V. Nabiyev & A. K. Erümit (Ed.). *Eğitimde Yapay Zekâ Kuramdan Uygulamaya* (pp. 38-56). Pegem Akademi.

Meço, G. and Coştu, F. (2022). Eğitimde yapay zekânın kullanılması: Betimsel içerik analizi çalışması. *Karadeniz Teknik Üniversitesi Sosyal Bilimler Enstitüsü Sosyal Bilimler Dergisi*, *12*(23), 171-193.

Murphy, R. F. (2019). Artificial intelligence applications to support k–12 teachers and teaching: a review of promising applications, challenges, and risks. *Perspective*. 1–20, https://doi.org/10.7249/PE315

Nabiyev, E. & Erümit, A. K. (2023). Yapay zekânın temelleri. In V. Nabiyev & A. K Erümit (Eds.), *Eğitimde yapay zekâ kuramdan uygulamaya* (pp. 2-35). Pegem Akademi.

O'Regan, G., (2016). *Introduction to the History of Computing: Undergraduate topics in computer science)* Springer International Publishing.

OECD. (2021). Digital government review of Türkiye. https://www.oecd.org/gov/digital-government-review-of-turkiye-3958d102-en.htm

Öğretir Özçelik, A. D. (2020). İnovasyon, yaratıcılık ve yenilenme. In A. D. Öğretir Özçelik & M. N. Tuğluk (Eds.), *Eğitimde ve endüstride 21. Yüzyıl becerileri* (pp. 1-25). Pegem Akademi.

Öngöz, S. (2023). Yapay zekâ teknolojisinin kullanıldığı yeni nesil öğretim materyalleri. In V. Nabiyev & A. K. Erümit (Eds.), *Eğitimde yapay zekâ kuramdan uygulamaya* (pp.58-82). Pegem Akademi.

Özgeldi, M. (2019). Yapay zekâ ve insan kaynakları. In G. Telli (Ed.), *Yapay zekâ ve gelecek* (pp. 198-22). Doğu Kitabevi.

Öztemel, E., (2020). Yapay zekâ ve insanlığın geleceği. In M. Şeker, Y. Bulduklu, C. Korkut, & M. Doğrul (Eds.), *Bilişim teknolojileri ve iletişim: Birey ve toplum güvenliği* (pp. 75-91). Türkiye Bilimler Akademisi.

Öztürk, K. and Şahin, M. E. (2018). Yapay sinir ağları ve yapay zekaya genel bir bakış. *Takvim-i Vekayi, 6(*2), 25-36.

Popenici, S. A. D. & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning, 12*(22), 1-13.

Rusmiyanto, R., Huriati, N., Fitriani, N., Tyas, N. K., Rofi'i, A., & Sari, M. N. (2023). The role of artificial intelligence (AI) in developing English language learner's communication skills. *Journal on Education*, *6*(1), 750-757.

Somyürek, S. (2009). Uyarlanabilir öğrenme ortamları: Eğitsel hiper ortam tasarımında yeni bir paradigma. *Bilişim Teknolojileri Dergisi, 2*(1), 29-38.

Syed, A.B. & Zoga, A.C. (2018). Artificial intelligence in radiology: current technology and future directions. *Semin Musculoskelet Radiol, 22,* 540-545

Şenocak, D. (2020). Açık ve uzaktan öğrenme ortamlarında yapay zekâ sunduğu fırsatlar ve yarattığı endişeler. *Açıköğretim Uygulamaları ve Araştırmaları Dergisi*, *6*(3), 56–78.

Şenyaman, G. (2023). The future of artificial intelligence in Arabic as a foreign language teaching: The example of ChatGPT. *RumeliDE Dil ve Edebiyat Araştırmaları Dergisi*, *33*, 1057–1070. https://doi.org/10.29000/rumelide.1285940

Tuğluk, M. N. & Gök Çolak, F. (2020). Sanayi toplumu ve eğitimi. In A. D. Öğretir Özçelik & M. N. Tuğluk (Eds.), *Eğitimde ve endüstride 21. Yüzyıl becerileri* (pp. 305-330). Pegem Akademi.

TÜBİTAK (Türkiye Bilimsel ve Teknik Araştırma Kurumu). (2023). 1711 - Yapay zekâ ekosistem çağrısı. https://bilgem.tubitak.gov.tr/yze/

Digital Transformation Office of the Presidency of the Republic of Turkey. (2021). *Ulusal yapay zekâ stratejisi 2021-2025*. https://cbddo.gov.tr/uyzs

Türkiye Yapay Zeka İnisiyatifi. (2024). *Hizmetler*. https://turkiye.ai/trai-academy/

Uçar, Ö. (2007). *Engelli çocuklar için yapay zekâ tabanlı eğitim-destek araçları geliştirilmesi* [Doctoral dissertation, Trakya University]. Yükseköğretim Kurulu Başkanlığı Tez Merkezi. https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Yalçın-Çelik, A., & Çoban, Ö. K. (2023). Investigating the performance of AI-based chatbots in answering chemistry questions. *The Journal of Turkish Educational Sciences*, *21*(3), 1540–1561. https://doi.org/10.37217/tebd.1361401

Wang, P., (2019). On defining artificial ıntelligence. *Journal of Artificial General Intelligence*, *10*(2) 1-37. https://doi.org/10.2478/jagi-2019-0002