

What Do Turkish Pre-Service Teachers Think About Artificial Intelligence?

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Abstract

The aim of the present study was to determine the views of pre-service teachers on artificial intelligence. In the present qualitative study, conducted with the phenomenology design, that data were collected from 94 pre-service teachers attending different departments at Manisa Celal Bayar University, Faculty of Education during the 2018-2019 academic year fall semester in Turkey. Data were collected with semi-structured interview form and written interview form, developed by the author. Collected data were analyzed by using content analysis method and classified under themes. Analyses demonstrated that pre-service teachers assigned different meanings to artificial intelligence, felt basically negative emotions for artificial intelligence, and did not want to live in a world ruled by artificial intelligence. Furthermore, it was found that pre-service teachers considered that artificial intelligence could have both several benefits and risks, and it might have both positive and negative effects on education. Based on the study findings, various recommendations were presented for future studies and implementations on the topic.

Keywords: artificial intelligence, pre-service teachers, views on artificial intelligence

1. Introduction

Nowadays, technology advances with great speed, affecting all areas in life. Thanks to new technologies, individuals are introduced to facilities in transportation, communication, science, education, etc. These facilities improve the quality of life of individuals and their desire to reach for the better, and in turn accelerate advances in new technologies. In this development process, artificial intelligence is one of the most prominent among the current technologies.

Artificial intelligence can be described as machines that could think autonomously and make intelligent decisions (Akerkar, 2014; Ginsenberg, 2012). Although the idea of developing systems with intelligent behavior similar to humans existed since the ancient times, the concept of artificial intelligence was first mentioned in the 1950s and defined as a new research field (Crevier, 1993; Ertel, 2017; Turing, 1950). Thus, the attention on the topic has led to several studies on artificial intelligence.

Today, artificial intelligence determines the future of computer systems and became a part of daily life (Russell & Norvig, 2010). Thus, both software and hardware innovations are introduced with the increasing computer intelligence and robots, smart homes, self-driving vehicles and numerous software are included in daily life. As a result, more effective treatment methods in the field of health, cheaper and abundant production in the field of industry, and more secure travel is possible in transportation are among the advantages of artificial intelligence (Hamet & Tremblay, 2017; Li, Hou, Yu, Lu, & Yang, 2017; Qi, 2008). Due to these advantages, artificial intelligence is described as the future of humanity in certain scientific and technological circles (Minsky, 2006). On the other hand, it is also considered that artificial intelligence could be the end of humanity and lead to unpredictable disasters (Hawking, Russell, Tegmark, & Wilczek, 2014).

There are various studies on artificial intelligence in the literature. In this context, studies on the development of artificial intelligence and the use of artificial intelligence systems in robots could be considered noteworthy (Pfeifer, Iida, & Bongard, 2006; Ziemke, 2001). Furthermore, studies on the uses of artificial intelligence in different fields such as science, medicine, industry, finance, law and security and studies on the effect of artificial intelligence on daily life are also available in the literature (Allen & Chan, 2017; Bahrammirzaee, 2010; Davies, 2011; Jiang et al., 2017; King et al., 2004; Krittanawong, Zhang, Wang, Aydar, & Kitai, 2017; Leitão, Maitik, &

Vrba, 2013; Makridakis, 2017; Qin, Liu, & Grosvenor, 2017; Kambhampati, Monson, & Drew, 2004).

In addition, the use of artificial intelligence in education and its reflections on education has been an important issue for researchers (Roll & Wylie, 2016). In particular, researchers commenced studying the use of artificial intelligence in education since 1980 (Mohammed & Watson, 2019; Self, 2016) and various studies have been conducted on this topic. Several studies were conducted on artificial intelligence support in educational practices (Bracaccio, Hojaj & Notargiacomo, 2019; Edwards, Edwards, Spence & Lin, 2018; Porayska-Pomsta, 2016), instruction of artificial intelligence using computer games and robotics (Lin, Wooders, Wang & Yuan, 2018; Rattadilok, Roadknight & Li, 2018; McKee, 2002, Schafer, 2004, Yoon & Kim, 2015), intelligent instructional systems and environments (Aleven, Roll, McLaren, & Koedinger, 2016; Chen, Cheng, & Chew, 2016; Dermeval, Paiva, Bittencourt, Vassileva & Borges, 2018; Greer & Mark, 2016; Mohamed & Lamia, 2018; Roscoe, Walker & Patchan, 2018), natural language processing in educational environment, automatic performance support and evaluation systems (Grivokostopoulou, Perikos, & Hatzilygeroudis, 2017; Rahimi, Litman, Correnti, Wang, & Matsumura, 2017; Santos, 2016). In these studies, it is stated that the use of artificial intelligence in education would make learning more individual, provide effective learning experiences, help to discover students' abilities, develop their creativity and reduce teachers' workload (Bajaj & Sharma, 2018; Liang & Chen, 2018; Xue & Li, 2018). Besides, it is expressed in the literature that artificial intelligence could support students in need of special education, address the learners in different learning styles, analyze the learners as a learning coach, make the learning process more efficient, and assist them in making career plans as a guidance consultant (Catlin & Blamires, 2019; Mu, 2019). The above-mentioned studies mainly focused on the support of education/instruction by artificial intelligence systems in addition to scrutinizing artificial intelligence systems based on different approaches in education. On the other hand, in addition to addressing the potential benefits of artificial intelligence for education, the views of pre-service teachers who would use these technologies in professional life are also a matter of curiosity. In particular, since no research carried out in this context in Turkey, this lack also draws attention to the need to investigate the topic. In this regard, the studies that would reveal the current position of pre-service teachers on the subject are important in making plans for the use of artificial intelligence in education more effectively and efficiently and would be a guide for our country in adaptation to new educational technologies. Thus, the present study aimed to determine the views of pre-service teachers on artificial intelligence. For this aim, following research questions were specified:

1. What is the meaning of artificial intelligence according to pre-service teachers?
2. What are the emotions that artificial intelligence evoked in pre-service teachers?
3. What is the desire of pre-service teachers to live in a world where artificial intelligence is available?
4. What is the necessity of artificial intelligence for humanity according to pre-service teachers?
5. What are the benefits of artificial intelligence for humanity according to pre-service teachers?
6. What are the risks of artificial intelligence for humanity according to pre-service teachers?
7. What are the effects of artificial intelligence on the field of education according to pre-service teachers?

2. Method

2.1 Research Model

The present study was modeled with phenomenological design within the scope of the qualitative research paradigm to find answers to research questions. The phenomenological design was preferred since it allows individuals to define their views on a known phenomenon comprehensively (Creswell & Poth, 2018). Based on this model, data were collected with semi-structured interviews and written interview forms to determine the views of pre-service teachers. Content analysis method was used to analyze the collected data and the conceptual structures in the data were discovered.

2.2 The Study Context and Participants

The study group included 94 pre-service teachers attending the freshmen class in six departments at Manisa Celal Bayar University, Faculty of Education during the 2018-2019 academic year fall semester in Turkey. In this context, purposive sampling was conducted based on the distribution of 468 freshmen pre-service teachers in the population and 20% of the population was included in the study sample. Thus, the study group consisted of 94 pre-service teachers on a volunteer basis. The distribution of the study group based on gender, age and department are presented in Table 1.

Table 1: Study group demographics

Gender	<i>f</i>	%	Department	<i>f</i>	%
Male	46	48,94	Teacher Training in Sciences	12	12,77
Female	48	51,06	Teacher Training in Mathematics at Primary School Level	12	12,77
<hr/>			Teacher Training in Turkish	17	18,09
Age			Teacher Training in Social Studies	17	18,09
18	38	40,43	Teacher Training at Primary School Level	18	19,15
19	52	55,32	Guidance and Psychological Counseling	18	19,15
20	4	4,26			
Total	94	100	Total	94	100

As seen in Table 1, the distribution of participants based on gender was similar. Furthermore, the study group age level varied between 18 and 20 years. In addition, the participant distribution based on the department was between 12 and 18.

The present study was conducted in Manisa Celal Bayar University, Faculty of Education, since the institution is a well-founded organization in Turkey and provide various undergraduate teaching programs. Furthermore, this institution has an advantageous position for the convenience in data collection processes since it is the university where the author is employed. Thus, due to the fact that it was a higher education institution with qualifications adequate for the present study, Manisa Celal Bayar University, Faculty of Education was selected as the study area.

2.3 Data Collection Instruments

In the study, a semi-structured interview form and a written interview form were developed by the author to determine the views of pre-service teachers on artificial intelligence. The forms produced in the process of developing data collection instruments were initially presented to 7 academicians, who were active in the field of Computer Education and Instructional Technology, and then to 1 measurement-evaluation expert and 1 Turkish language expert. The form was tested and finalized after it was applied to 10 pre-service teachers with similar qualifications with the target audience in the pilot study.

In order to determine the participant demographics, the developed data collection instruments included 3 questions on the age, gender and the department of the participants. Furthermore, 7 open-ended questions were included in the data collection instruments to determine the participant views on artificial intelligence. These questions are presented below:

- 1) What is the meaning of artificial intelligence in your opinion?
- 2) What do you feel about artificial intelligence? Please explain the reasons.
- 3) Would you like to live in a world with artificial intelligence? Please explain the reasons.
- 4) Is artificial intelligence essential for humanity, or not? Please explain the reasons.
- 5) What are the potential benefits of artificial intelligence for humanity? Please explain the reasons.
- 6) What are the risks of artificial intelligence for humanity? Please explain the reasons.
- 7) What are the potential benefits and risks of artificial intelligence in teaching profession? Please explain the reasons.

2.4 Data Collection and Analysis

In the study, data were collected during the 2018-2019 academic year fall semester at Manisa Celal Bayar University, Faculty of Education in Turkey. In this process, appointments were made with the pre-service teachers included in the sample and data collection instruments were applied at the author's office at an adequate time for the participants. The setting was preferred to achieve a healthy data collection process since it was secluded from the factors that may adversely affect the data collection process. The data collection process was conducted by the author.

Prior to the application of the data collection instruments, all participants were provided with information about the aim and content of the study, how the collected data would be used, the participant rights and data privacy. Thus, informed consent was obtained from all participating pre-service teachers. Data were collected from 62 participants (66%) using a written interview form. Furthermore, semi-structured interviews were conducted with 32 participants (34%). The data collected with the interviews were recorded with an audio recorder. At the beginning of the interviews, introductory information was provided by the author to make the participants feel comfortable. Then, the interview questions were asked beginning with general questions and ending with private ones in the form of a chat. Thus, a positive communication environment was established. In the case of

incomprehensible responses, the probe questions were asked and they were asked to express their views in detail. To establish long-term interaction with the participants, data were collected from a large number of participants and the interviews lasted between 40 and 53 minutes. At the end of each interview, the author provided a brief summary for the participants on the collected data and asked approval for data accuracy. In the process of data collection, the author refrained from judging or guiding behavior about the participant statements. Thus, participants were able to express their views comfortably. In order to ensure the credibility of the study, different data collection techniques were used for data triangulation. Furthermore, data were collected from participants of different ages, gender and departments to achieve data source diversity. Response frequencies for data collection instruments are presented in Table 2.

Table 2: Response frequencies for data collection instruments based on departments

Department	<i>f</i>	Interview	Written form
Teacher Training in Sciences	12	4	8
Teacher Training in Mathematics at Primary School Level	12	4	8
Teacher Training in Turkish	17	6	11
Teacher Training in Social Studies	17	6	11
Teacher Training at Primary School Level	18	6	12
Guidance and Psychological Counseling	18	6	12
Total	94	32	62

The data collected with the audio recordings in the interviews and the data collected with the written interview forms were transcribed to a word processor software in the computer environment.

2.5 Data Analysis

The distribution of the participants based on the demographics was calculated with SPSS 25 software. In this context, percentage and frequency values were determined based on participant gender, age, and department. On the other hand, the response of each participant in each open-ended question was analyzed using content analysis with MAXQDA 2018 software. Thus, the analysis was conducted by two field experts and to establish the study credibility. Cohen's Kappa value was calculated to determine the consistency of the content analysis. It was found that the Kappa value was .92 for the overall analysis. Furthermore, the Kappa value varied between .90 and .95 for each question posed to the participants. Thus, it was understood that the inter-coder agreement was high (Landis & Koch, 1977). The conducted analyses revealed a set of themes. Furthermore, in order to ensure the transferability of the study, several direct quote samples of the participant statements were presented.

3. Results

3.1 Findings on the meaning of artificial intelligence

Within the scope of the first research question, the themes achieved about the meaning of artificial intelligence according to the participants are presented in Table 3.

Table 3: Themes on the meaning of artificial intelligence

Themes	<i>f</i>	Participant Statements
System	27	<p>"Artificial intelligence is a system that can think and decide autonomously like the human brain" [K4]</p> <p>"Systems that can think and learn autonomously" [K51]</p> <p>"Artificial intelligence is a system that can do the things humans cannot do and think" [K71]</p>
Robots	21	<p>"The ability of a robot to do certain movements under computer control connotes artificial intelligence" [K22]</p> <p>"In my opinion, artificial intelligence is a robotic system that can think and decide autonomously" [K46]</p> <p>"Artificial intelligence is the ability of a computer-controlled robot to conduct human activities" [K69]</p>

A type of intelligence	10	<i>"It is a type of digital intelligence that does not develop naturally but installed in man-made machines and robots"</i> [K7] <i>"A type of manufactured intelligence, different from human intelligence, in other words, man-made intelligence"</i> [K45]
Technology	9	<i>"It means high-level technology, advanced technology"</i> [K28] <i>"A successful but scary technology"</i> [K48] <i>"A technology that could benefit all aspects of humanity"</i> [K62]
Facility	7	<i>"Studies that would highly facilitate human life"</i> [K63] <i>"A man-made structure that facilitates human life"</i> [K82]
Software	7	<i>"A mixed code component that could be programmed autonomously"</i> [K3] <i>"Man-made programmed software for thinking"</i> [K75]
Entity	5	<i>"It reflects terrifying entities that could solve complex problems with a single sign"</i> [K23] <i>"An entity produced by human intelligence and could beat the human intelligence"</i> [K35]
Development	3	<i>"In my view, artificial intelligence is development"</i> [K50] <i>"It reflects a development"</i> [K87]
Danger	2	<i>"An innovation that would end humanity and reminds me of danger"</i> [K61] <i>"Artificial intelligence reminds me of danger"</i> [K74]
Future	1	<i>"Artificial intelligence reflects the future in my opinion"</i> [K30]
Requirement	1	<i>"In my opinion, artificial intelligence means a requirement that would advance the humankind"</i> [K56]
Productivity	1	<i>"An innovation that is placed in the machines and computers and that improves the productivity of the system"</i> [K11]

The findings presented in Table 3 demonstrated that the meaning of artificial intelligence according to the participants is mainly in the context of self-thinking, self-learning, autonomous decision-making systems, and robots. Furthermore, the participants described artificial intelligence as a type of intelligence produced by humans, a high-level technology, a life facilitator, a self-programmable software, and an entity that can solve complex problems and beat human intelligence. On the other hand, a relatively small number of participants described artificial intelligence as development, danger, future, a requirement and productivity in human progress.

3.2 Findings on the emotions that artificial intelligence evoked in the participants

Within the scope of the second research question, the themes achieved about the emotions that artificial intelligence evoked in the participants are presented in Table 4.

Table 4: Themes on the emotions that artificial intelligence evoked in the participants

Themes	<i>f</i>	Participant Statements
Fear	52	<i>"I feel fear. Because it might have bad ideas in the future. They can destroy our lives"</i> [K7] <i>"I am afraid of excessive advances in artificial intelligence"</i> [K19] <i>"Fear. Because, if it can decide autonomously, it can improve itself and control the word"</i> [K29] <i>"It makes me feel fear. Because it can spin out of control after a while and adopt a completely different dimension. This would be a great threat to the world"</i> [K32]
Concern	36	<i>"Concern. Because, according to the media reports, artificial intelligence implements its own decisions, challenging the given instructions"</i> [K2] <i>"I am concerned about humanity. Because it could lead to unpredictable consequences"</i> [K4] <i>"It concerns me. Because, if it can think autonomously and do whatever it wants to do, it can make wrong decisions. It can do things that are not right"</i> [K14]
Excitement	30	<i>"It excites me. Because something that you produced and worked on thinks and acts like a human. Its success would excite me"</i> [K26] <i>"In fact, I am excited with it. Because artificial intelligence is the miracle of our times. In other words, an invention with artificial intelligence could facilitate the life of humankind"</i> [K42]

		<i>"Excitement. Because the ability of a human-made system to think and make decisions is an incredible phenomenon" [K55]</i>
Happiness	7	<i>"It makes me feel happy. Because this level of technological development is great" [K35]</i> <i>"It makes me feel happy. Because I think that it would benefit the humankind" [K41]</i>
Hope	1	<i>"Hope. Because I hope that the future world could be better thanks to artificial intelligence" [K75]</i>
Hate	1	<i>"Hate. Because, although everything goes well while playing, the game can beat me due to ridiculous reasons" [K73]</i>
Curiosity	1	<i>"Artificial intelligence makes me feel curious about what could happen in the future" [K67]</i>
Relaxation	1	<i>"It makes me feel relaxed. For example, if there was a system that cooks the dishes autonomously at home, I would have less responsibility and I would find time to rest" [K46]</i>
Baffling	1	<i>"I think it is unbelievable. I am baffled. I feel baffled. Because a robot that thinks like humans is a baffling thing" [K45]</i>

Based on the findings presented in Table 4, it was deduced that the participants felt different emotions about artificial intelligence. In this context, participants were predominantly fearful about artificial intelligence. It was determined that the participants also felt concern and excitement. On the other hand, albeit fewer, certain participants stated various emotions such as happiness, hope, hate, curiosity, relaxation and baffling about artificial intelligence. The findings demonstrated that most participants felt negative emotions about artificial intelligence.

3.3 Findings on the desire to live in a world where artificial intelligence is available

Within the scope of the third research question, the themes achieved about the desires of the participants to live in a world where artificial intelligence is available are presented in Table 5.

Table 5: Themes and sub-themes on the desire to live in a world where artificial intelligence is available

Themes and Sub-Themes	<i>f</i>	Participant Statements
No (I would not like to live...)	66	
Personal Reasons	24	
Affective	11	<i>"No. Because, it is not nice to live with an intelligence higher than human intelligence. I would not trust it" [K19]</i> <i>"I think, I would not want to experience it. Because it is scary" [K36]</i> <i>"No, I would not like to. I would be unhappy with the presence of non-human intelligent entities with unemotional reactions" [K49]</i>
Psychological	5	<i>"No. In an environment where everything is done by artificial intelligence, people would be dependent on this technology" [K15]</i> <i>"When I think about it, I would not want to live in such a world although it would fulfill out tasks rapidly and easily. Because individuals would get lazy" [K80]</i>
Cognitive	4	<i>"No. Because artificial intelligence would atrophy human intelligence in my opinion" [K29]</i> <i>"I would not want it to become prominent. Because its popularity would atrophy human intelligence" [K82]</i>
Social	4	<i>"In my opinion, artificial intelligence would kill socialization. I would not want it for this reason" [K30]</i> <i>"I would not want it. Because, human communications would cease, and we could resolve everything with a keystroke" [K46]</i>
Systemic Reasons	19	<i>"I would not want it. Artificial intelligence could make mistakes since it is produced by humans" [K40]</i> <i>"No, I would not want it. Because it is not human, it is artificial intelligence. It would not be possible to predict what it would do" [K69]</i>
Humanitarian Reasons	10	<i>"Artificial intelligence could enslave us humans in a world where it is prominent. I would not want it for this reason" [K2]</i> <i>"No, I would not want it. Because it can end humankind" [K67]</i>

Economic Reasons	5	<i>"No, I would not want to experience it. Humans can lose their jobs because of artificial intelligence" [K4]</i> <i>"I would not want it. Artificial intelligence performing the tasks that humans can do would reduce the need for humans and unemployment would be widespread" [K85]</i>
Others	8	<i>"No. I would not want it because I do not consider it necessary" [K8]</i> <i>"I would not want it. When I think about the human condition in the presence of smartphones, I would not want to live in a with artificial intelligence" [K38]</i>
Yes (I would like to live...)	26	
Facilitates life	14	<i>"I would like to. Because life would be easy thanks to artificial intelligence. For instance, a robot that would help me in the kitchen... It can take care of the work in the kitchen when I finish my chores" [K26]</i> <i>"Yes, I would like to. Because my life would be easier" [K66]</i>
Resolve the problems of humanity	4	<i>"I would like to. Because it can resolve the problems of humanity" [K33]</i> <i>"I would like to. It can find solutions to the human problems experienced in the world" [K62]</i>
Develop the society	2	<i>"I would want it for sure. Because artificial intelligence could improve social development" [K9]</i> <i>"I would like to. Because systems that could think autonomously could develop the society" [K51]</i>
Make the world a safer place	1	<i>"Yes. Because, in my opinion, it would make the world a safer place for humans" [K12]</i>
Others	5	<i>"I would like to. Because an artificial intelligence installed system cannot make mistakes that easily" [K42]</i> <i>"Yes, I would like to experience it, but its use should be limited" [K72]</i>
Undecided	12	<i>"In fact, I am undecided. Today, these types of things are used for beneficial purposes, but I think that if the use would be widespread, we could see misuses" [K34]</i> <i>"I am undecided. Because I am concerned with adverse situations that could harm humanity" [K54]</i>

The findings presented in Table 5 demonstrated that participants did not want to live in a world where artificial intelligence is predominant. In this context, the participants stated various reasons such as personal, systemic, humanitarian and economic reasons. On the other hand, it was determined that relatively fewer participants stated that they wanted to live in a world where artificial intelligence is predominant. In this context, the participants stated that artificial intelligence could facilitate human life, solve the problems of humanity, improve society and make the world a safer place. Furthermore, it was determined that there were participants who were indecisive about the necessity of artificial intelligence and only a few indecisive views were expressed.

3.4 Findings on the necessity of artificial intelligence for humankind

Within the scope of the fourth research question, the themes achieved about the views of the participants on the necessity of artificial intelligence for humankind are presented in Table 6.

Table 6: Themes on the necessity of artificial intelligence for humankind

Themes	f	Participant Statements
Necessary	59	<i>"It is necessary to facilitate activities such as research, experiments and observations especially in fields such as health, technology and science" [K6]</i> <i>"It is necessary. Humans may not fulfill all tasks and cannot reach all places all the time. Artificial intelligence facilitates human life" [K26]</i> <i>"It is necessary. It can resolve the problems that humanity faces" [K33]</i> <i>"It is necessary. Because artificial intelligence is one of the most important weapons of developed countries. We should catch up with this technology" [K54]</i> <i>"It can reduce human error up to zero in a factory. Thus, it is necessary. It increases and sustains production" [K78]</i>
Unnecessary	24	<i>"In my opinion, it is unnecessary. Because, artificial intelligence could be</i>

		<p><i>developed to exceed the human mind, and this means the destruction of humankind by the robots” [K5]</i></p> <p><i>“In my opinion, it is not necessary. Because, after a point in time, humans will not do anything, will not think and end up stupid” [K25]</i></p> <p><i>“In my opinion, it is unnecessary. Because artificial intelligence will replace humans and increase employment and unemployment and most professions will disappear” [K56]</i></p> <p><i>“In my opinion, it is unnecessary. In fact, humans have tended for themselves until now. They can still do the same in the future” [K69]</i></p>
Partially necessary	18	<p><i>“I think, it is partially necessary as long as it is not exaggerated” [K29]</i></p> <p><i>“It is necessary, but partially. Because humanity needs technology up to a point” [K30]</i></p> <p><i>“It is partially necessary for certain issues. It is necessary for certain needs” [K93]</i></p>
Undecided	8	<p><i>“I am undecided on this issue. Because it has advantages and disadvantages for humanity” [K22]</i></p> <p><i>“I am not sure about that. It can be necessary for certain situations, and unnecessary for others” [K45]</i></p> <p><i>“I am undecided. In my opinion, it is both necessary and unnecessary. Because everything has disadvantages and advantages” [K47]</i></p>

The findings presented in Table 6 demonstrated that most participants stated that artificial intelligence was necessary. In this context, the participant views centered on the conveniences that artificial intelligence would provide in fields such as health, technology, science, and they stated that it would facilitate daily life, solve problems of humanity, increase productivity in industries. On the other hand, it was observed that relatively fewer participants stated that artificial intelligence was unnecessary. In this context, participants stated that artificial intelligence would destroy humanity, stupefy the people, and increase unemployment. However, few participants stated that artificial intelligence was partially necessary, that certain needs can be met via artificial intelligence, but predominant artificial intelligence was harmful. Furthermore, it was determined that undecided views on the necessity of artificial intelligence were only a few.

3.5 Findings on the benefits of artificial intelligence

Within the scope of the fifth research question, the themes achieved about the views of the participants on the benefits of artificial intelligence are presented in Table 7.

Table 7: Themes on the benefits of artificial intelligence

Themes	f	Participant Statements
Benefits for daily life	67	<p><i>“It can facilitate daily tasks” [K6]</i></p> <p><i>“It can save time in daily chores” [K35]</i></p> <p><i>“It can fulfill challenging daily tasks for humans” [K36]</i></p> <p><i>“It can facilitate daily human tasks” [K58]</i></p> <p><i>“It can free people from daily routine responsibilities” [K66]</i></p>
Economic benefits	25	<p><i>“It can lead to new employment opportunities in several fields” [K9]</i></p> <p><i>“It can improve quality in production” [K15]</i></p> <p><i>“I can lead to maximum productivity” [K57]</i></p> <p><i>“In can increase production in factories” [K78]</i></p>
Health benefits	16	<p><i>“In the field of health, it can prolong human life” [K2]</i></p> <p><i>“In the field of health, more successful surgeries can be conducted” [K22]</i></p> <p><i>“It may lead to equal opportunities in health” [K65]</i></p>
Developmental benefits	10	<p><i>“It can lead to development and advances in humanity” [K51]</i></p> <p><i>“It can advance technologies” [K52]</i></p>
Scientific benefits	5	<p><i>“It can significantly contribute to studies on universe and science” [K8]</i></p> <p><i>“It can lead to advances in science” [K72]</i></p>
Educational benefits	3	<p><i>“It can lead to rapid learning in education” [K4]</i></p> <p><i>“It can facilitate learning in education” [K46]</i></p>

Benefits for access to information	3	<i>"It facilitates access to information"</i> [K31] <i>"It can help us access the information"</i> [K41]
Defense benefits	1	<i>"Considering the defense industry, robots with artificial intelligence that could provide the best defense without loss of life could provide advantages for nations"</i> [K56]
Environmental benefits	1	<i>"It can prevent the harms that humans cause in the global ecosystem such as global warming, environmental pollution, etc."</i> [K55]

The findings presented in Table 7 demonstrated that the participant views on the benefits of artificial intelligence were diverse. In this context, participants mostly expressed the potential benefits of artificial intelligence in daily life. These benefits that could be induced by artificial intelligence in daily life included facilitation of daily tasks, saving time, and facilitating manual work. Furthermore, participants stated that artificial intelligence could provide benefits in economy, health, human development, science, education and access to information. On the other hand, a few participants also mentioned the benefits of artificial intelligence in defense and environmental issues.

3.6 Findings on the risks of artificial intelligence

Within the scope of the sixth research question, the themes achieved about the views of the participants on the risks of artificial intelligence are presented in Table 8.

Table 8: Themes on the possible risks of artificial intelligence

Themes	<i>f</i>	Participant Statements
Passivation of the individuals	47	<i>"It leads to passive individuals who are lazy, without self-esteem and without new ideas"</i> [K20] <i>"It passivizes individuals. It leads to solitude and exclusion of one's self from the external environment"</i> [K37]
Abuse	27	<i>"Robots can commit crimes on order. They can be abused"</i> [K22] <i>"If artificial intelligence is abused in wars, it can cause immense loss of life and property"</i> [K66]
Economic losses	16	<i>"Use of artificial intelligence can destroy certain occupational groups, in my opinion"</i> [K4] <i>"Humans can be futile due to artificial intelligence replacing humans in all occupations. It can lead to unemployment"</i> [K33]
Getting out of control	15	<i>"It could get out of control and could endanger humans"</i> [K1] <i>"It can implement its own ideas by getting out of human control after a stage"</i> [K47]
Destruction of humanity	14	<i>"The most significant risk in artificial intelligence could be the destruction of humanity"</i> [K5] <i>"The highest risk is the destruction of humanity, in my opinion"</i> [K50]
Ruling humans	10	<i>"It could become sovereign over humans and rule the humanity"</i> [K71] <i>"Robots can conquer the world"</i> [K80]
Violation of privacy	3	<i>"It could get hold of private documents of individuals and states"</i> [K42] <i>"It could get hold of all confidential information"</i> [K44]
Health risks	3	<i>"Artificial intelligence causes various illnesses such as obesity"</i> [K2] <i>"It makes people lazy, leading to inaction. Which in turn leads to various diseases"</i> [K63]
AI errors	3	<i>"Errors in the program could lead to adverse consequences"</i> [K21] <i>"Errors in the program could lead to wrong decisions"</i> [K55]
Environmental risks	3	<i>"Most prominently, it destructs nature. It might pollute the environment"</i> [K13] <i>"It is environmentally harmful. It could destruct the natural balance"</i> [K27]
Increases human ambition	2	<i>"It increases human ambition more, in my opinion. This could lead to an uninhabitable world"</i> [K23] <i>"It could cause individuals to be content with what they have, want more and become ambitious"</i> [K24]
Security risks	2	<i>"It can be hacked by a hostile nation. This leads to security risks"</i> [K78]

"It could be hacked by hackers and lead to security problems" [K81]

The findings presented in Table 8 demonstrated that the participants stated that artificial intelligence could lead to various risks. In this context, participants predominantly mentioned that artificial intelligence would inevitably passivize human beings. Furthermore, the participants also mentioned that artificial intelligence has risks such as the use of artificial intelligence for malicious purposes, causing economic damages, becoming out of control, destroying and ruling humanity. Lesser mentioned risks included violation of privacy, health risks, malfunctions, environmental damages, rendering individuals ambitious, and security problems. On the other hand, the response frequencies demonstrated that participants mentioned risks of artificial intelligence slightly more than its benefits.

3.7 Findings on the effect of artificial intelligence on education

Within the scope of the seventh research question, the themes and sub-themes achieved about the views of the participants on the effect of artificial intelligence on education are presented in Table 9.

Table 9: Themes and sub-themes on the possible effect of artificial intelligence on education

Themes and Sub-Themes	<i>f</i>	Participant Statements
Positive effects	73	
Instructional benefits	27	<i>"It can attract the attention of the students to the topic of instruction"</i> [K10] <i>"It can monitor student learning"</i> [K22] <i>"It can instruct the course better than the teacher"</i> [K29] <i>"It can help students to do more exercise"</i> [K34] <i>"It can speed up teaching"</i> [K39] <i>"It can facilitate experiments"</i> [K63] <i>"It can take personal care of the students"</i> [K65] <i>"It could provide more powerful material"</i> [K75] <i>"It can instruct the course using different methods"</i> [K88] <i>"It can facilitate instruction"</i> [K94]
Benefits for the teacher	19	<i>"It can support self-development of the teacher"</i> [K2] <i>"It can serve as a supplementary resource for the teachers"</i> [K41] <i>"It can assist the teachers to Access information"</i> [K42] <i>"It can support the teacher when the teacher is not sufficient in the classroom"</i> [K53] <i>"It can assist the teacher in developing class material"</i> [K54] <i>"It can make the teachers get less tired"</i> [K70]
Learning benefits	16	<i>"It can facilitate comprehension of difficult topics"</i> [K32] <i>"It can improve the retention of learning"</i> [K37] <i>"It can make learning fun"</i> [K39] <i>"It can facilitate learning"</i> [K46]
Benefits for the students	6	<i>"It can improve the knowledge of students on information technologies"</i> [K31] <i>"It can improve the visual memory skills of the students"</i> [K40] <i>"It can make the students think"</i> [K77]
Educational benefits	5	<i>"It can facilitate education"</i> [K30] <i>"It can save time in education"</i> [K51]
Negative effects	73	
On teaching profession	42	<i>"It will end teaching profession"</i> [K5] <i>"It will replace the teachers"</i> [K18] <i>"It will devalue teaching profession"</i> [K20] <i>"It could replace the teachers in the future"</i> [K56] <i>"There might be no need for teachers"</i> [K58]
On instruction	14	<i>"There will be communication conflicts in the class. Because it is difficult for humans to communicate with an artificial entity"</i> [K8] <i>"The students might ignore the artificial intelligence in class. Thus, a healthy instruction will not be possible"</i> [K13] <i>"It will lead to rigid and unemotional instruction"</i> [K55]

On education	7	<i>“A healthy education will not be possible”</i> [K37] <i>“Qualified education will not be possible”</i> [K85]
On student	5	<i>“It will make students individuals who do not think, research or question existing knowledge”</i> [K9] <i>“The students could become lazy; it could limit their cognitive-creative skills”</i> [K53]
On teacher	5	<i>“It decreases the inquisitive nature of the teachers”</i> [K12] <i>“It makes the teacher lazy”</i> [K67]

The findings presented in Table 9 demonstrated that participants considered that artificial intelligence could have both positive and negative effects on education. In this context, participants mostly stated its contribution to instruction among the positive effects of artificial intelligence on education. Participants also mentioned various benefits of artificial intelligence such as attracting students' attention to the topic, monitoring learning, teaching and exercising. Furthermore, the participants stated that artificial intelligence could provide several benefits for the teacher, learning, students and education. On the other hand, the participants expressed the possible negative effects of artificial intelligence on education mainly in the context of its effects on the teaching profession. Among these effects, the participants mentioned that artificial intelligence could end the teaching profession, devalue the profession and replace the teachers. Furthermore, participants mentioned the potential negative effects of artificial intelligence on instruction, education, student and teacher. On the other hand, it was determined that the positive and negative effect of artificial education on education were equal according to the participant response frequencies and they did not have a dominant tendency in this regard.

4. Conclusion and Discussion

The present study was conducted to determine the views of pre-service teachers on artificial intelligence. For this purpose, semi-structured and written interviews were conducted with 94 pre-service teachers attending Manisa Celal Bayar University, Faculty of Education in Turkey.

The study findings demonstrated that pre-service teachers assigned various meanings to artificial intelligence. In this context, pre-service teachers predominantly described artificial intelligence as self-thinking systems and robots. Similarly, artificial intelligence was described as systems that could be integrated with robots and could make independent decisions based on the situations they encounter in the literature (Chand, Ramachandran, Stoyanov, & Lovat, 2018; Kulkarni & Joshi, 2015; Verma & Kumar, 2018). Furthermore, pre-service teachers described artificial intelligence as a type of intelligence, advanced technology, a facility and software developed by individuals. Considering the fact that artificial intelligence is a software technology that could provide convenience in life (Kaplan, 2016; Mishra, 2011; Warwick, 2012), it was determined that the preservice teachers had similar views. In addition, the description of artificial intelligence as a non-human entity, connotating development, danger, and future, as a necessity and its association with productivity were among the descriptions stated by the pre-service teachers. This could be due to the fact that the media describes artificial intelligence as being capable of producing entities that could think like humans and reports that this technology could shape the future and improve productivity in several areas in life, and on the other hand it could lead to dangerous consequences (Makridakis, 2017; Nilsson, 2010; Sotala, 2010).

In the context of the emotions evoked by artificial intelligence, it was determined that pre-service teachers had predominantly negative emotions. Thus, pre-service teachers stated that they mostly feel fear and concern about artificial intelligence. This could be due to the fact that artificial intelligence could make unpredictable decisions and could be used in bad faith (Brundage et al., 2018; Page, Bain, & Mukhlish, 2018, Parnas, 2017). On the other hand, based on the idea that artificial intelligence could offer several conveniences in life, improving living standards and introduce various innovations (Davenport, 2018; Mishra, 2011), it was determined that pre-service teachers also had positive emotions such as excitement, happiness and hope about the technology.

Analysis of the views of the pre-service teachers on the desire to live in a world with artificial intelligence demonstrated that the pre-service teachers' responses were mostly negative, and they did not want to live in such a world. Pre-service teachers explained this by stating the negative effects of artificial intelligence within the context of individual and systemic factors. Similarly, previous studies reported that the prevalence of artificial intelligence could introduce various risks for personal and social lives (Russell, Hauert, Altman, & Veloso, 2015; Scherer, 2015). On the other hand, a few pre-service teachers desired to live in a world with artificial intelligence by stating that it would make their lives easier, solve the problems of humanity, improve the society and make the world a safer place. Similar to these considerations, it was reported that due to the opportunities provided by artificial intelligence, difficult jobs could become easy, effective solutions could be found for difficult problems, and the welfare of humanity could be improved (Kopeck, Pileggi, Ungar, & Shetty, 2016; Pannu, 2015; Skouby &

Lynggaard, 2014). Furthermore, it was observed that only a few pre-service teachers were undecided about living in a world with artificial intelligence due to the fact that the technology has both advantages and disadvantages and these pre-service teachers did not have sufficient knowledge on the topic.

Pre-service teachers mostly considered that artificial intelligence was necessary for humanity. In this context, pre-service teachers stated that artificial intelligence would provide benefits in the fields of health, technology and science, make life easier, and solve complex problems. Similarly, previous studies reported that artificial intelligence could facilitate various areas in life and support new developments in science and technology (Future of Life Institute, 2016; Sotala, 2012; Şen, 2018). On the other hand, a relatively small number of pre-service teachers stated that artificial intelligence was unnecessary, stating that it could destroy humanity, pacify individuals, and increase unemployment. However, there were also undecided pre-service teachers. Considering the fact that artificial intelligence could introduce various risks besides its advantages (Müller, 2016; Parnas, 2017; Turchin & Denkenberger, 2018), it can be argued that this finding was consistent with the literature. It was also an interesting contrast that pre-service teachers mostly considered artificial intelligence as necessary, however often feared artificial intelligence, and did not want to live in a world with artificial intelligence. This could be due to the fact that they could not predict the capabilities and future consequences of artificial intelligence.

Pre-service teachers considered that artificial intelligence could have various benefits. In this context, pre-service teachers stated that artificial intelligence would provide benefits for daily life. Similarly, it reported that the proliferation of artificial intelligence would convenience the daily tasks of individuals (Poola, 2017; Zabjek, 2018). Furthermore, pre-service teachers stated that artificial intelligence could be beneficial in the fields of economics and health. In addition, a few participants mentioned the possible benefits of artificial intelligence in fields such as science, education, defense and the environment. Considering that artificial intelligence has the potential to have positive contributions in various areas of human life (O'Leary, 2018; Shukla & Vijay, 2013), it can be observed that pre-service teachers expressed similar ideas. On the other hand, the reason for the lesser consideration of the benefits of artificial intelligence by pre-service teachers could be due to the fact that pre-service teachers followed related developments on a limited basis.

Pre-service teachers stated various risk factors on the possible risks of artificial intelligence. In this context, pre-service teachers considered that artificial intelligence would pacify humans. Similarly, previous studies reported that artificial intelligence could make individuals lazy despite its potential to fulfill several tasks (Barber, 2015; Nasir, 2018). On the other hand, the fact that technology might produce various new businesses (Ford, 2013) may encourage individuals to be productive in these new fields. Furthermore, the pre-service teachers stated that artificial intelligence has the risks of abuse, economic costs, potential to get out of control, destroy humanity and rule the people. In addition, possible problems such as the violation of confidentiality, health hazards, potential misconduct, environmental damages and security risks were expressed among the risks of artificial intelligence. Based on various risks associated with artificial intelligence and possible negative consequences for humanity (Mannino et al., 2015; Müller, 2016; Osoba & Welser, 2017), it was determined that the pre-service teachers had similar views. However, it was found that the potential risks of artificial intelligence were relatively more pronounced by the participants when compared to potential benefits. This could be due to the predominant fear of pre-service teachers towards artificial intelligence.

Pre-service teachers considered that artificial intelligence could have both positive and negative effects on education. In this context, pre-service teachers stated that artificial intelligence could have positive effects on instruction, teachers, learning, students and education. Similarly, previous studies reported that artificial intelligence has a significant potential to increase the quality of education, contribute to instruction, and make learning fun and support learning (Aleven et al., 2016; Barnes et al., 2017; Grivokostopoulou et al., 2017; Santos, 2016; Schofield, Evans-Rhodes, & Huber, 1990; Walker & Ogan, 2016). On the other hand, pre-service teachers considered that the most significant negative effect of artificial intelligence on education was the possible destruction of the teaching profession. It can be argued that the idea that artificial intelligence could perform human jobs and could destroy certain professions, leading to unemployment (Campa, 2014; Dirican, 2015; Korinek & Stiglitz, 2017; McClure, 2018) supported the concerns of pre-service teachers on the issue. On the other hand, it was also reported that advanced technologies and artificial intelligence could not replace the teachers, however it may lead to the transformation of the profession (Baker, 2000; McArthur, Lewis, & Bishary, 2005; Popenici & Kerr, 2017). Thus, it can be suggested that pre-service teachers lacked knowledge on the possible future of the teaching profession. In addition, they considered that artificial intelligence may have negative effects on instruction, education, students and teachers. However, pre-service teachers expressed equally positive and negative views on the effect of artificial intelligence on education and they did not reveal a dominant tendency in this regard. This could be due to the fact that the use of artificial intelligence in education is not common in Turkey and the resulting lack of knowledge on the advantages and disadvantages of artificial intelligence in education.

Based on the results, when their negative feelings about artificial intelligence and the lack of knowledge about this

technology considered, it is understood that the pre-service teachers' need for training on the subject. Furthermore, considering that artificial intelligence applications in education have an impact on different stages of instruction such as lesson planning, lecturing, classroom activities, individualization of instruction, analysis of the students, classroom management, guidance, assessment and evaluation processes (Catlin & Blamires, 2019; Liang & Chen, 2018; Mu, 2019), it is thought that pre-service teachers should develop their pedagogical skills and competences in this context. In this respect, it is a necessity to design new courses and rearrange current courses in the curriculum to make pre-service teachers acquire the required knowledge and skills about the use of this technology for educational purposes. Thus, pre-service teachers could be supported to be ready for educational environments of the future. On the other hand, future studies should be conducted to better understanding of the positions of pre-service teachers about artificial intelligence in Turkey.

Recommendations for future studies are listed below,

- 1) Similar qualitative studies could be conducted at different grade levels in different faculties of education at different universities to determine the views of pre-service teachers on artificial intelligence.
- 2) Similar qualitative studies could be conducted to determine the knowledge and skills of pre-service teachers about the use of artificial intelligence application in education.
- 3) Similar studies could be conducted with pre-service teachers in different countries. Thus, the views of pre-service teachers on artificial intelligence in different cultures could be determined and compared.
- 4) Future quantitative studies could be conducted with the survey model, and questionnaires and scales could be developed to determine the current status of a higher number of pre-service teachers.
- 5) Future quantitative studies could be conducted to determine the correlations between the current status of pre-service teachers and certain variables such as openness to innovation, attitudes, perceptions and anxiety.
- 6) Future design-based studies could be conducted to design educational environments that effectively use artificial intelligence in education. Furthermore, the views and competencies of pre-service teachers on smart learning environments could be explored.
- 7) Within the scope of the qualitative research paradigm, the views of faculty members in education faculties could be determined. Furthermore, future quantitative studies could be conducted to investigate the current status of instructors in the field of artificial intelligence, and its correlations with different variables such as openness for innovation, attitudes, perceptions and anxiety.
- 8) Future qualitative studies could investigate the views of the teachers employed in primary education institutions on artificial intelligence. Furthermore, in future quantitative studies, correlations between the current knowledge of the teachers on artificial intelligence and different variables such as openness to innovation, attitudes, perceptions and anxiety could be investigated.

Based on the findings of the present research, the following recommendations for implementation to the faculty of education in the study are listed,

1. It could be considered to design the courses to improve the knowledge and skills of pre-service teachers on artificial intelligence. In this way, it could be ensured that pre-service teachers are better able to understand artificial intelligence, to raise their awareness of the possibilities offered by this technology and to overcome their prejudices and fears.
2. It could be considered that new courses could be designed to teach pre-service teachers about artificial intelligence applications used in education. Besides, in this context, required arrangements could be made on existing Instructional Technologies and Material Design course in the faculty of education. Thus, it could be ensured that pre-service teachers become familiar with artificial intelligence applications used in education in the world, and it could be aimed that pre-service teachers learn hardware and software technologies developed in this regard.
3. Within the scope of new courses designed specifically based on each discipline in the faculty of education, it could be aimed to make the pre-service teachers acquire the required pedagogical knowledge and skills to integrate artificial intelligence applications into teaching. In this way, pre-service teachers could be taught the effective use of artificial intelligence applications such as electronic performance support and evaluation systems, natural language processing systems in the educational environment, intelligent teaching systems.
4. The contents of the courses such as Classroom Management, Measurement and Evaluation in the curriculum of faculty of education could be rearranged based on the use of artificial intelligence in education. Thus, it could be aimed that the pre-service teachers learn to use artificial intelligence effectively in different dimensions of education and develop required pedagogical skills.
5. It could be aimed to train the pre-service teachers to make lesson plans based on artificial intelligence applications in education. Therefore, it could be made rearrangement within the scope of the related courses in the faculty of education curriculum.
6. It could be considered to make arrangements within the scope of Teaching Practice Course in the faculty of education, and pre-service teachers could be encouraged to integrate the artificial intelligence applications

into teaching, to use them actively and to make several educational activities within this scope.

In case the findings of the above-mentioned future studies support the findings of the current research, the implementations listed above could be considered again and also teacher training curriculum could be reorganized and improved in Turkey in this context. Thus, pre-service teachers could be supported in the effective use of smart educational technologies of the future.

Limitations

The present study is limited by the utilized data collection instruments and the study group. Furthermore, the low generalizability of the findings obtained within the scope of the present qualitative study to the population is another limitation.

References

- Akerkar, R. (2014). *Introduction to artificial intelligence* (2nd ed.). Delhi: PHI Learning.
- Aleven, V., Roll, I., McLaren, B. M., & Koedinger, K. R. (2016). Help helps, but only so much: Research on help seeking with intelligent tutoring systems. *International Journal of Artificial Intelligence in Education*, 26(1), 205-223.
- Allen, G., & Chan, T. (2017). *Artificial intelligence and national security*. MA: Belfer Center for Science and International Affairs.
- Bahrammirzaee, A. (2010). A comparative survey of artificial intelligence applications in finance: Artificial neural networks, expert system and hybrid intelligent systems. *Neural Computing and Applications*, 19(8), 1165-1195.
- Bajaj, R., & Sharma, V. (2018). Smart education with artificial intelligence based determination of learning styles. *Procedia Computer Science*, 132, 834-842.
- Baker, M. J. (2000). The roles of models in artificial intelligence and education research: A prospective view. *Journal of Artificial Intelligence and Education*, 11, 122-143.
- Barber, N. (2015). *Can artificial intelligence make us stupid?* Retrieved from <https://www.psychologytoday.com/us/blog/the-human-beast/201507/can-artificial-intelligence-make-us-stupid>
- Barnes, T., Boyer, K., Sharon, I., Hsiao, H., Le, N. T., & Sosnovsky, S. (2017). Preface for the special issue on AI-supported education in computer science. *International Journal of Artificial Intelligence in Education*, 27(1), 1-4.
- Braccaccio, R., Hojaij, F., & Notargiacomo, P. (2019). Gamification in the study of anatomy: The use of artificial intelligence to improve learning. *The FASEB Journal*, 33(1_supplement), 444-28.
- Brundage, M., Avin, S., Clark, J., Toner, H., Eckersley, P., Garfinkel, B., . . . Amodei, D. (2018). *The malicious use of artificial intelligence: forecasting, prevention, and mitigation*. Retrieved from <https://arxiv.org/ftp/arxiv/papers/1802/1802.07228.pdf>
- Campa, R. (2014). Technological growth and unemployment: A global scenario analysis. *Journal of Evolution and Technology*, 24(1), 86-103.
- Catlin, D., & Blamires, M. (2019). Designing robots for special needs education. *Technology, Knowledge and Learning*, 24(2), 291-313.
- Chand, M., Ramachandran, N., Stoyanov, D., & Lovat, L. (2018). Robotics, artificial intelligence and distributed ledgers in surgery: Data is key! *Techniques in Coloproctology*, 22(9), 645-648.
- Chen, N. S., Cheng, I. L., & Chew, S. W. (2016). Evolution is not enough: Revolutionizing current learning environments to smart learning environments. *International Journal of Artificial Intelligence in Education*, 26(2), 561-581.
- Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry & research design: Choosing among five approaches* (4th ed.). CA: SAGE Publications.
- Crevier, D. (1993). *AI: Tumultuous history of the search for artificial intelligence*. NY: Basic Books.
- Davenport, T. H. (2018). *The AI advantage: How to put the artificial intelligence revolution to work*. MA: MIT Press.
- Davies, C. R. (2011). An evolutionary step in intellectual property rights – Artificial intelligence and intellectual property. *Computer Law & Security Review*, 27, 601-619.

- Dermeval, D., Paiva, R., Bittencourt, I. I., Vassileva, J., & Borges, D. (2018). Authoring tools for designing intelligent tutoring systems: A systematic review of the literature. *International Journal of Artificial Intelligence in Education*, 28(3), 336-384.
- Dirican, C. (2015). The impacts of robotics, artificial intelligence on business and economics. *Procedia-Social and Behavioral Sciences*, 195, 564-573.
- Edwards, C., Edwards, A., Spence, P. R., & Lin, X. (2018). I, teacher: Using artificial intelligence (AI) and social robots in communication and instruction. *Communication Education*, 67(4), 473-480.
- Ertel, W. (2017). *Introduction to artificial intelligence* (2nd ed.). Switzerland: Springer.
- Ford, M. (2013). Could artificial intelligence create an unemployment crisis? *Communications of the ACM*, 56(7), 1-3.
- Future of Life Institute. (2016). *Benefits & risks of artificial intelligence*. Retrieved from <https://futureoflife.org/background/benefits-risks-of-artificial-intelligence/?cn-reloaded=1>
- Ginsenberg, M. (2012). *Essentials of artificial intelligence*. CA: Morgan Kaufmann Publishers.
- Greer, J., & Mark, M. (2016). Evaluation methods for intelligent tutoring systems revisited. *International Journal of Artificial Intelligence in Education*, 26(1), 387-392.
- Grivokostopoulou, F., Perikos, I., & Hatzilygeroudis, I. (2017). An educational system for learning search algorithms and automatically assessing student performance. *International Journal of Artificial Intelligence in Education*, 27(1), 207-240.
- Hamet, P., & Tremblay, J. (2017). Artificial intelligence in medicine. *Metabolism Clinical and Experimental*, 69, 36-40.
- Hawking, S., Russell, S., Tegmark, M., & Wilczek, F. (2014, May 1). Stephen Hawking: 'Transcendence looks at the implications of artificial intelligence - but are we taking AI seriously enough?'. *The Independent*. Retrieved from <https://www.independent.co.uk/news/science/stephen-hawking-transcendence-looks-at-the-implications-of-artificial-intelligence-but-are-we-taking-9313474.html>
- Jiang, F., Jiang, Y., Zhi, H., Dong, Y., Li, H., Ma, S., . . . Wang, Y. (2017). Artificial intelligence in healthcare: Past, present and future. *Stroke and Vascular Neurology*, 2(4), 230-243.
- Kaplan, J. (2016). *Artificial intelligence: What everyone needs to know*. NY: Oxford University Press.
- King, R. D., Whelan, K. E., Jones, F. M., Reiser, P. G. K., Bryant, C. H., Muggleton, S. H., . . . Oliver, S. G. (2004). Functional genomic hypothesis generation and experimentation by a robot scientist. *Nature*, 427, 247. doi:10.1038/nature02236
- Kopec, D., Pileggi, C., Ungar, D., & Shetty, S. (2016). *Artificial intelligence and problem solving*. MA: Mercury Learning & Information.
- Korinek, A., & Stiglitz, J. E. (2017). *Artificial intelligence and its implications for income distribution and unemployment*. Retrieved from <https://www.nber.org/papers/w24174.pdf>
- Krittanawong, C., Zhang, H., Wang, Z., Aydar, M., & Kitai, T. (2017). Artificial intelligence in precision cardiovascular medicine. *Journal of The American College of Cardiology*, 69(21), 2657-2664.
- Kulkarni, P., & Joshi, P. (2015). *Artificial intelligence: Building intelligent systems*. Delhi: PHI Learning.
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33, 159-174.
- Leitão, P., Mařík, V., & Vrba, P. (2013). Past, present, and future of industrial agent applications. *IEEE Transactions on Industrial Informatics*, 9(4), 2360-2372.
- Li, B., Hou, B., Yu, W., Lu, X., & Yang, C. (2017). Applications of artificial intelligence in intelligent manufacturing: A review. *Frontiers of Information Technology & Electronic Engineering*, 18(1), 86-96.
- Liang, Y., & Chen, L. (2018). Analysis of current situation, typical characteristics and development trend of artificial intelligence education application. *China Electrofication Education*, 2018(3), 24-30.
- Lin, P. H., Wooders, A., Wang, J. T. Y., & Yuan, W. M. (2018). Artificial intelligence, the missing piece of online education? *IEEE Engineering Management Review*, 46(3), 25-28.
- Makridakis, S. (2017). The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms. *Futures*, 90, 46-60.
- Mannino, A., Althaus, D., Erhardt, J., Gloor, L., Hutter, A., & Metzinger, T. (2015). *Artificial intelligence: Opportunities and risks*. Retrieved from <https://ea-foundation.org/files/ai-opportunities-and-risks.pdf>
- McArthur, D., Lewis, M., & Bishary, M. (2005). The roles of artificial intelligence in education: Current progress and future prospects. *Journal of Educational Technology*, 1(4), 42-80.

- McClure, P. K. (2018). "You're fired," says the robot: The rise of automation in the workplace, technophobes, and fears of unemployment. *Social Science Computer Review*, 36(2), 139-156.
- McKee, G. T. (2002, May). *The development of Internet-based laboratory environments for teaching robotics and artificial intelligence*. Paper presented at the 2002 IEEE International Conference on Robotics & Automation, Washington, DC. Retrieved from <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1013639>
- Minsky, M. (2006). *The emotion machine: Commonsense thinking, artificial intelligence and the future of the human mind*. NY: Simon & Schuster Paperbacks.
- Mishra, R. B. (2011). *Artificial intelligence*. New Delhi: PHI Learning.
- Mohamed, H., & Lamia, M. (2018). Implementing flipped classroom that used an intelligent tutoring system into learning process. *Computers & Education*, 124, 62-76.
- Mohammed, P. S. & Watson, E. N. (2019). Towards inclusive education in the age of artificial intelligence: Perspectives, challenges, and opportunities. In J. Knox, Y. Wang, & M. Gallagher (Eds.), *Artificial intelligence and inclusive education* (pp. 17-37). Singapore: Springer.
- Mu, P. (2019). *Research on artificial intelligence education and its value orientation*. Paper presented at the 1st International Education Technology and Research Conference (IETRC 2019), China, Retrieved from https://webofproceedings.org/proceedings_series/ESSP/IETRC%202019/IETRC19165.pdf
- Müller, V. C. (2016). Editorial: Risks of artificial intelligence. In V. C. Müller (Ed.), *Risks of artificial intelligence* (pp. 1-8). FL: CRC Press.
- Nasir, S. (2018). *Is AI making humans lazy? Here's what UAE residents say* Retrieved from <https://www.khaleejtimes.com/nation/dubai/Is-AI-making-humans-lazy-Here-what-UAE-residents-say>
- Nilsson, N. J. (2010). *The quest for artificial intelligence: A history of ideas and achievements*. NY: Cambridge University Press.
- O'Leary, M. B. (2018). *Revolutionizing everyday products with artificial intelligence*. Retrieved from <http://news.mit.edu/2018/revolutionizing-everyday-products-with-artificial-intelligence-mit-meche-0601>
- Osoba, O. A., & Welsch, W. (2017). *An intelligence in our image: The risks of bias and errors in artificial intelligence*. CA: Rand Corporation.
- Page, J., Bain, M., & Mukhlis, F. (2018, August 24-27). *The risks of low level narrow artificial intelligence*. Paper presented at the 2018 IEEE International Conference on Intelligence and Safety for Robotics, Shenyang, China. Retrieved from <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8535903>
- Pannu, A. (2015). Artificial intelligence and its application in different areas. *Artificial Intelligence*, 4(10), 79-84.
- Parnas, D. L. (2017). The real risks of artificial intelligence. *Communications of the ACM*, 60(10), 27-31.
- Pfeifer, R., Iida, F., & Bongard, J. (2006). New robotics: Design principles for intelligent systems. *The MIT Press Journals*, 11(1-2), 99-120.
- Poola, I. (2017). How artificial intelligence in impacting real life everyday. *International Journal of Advance Research and Development*, 2(10), 96-100.
- Popenici, S. A., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, 12(1), 1-13.
- Porayska-Pomsta, K. (2016). AI as a methodology for supporting educational praxis and teacher metacognition. *International Journal of Artificial Intelligence in Education*, 26(2), 679-700.
- Qi, L. (2008, August 2-3). *Research on intelligent transportation system technologies and applications*. Paper presented at the 2008 Workshop on Power Electronics and Intelligent Transportation System, Guangzhou, China Retrieved from <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4634911>
- Qin, J., Liu, Y., & Grosvenor, R. (2016). A categorical framework of manufacturing for industry 4.0 and beyond. *Procedia Cirp*, 52, 173-178.
- Rahimi, Z., Litman, D., Correnti, R., Wang, E., & Matsumura, L. C. (2017). Assessing students' use of evidence and organization in response-to-text writing: Using natural language processing for rubric-based automated scoring. *International Journal of Artificial Intelligence in Education*, 27(4), 694-728.
- Ramesh, A. N., Kambhampati, C., Monson, J. R., & Drew, P. J. (2004). Artificial intelligence in medicine. *Annals of The Royal College of Surgeons of England*, 86(5), 334-338.

- Rattadilok, P., Roadknight, C., & Li, L. (2018, December). Teaching students about machine learning through a gamified approach. In *2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)* (pp. 1011-1015). IEEE.
- Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education. *International Journal of Artificial Intelligence in Education*, 26(2), 582-599.
- Roscoe, R. D., Walker, E. A., & Patchan, M. M. (2018). Facilitating peer tutoring and assessment in intelligent learning systems. In S. D. Craig (Ed.), *Tutoring and intelligent tutoring systems* (pp. 41-68). New York, NY: Nova Science Publishers, Inc.
- Russell, S., Hauert, S., Altman, R., & Veloso, M. (2015). Ethics of artificial intelligence. *Nature*, 521(7553), 415-416.
- Russell, S. J., & Norvig, P. (2010). *Artificial intelligence: A modern approach* (3rd ed.). NJ: Pearson.
- Santos, O. C. (2016). Training the body: The potential of AIED to support personalized motor skills learning. *International Journal of Artificial Intelligence in Education*, 26(2), 730-755.
- Schafer, J. B. (2004, April 16-17). *Hands-on artificial intelligence education using LEGO Mindstorms: Lessons learned*. Paper presented at the Midwest Instruction and Computing Symposium, University of Minnesota, Morris. Retrieved from http://faculty.chas.uni.edu/~schafer/publications/MICS_2004.pdf
- Scherer, M. U. (2015). Regulating artificial intelligence systems: Risks, challenges, competencies, and strategies. *Harvard Journal of Law & Technology*, 29(2), 354-398.
- Schofield, J. W., Evans-Rhodes, D., & Huber, B. R. (1990). Artificial intelligence in the classroom: The impact of a computer-based tutor on teachers and students. *Social Science Computer Review*, 8(1), 24-41.
- Self, J. (2016). The birth of IJAIED. *International Journal of Artificial Intelligence in Education*, 26(1), 4-12.
- Shukla, S. S., & Vijay, J. (2013). Applicability of artificial intelligence in different fields of life. *International Journal of Scientific Engineering and Research*, 1(1), 28-35.
- Skouby, K. E., & Lynggaard, P. (2014, November 27-29). *Smart home and smart city solutions enabled by 5G, IoT, AAI and CoT services*. Paper presented at the 2014 International Conference on Contemporary Computing and Informatics, Mysore, India. Retrieved from <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7019822>
- Sotala, K. (2010, October 4-6). *From mostly harmless to civilization-threatening: Pathways to dangerous artificial intelligences*. Paper presented at the ECAP10: VIII european conference on computing and philosophy, Munich. Retrieved from <https://intelligence.org/files/MostlyHarmless.pdf>
- Sotala, K. (2012). Advantages of artificial intelligences, uploads, and digital minds. *International Journal of Machine Consciousness*, 4(1), 275-291.
- Şen, Z. (2018). Significance of artificial intelligence in science and technology. *Journal of Intelligent Systems: Theory and Applications*, 1(1), 1-4.
- Turchin, A., & Denkenberger, D. (2018). Classification of global catastrophic risks connected with artificial intelligence. *AI & SOCIETY*, 1-17. doi:<https://doi.org/10.1007/s00146-018-0845-5>
- Turing, A. M. (1950). Computing machinery and intelligence. *Mind*, 49, 433-460.
- Verma, A., & Kumar, S. (2018, January 11-12). *Cognitive robotics in artificial intelligence*. Paper presented at the 2018 8th International Conference on Cloud Computing, Data Science & Engineering, India. Retrieved from <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8442725>
- Walker, E., & Ogan, A. (2016). We're in this together: Intentional design of social relationships with AIED systems. *International Journal of Artificial Intelligence in Education*, 26(2), 713-729.
- Warwick, K. (2012). *Artificial intelligence: The basics*. OX: Routledge.
- Xue, Q., & Li, F. (2018). Security risks and countermeasures in artificial intelligence education applications. *Journal of Distance Education*, 36(4), 88-94.
- Yoon, D. M., & Kim, K. J. (2015). Challenges and opportunities in game artificial intelligence education using Angry Birds. *IEEE Access*, 3, 793-804.
- Zabjek, A. (2018). *How artificial intelligence is reshaping our lives*. Retrieved from <https://phys.org/news/2018-04-artificial-intelligence-reshaping.html>
- Ziemke, T. (2001). The construction of 'reality' in the robot: Constructivist perspectives on situated artificial intelligence and adaptive robotics. *Foundations of Science*, 6(1-3), 163-233.