RESEARCH ON THE ATTITUDES OF HIGH SCHOOL STUDENTS FOR THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN EDUCATION

Vladislav Slavov[1], Kamelia Yotovska[2] and Asya Asenova[2]
[1]*Technical University of Sofia, Faculty of Automatics, 8 Kliment Ohridski blvd., Sofia, Bulgaria*
[2]*Sofia University "St. Kliment Ohridski", Faculty of Biology, 1164 Sofia, 8 Dragan Tsankov Blvd, Bulgaria*

ABSTRACT

Artificial intelligence (AI) technology is already challenging a variety of societal areas, including education. It is transforming education to data driven. AI-enhanced technologies in education (abbreviated AIinED) will have a significant role in changing the teaching and learning methods, as well as impacting the behavior and organization of the educational system. It is considered that the AIinED will change the paradigm of education in the future. And yet, AIinED is still more in the lab than being practically implemented in education and training. We consider three major players in the implementation of AIinED – students, teachers, and society. All three can benefit from AIinED and at the same time be a potential target of the risks that AIinED brings along with its promises – may be one of the reasons why main stakeholders (UNESCO, EC etc.) have been developing guidelines and recommendations for ethical use of AIinED. The literature shows that the center of AIinED system will be the student, but we consider the student not only as a target but also as a source of ideas for AIinED development with the potential to accelerate the process of adoption of AIinED. Hence, one of the big questions should be how the students foresee the role of artificial intelligence in education. To initiate such a question, though, it is important to know the level of understanding among the students about what and where artificial intelligence is. There are three major aspects that AIinED must be considered accordingly – technological, lawful, and ethical.
This paper presents the results of a study on high school students' understanding of AI technologies and their attitudes to their application in education. A survey was used as a tool to elaborate. The conceptual model of the research was developed on the basis of established theories linking attitudes to behavior and the acceptance of artificial intelligence technologies in education. Each element of this concept is explored with a different part of the questionnaire, which contains a total of 12 questions (some of which with sub-questions). The survey was elaborated online within October-November 2021. A link to the questionnaire in Bulgarian was provided to 178 high and vocational high schools educating students aged 14-19 (grades 8-12) across the country (Bulgaria). 766 students submitted their replies through the online survey form.
Descriptive statistics and analysis of the frequencies of the respondents' opinions were made based on the data. The results show that the students participating in the survey:(a) understand the essence of AI technologies; (b) they are convinced of the usefulness of the application of artificial intelligence technologies in their daily activities and strongly believe that it improves it; (c) are not entirely clear about the benefits of artificial intelligence enhanced technologies in learning and teaching; (d) do not demonstrate sufficient knowledge and understanding of the necessity of ethical use of AI technologies in education;
The latter reduces the positive influence of the perceived usefulness of artificial intelligence technologies in the learning process on students' attitudes.

KEYWORDS

Artificial Intelligence Technologies, Artificial Intelligence in Education, Online Survey, Ethics in AIinED

1. INTRODUCTION

The implementation and later adoption of new technologies has always been a key to the future progress in all areas of our lives. The questions about the risks related to that have always gone along with the opportunities. Even when in the early 80s of the last century, computers called by Steven Jobs “the bicycle of the 20th century” (Jobs, July-August 1981) became part of many people’s lives, the questions on the fears and threats were raised (Burnham, 1983). And if the computer was the bicycle of the 20th century, artificial

intelligence turns to become its engine (Stephen Lucci, 2016). The risks of using AI raised awareness in 2014 after the release of Nick Bostrom's Superintelligence (Bostrom, 2014). Nowadays, managing the risks of implementation of AI and ethical use of AI are important steps towards the integration of AI in different areas (Benjamin Cheatham, Kia Javanmardian, and Hamid Samandari, 2019), (Galaz *et al.*, 2021).

1.1 Artificial Intelligence

In psychology, intelligence is a generalized concept of a person's thinking abilities, i.e. his ability to understand, to be able to abstract, to solve problems applying his knowledge, and to use language (Gardner, 2010), (Gardner, 2012).

Artificial intelligence (AI) is any result of the work of a computer, which, if it was the product of human activity, would be considered reasonable (Legg and Hutter, 2007). This is enhanced by (Chen, Chen and Lin, 2020) saying that AI is a field of study and the resulting innovations and developments that have culminated in computers, machines, and other artifacts having human-like intelligence characterized by cognitive abilities, learning, adaptability, and decision-making capabilities, adding that AI is the culmination of computers, computer-related technologies, machines, and information communication technology innovations and developments, giving computers the ability to perform near or human-like functions.

Artificial intelligence is a wide-ranging tool that enables people to rethink how we integrate information, analyze data, and use the resulting insights to improve decision-making – and already it is transforming every walk of life (West, 2018; Ross *et al.*, 2022).

1.2 Artificial Intelligence Technologies in Education

There is no doubt that AI is the inevitable future of a lot of industrial sectors but also the future of schools, universities, training centers (Dai and Ke, 2022) bringing them to the fourth education revolution (Seldon and Abidoye, 2018). If we can compare the implementation of AI in education with the human life cycle, the AIinED is still an embryo. AIinED will reshape not only the way of teaching and learning but will significantly impact the organization of educational institutions and systems.

There is a slow adoption rate of technologies in education (Chen X., Xie H., Zou D., Hwang G.-J., 2020), because of mismatch between real needs and supply. The lack of use of technologies is affecting every level of education - from primary schools to universities. There is a need for building the evidence base for more effective learning with technology. This will go hand in hand with tools and processes for collecting, storing, exploring, and reasoning on large-scale educational data. That “big data” will be from students’ technology supported learning activities, transforming the data into information, and producing, recommending actions aimed at improving learning outcomes.

Most of the strategic documents and regarding AIinED issued by EU and UNESCO by October 2021, (Duggan, 2020; EUROPEAN COMMISSION, 2021) are focused on the benefits that artificial intelligence will bring to the students. They put the student as the center of the AIinED system, which is inevitable. AIinED though will influence not only the students but also the teachers and should contribute to the wellbeing of the society. The development of successful policies for AIinED the learners, educators and society should be considered as a whole, and the point of view and the benefits for each of these groups should be accounted for.

AIinED will enhance the learning for not only the students who are part of the formal education, but also students from all ages through vocational education and life-long learning programs (van der Vlies R, 2010; Roll and Wylie, 2016). Students’ performance is the most significant source of data for AIinED but it will not be correct that data such as grade scores, results from school and state exams, attendance and punctuality records, school reports, comparative scores with regard to peers or classmates is enough as quality, quantity and type.

Although governments will be responsible for the implementation of AIinED, there are three major role players and users in that process: students, teachers, society (not only parents). All their opinions must matter, but also it can be a valuable source of ideas and can reveal the actual expectations to AIinED.

1.3 Schooling and Artificial Intelligence Technologies

According to B. Marr, AI will contribute to the acquisition of better school and university education (Marr, 2018). The effect of so-called smart classrooms and academic learning labs where AI is applied is already being seen. It supports teaching, enhances the individual approach by responding to the needs of learners.

These new methods help teachers and university professors to concentrate on understanding and adapting new knowledge and skills.

The ability for a machine to perform intelligent tasks that are generally assigned to the human mind, and override the problem-solving of information processing, prediction, and choosing the best and most effective action to achieve a certain goal is something that is already a reality.

More and more innovations and best practices are being applied in the direction of how artificial intelligence can change education such as systems, chatbots, semantic analysis, natural language processing, automatic scoring and feedback, audio games and vision-based robotics, problem-solving (Kahn and Winters, 2017).

Platforms have been created that, based on feedback questionnaires, can accurately specify the educational levels, and needs of those using them (Content Science, 2017; Century, 2019).

Such type of platforms can become universal classrooms or learning subjects to be used by everyone, but at a low cost or for free. This will contribute to equality of access (even children who do not know languages can use the functions of an instant translator) and will strengthen the role of Internet technologies in the learning process (Todorova, 2019).

Implementation of AI-based applications can help solve the problems of low quality of education and its inaccessibility in remote areas, and also improve the existing education systems (Ivanova et al., 2020).

According to the EC Communication "Artificial Intelligence for Europe" there are three main challenges facing the EU which underline the fundamental role of education and training, the responsibility of which lies with the Member States. The first challenge is to prepare society as a whole. It means helping all Europeans to develop basic digital skills, as well as skills that are complementary in nature and cannot be replaced by any machine - such as critical thinking, creativity, management ability. Second, efforts should focus on helping people in those jobs that are likely to undergo the greatest transformation or disappear as a result of automation, robotics and AI. Third, more AI specialists should be trained based on long-standing academic traditions, to create a suitable environment for them to work in the EU and, if possible, to attract talents from abroad. Hence, the modernization of education at all levels should become a major national priority (for Bulgaria), and in the field of scientific research, artificial intelligence should become one of the priority areas in information and communication technologies.

In order for the education system in Bulgaria to respond to the challenge of developing knowledge and skills necessary for work in the field and AI, as well as for work in an environment with AI, these priority directions for development in the education system of Bulgaria are enshrined in the Law on Preschool and school education (2016), the Law on Higher Education and other normative acts of the Ministry of Education and Science, the proposals of the Ministry of Education, Culture and Science contained in the document "Artificial Intelligence in Education and Science" (Ministry of Education and Science of Bulgaria, 2020).

The article presents the results of a study on Bulgarian students' understanding of artificial intelligence and their attitudes towards its application in the learning process.

2. METHODOLOGY

The research questions are focused on the attitudes of the relevant age students towards AI. The research was conducted through a survey. The questionnaire was self-constructed for the purposes of the study. The literature lacks a similar off-the-shelf instrument whose reliability and validity have been established. The conceptual model of the study was developed based on established theories relating attitudes to behavior and the adoption of artificial intelligence in education. Each element of this concept is explored with a different part of the questionnaire, which contains a total of 12 questions (some with sub-questions). The survey was conducted online in the period October-November 2021. A link to the questionnaire in Bulgarian was provided to 178 high and vocational high schools educating students aged 14-19 (grades 8-12) across the country (Bulgaria). 766 students submitted their replies through the online survey form. The total number of

students enrolled in high schools and vocational high schools in Bulgaria in the 2021/2022 academic year was 255 342. Such, the results confidence level is 95 % results with error margins within 3.5 % (Whitley and Ball, 2002).

The main part of the sample consists of students aged 15-18 years (Table 1). The largest relative share is respondents aged 16 (25.5%), followed by almost the same share of 15-year-olds (24.8%). The surveyed students aged 17 have a relative share of 20.1% (154 students), and 18-year-olds – 16.1% (124 students).

The share of students who completed the survey studying in vocational high schools is significant - 75.2%, and 21.9% are high school students.

It is noticeable that the sex of the students is 62 % to 38 % for the male students. This result is not surprising considering the relative number of male and female students in the vocational schools in Bulgaria, according to statistics. The National Statistical Institute of Bulgaria gives 60 % of male students towards 40% of females in Bulgarian vocational schools in 2021/2022 (Information system "Infostat" of the National Statistics Institute of Bulgaria).

Table 1. Sociodemographic characteristics in the sample (N= 766, ε = 3.5 %, CL= 95 %)

Variables	n	% of the sample
Age		
14 years	74	9,7
15 years	190	24,8
16 years	195	25,5
17 years	154	20,1
18 years	124	16,2
19 years	15	2
Other	14	1,7
Type of school		
High School	168	21,9
Vocational high school	576	75,2
Other	22	2,9
Sex		
Male	475	62
Female	281	38
Total	**56**	**100**

Descriptive statistics and frequency analysis of respondents' opinions were made on the data. Some questions were open to more than one answer.

3. RESULTS AND DISCUSSIONS

3.1 Understanding AI Technologies

The center of the survey is the students' understanding of the nature of artificial intelligence as the students were asked "What is AI?" (Figure 1). The relative share of respondents who associate artificial intelligence with the ability of a machine/device to demonstrate human-like abilities is the largest (74.41%). Students understand that artificial intelligence occurs when a machine thinks, plans, creates, chooses, learns. The relative share of those who answered that artificial intelligence is receiving data from technical systems that register changes in parameters in their environment, process them and perform actions related to achieving a specific goal can be accepted as relatively high - 62.27%. There are fewer students (28.08%) who are recognized as artificial intelligence machines or software capable of adapting their behavior (to some extent) by analyzing the results of previous actions.

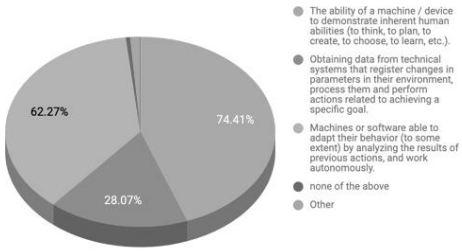

Figure 1. What is artificial intelligence?

From a research point of view, interesting are the answers to the question about examples of artificial intelligence enhanced technologies (Figure 2). Virtual assistants are the most recognizable example of artificial intelligence - 551 of the respondents with a relative share of 71.93%, followed by autonomous cars (cars without a driver) - selected by 547 students with a relative share of 71.41% and almost the same result for robots (selected by 543 the student with a relative share of 70.89%). Speech and face recognition systems are also a recognizable example (chosen by 418 students, with a relative share of 54.57%). The relative share of telephone assistant respondents is smaller (291 students with a relative share 37.99%) and online search engines (235 students with a relative share of 30.68%).

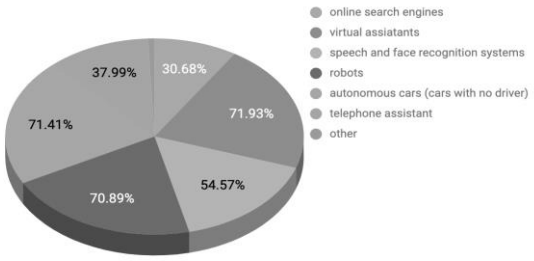

Figure 2. Examples of artificial intelligence

For the students, the most recognizable field in which artificial intelligence is used is digital personal assistants (74.93%). Smartphones offer virtual assistants that answer questions, make recommendations, and organize daily routines (eg Siri, Alexa, etc.). This result is most likely related to the fact that in Bulgaria, 71.8% of individuals aged between 16 and 74 (according to National Statistical Institute data) use mobile phones or smartphones to access the Internet. These devices are affordable and widely used.

In second place in terms of recognition are smart homes (67.62%). Respondents know this application of artificial intelligence from the curriculum content of biology and health education and geography and economics. In this age group, part of the training is related to working on "smart house" projects, with the aim of saving energy. A smart house is also recognized as a dwelling in which devices are installed that are connected to each other and this enables remote monitoring and control of appliances and systems such as locks, video surveillance, heating, etc. – a reality in many homes (Figure 3).

As applications of artificial intelligence, students also recognize smart cities and infrastructure (respondents with a relative share of 54.70%), automatic sensor systems that identify potentially dangerous situations (respondents with a relative share of 53.00%), as well as "automatic" translations (respondents with a relative share of 52.61%). The recognition of these fields of application of AI is largely associated with projects implemented in large cities to improve mobility and reduce congestion through traffic regulation. Popular among students are the use of automatic sensors such as thermal cameras (which recognize people with an elevated temperature), sensors in cars when the distance is reduced, for warnings in case of flood, tsunami, etc.

Less than half of respondents (40.99%) recognize the application of AI when using online search. This result is interesting given the fact that students use search engines on a daily basis. Consequently, most students do not appreciate the role of AI in search engines' processing of large volumes of data to provide increasingly precise and personalized search results. The situation is similar with the application of AI in combating disinformation (40.60%) and online shopping and advertising (40.34%). Among the likely reasons for these results is students' lack of awareness of how to identify "fake" news. It shows the need for app promotion campaigns that analyze social media data and assess the authority of online sources. The surveyed students are aged 14-18 years, which explains the lower results regarding the application of AI in providing personalized purchase suggestions based on products that have been searched for or purchased in the past. Students in this age group in Bulgaria rarely shop online (due to limited access to eligible payment methods), and the lack of this experience is largely associated with the results obtained.

The application of AI in healthcare is relatively recognizable - 298 respondents with a relative share of 38.90% are informed about the possibilities of analyzing large volumes of data and discovering patterns in order to improve the diagnosis of diseases. It is likely that the students' awareness of the pandemic crisis related to the spread of COVID-19 and the mathematical models used in relation to situation analysis and future forecasts have influenced this result in a positive direction.

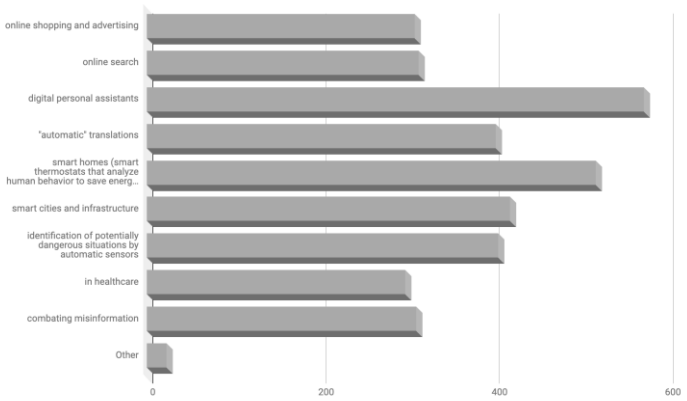

Figure 3. In which areas is artificial intelligence technologies is being used?

3.2 AI Technologies in Teaching and Learning

The research seeks to explore students' views on how artificial intelligence can change education. In this regard, two open questions were formulated in the survey - the place of AIinED n the teaching process and in relation to learning.

The question of how AI technologies could be used in teaching is considered in the following directions - how it could support it and what functions robots/machines could perform in class to support the work of the teacher.

The trends in students' responses are in several aspects (directions). The first of these is artificial intelligence as a teaching assistant. In this aspect, the vision is to offer individual training programs developed with the help of artificial intelligence. Thus, to prepare the student to follow an algorithm instead of a teacher.

Teachers make a lot of effort to help each student, taking into account his individual characteristics. This is especially difficult in classes of thirty or more students. Students perform the same tasks, use the same textbooks, regardless of the success rate of each student in each subject. One part of the class fails to learn the material, while the other learns it quicker and loses interest. Respondents see an opportunity for AI to tackle this problem. What's more, it now helps teachers personalize the learning process. Students are given the opportunity to familiarize themselves with the new material at a pace convenient for them, using special applications. Thus, these applications become assistant teachers and help them realize their maximum potential.

The second general aspect in the opinion of the respondents, regarding the place of artificial intelligence in teaching, is related to the capabilities of AI to analyze the behavior of students. According to some respondents, AI-connected cameras can not only conduct automatic attendance monitoring, but also analyze student behavior. These systems are able to recognize and evaluate how students react to different topics and tasks, how well they cooperate, whether they work alone, or whether they get bored. This would give the teacher information to help him adapt his teaching, depending on the particular situation.

Some typical answers from the students surveyed:

"AI can find easier to understand and curated information, built incrementally by AI throughout the learning process, to be delivered to students in a fast and convenient way."

"They can be used to conduct virtual experiments..."

"AI can make it easier to create and review tests, saving teacher time and fatigue."

"... to increase children's interest and motivation. Of course, artificial intelligence cannot replace the teacher, but it can help him."

AI is unlikely to ever fully replace teacher assessment, but it is increasingly entering the process. In the future, AI-enhanced technologies will fully verify written papers and exam tasks with the help of establishing metrics and benchmarks, excluding bias and favoring certain students.

A significant part of those who answered the question about the place of artificial intelligence in teaching (with a relative share of 54.70%) are not convinced of the usefulness of artificial intelligence in teaching. They prefer the traditional way of teaching, contact with the teacher "face to face" and do not approve of the use of AI in the teaching process. The likely reasons for this result are due to the extended periods of distance learning in an electronic environment during the last two academic years due to the pandemic caused by COVID-19.

The second open-ended question from the survey regarding students' opinion on the connection between artificial intelligence and education is centered on learning (How could artificial intelligence be used in the learning process?). The trends in the students' answers are in the following aspects: through the application of AI, everyone can progress according to their abilities by personalizing the learning content according to the individual achievements of the students; artificial intelligence can be used to self-check homework; to be able to automate and personalize the assessment of knowledge (it is a common practice in schools to assess all students with same standardized tests); detect gaps in knowledge and inform the individual student which part of the learning content to pay attention to again.

Among the students' answers, the following are of interest:

"Voice assistants can tailor what material to keyword search based on a given issue or topic. Now, when doing projects through search engines, a lot of information comes out that we don't need."

"...tests tailored to the individual capabilities and level of each student can easily be created. It's not good to give struggling students and excellent students the same tests."

"...finding out what I haven't learned well and helping me to learn and understand it well."

Students with a relative share of 37.99% are not convinced of the usefulness of artificial intelligence in the learning process.

The respondents gave interesting answers to the question of how they imagine a "smart" classroom. Most of the answers are in the direction of equipment, thanks to which the educational process becomes completely digital, and notebooks and textbooks are replaced by laptops, smartphones, and tablets.

Almost half of the answers are related to energy-saving solutions. Among them are: adjustable light - "controlling the brightness of the lamps in the classrooms so that the light is always suitable for learning for those who study at later hours"; "heat control of radiators and air conditioners in the classroom to save energy" so that "the temperature is constant and does not affect the learning process"; "smart windows that open automatically when it gets too hot or during breaks", a "smart" voice assistant to help with the learning process, etc.

3.3 Attitude to the Risks and Ethical use of AI Technologies

Respondents formulate risks of using artificial intelligence in education (open question from the survey). The answers formulated by the students are related to the experience of emotions in the learning process and "real student-teacher communication with corresponding shared feelings" ("modern robots can simulate some feelings of people, but not feel them"). Other potential risks are related to the danger of the "gradual

disappearance of the teaching profession", the sudden interruption of the learning process ("any machine/robot can break down at any moment", "most students will not understand the opportunity they are given, and they will try to trick. In general, the surveyed students realize that as a result of improper use of artificial intelligence technologies, people can lose important skills and knowledge, and professions can disappear. There is a prevailing view that despite the possibility that technology can demonstrate human-like capabilities, it does not mean that it can completely replace humans.

To an open question from the survey why it is necessary to regulate the use of artificial intelligence technologies by law, respondents with a relative share of 52.61% did not give a specific answer (they did not answer anything, or they answered with "I don't know", "I have no idea"). This can be considered as a red flag, alarming responsible policymakers and authorities for the lack of understanding among the young people regarding the ethical use of AI.

The fact that AI-based applications can collect and analyze information about academic performance, reasons for leaving school, teachers' professional habits and other indicators. In this way, the probability of students dropping out of school can be predicted, and appropriate measures can be taken to prevent it.

Of course, disputes about the improper use of these data and technical means are inevitable here (Legg and Hutter, 2007), (van der Vlies R, 2010). The absence of a corresponding legal framework also heightens public anxiety about such systems. It is assumed that the relevant legal regulation will be prepared in a timely manner. For example, it is expected in September 2022 the European Commission to publish “Ethical guidelines on artificial intelligence and data in education and training based on the Ethics Guidelines for Trustworthy Artificial Intelligence” (Commission expert group on artificial intelligence (ai) and data in education and training (E03774), 2021).

Figure 4 represents the results of the question of how important the ethical use of artificial intelligence technologies in education is. It is noteworthy that students find it difficult to assess the importance of this problem - 294 of the respondents (with a relative share of 39 %) do not have an opinion on the issue, and 128 (with a relative share of 16.1 %) think that it is not important. These results incline to more uncertainty and can be interpreted as insufficient knowledge and understanding among the students on application of ethical principle when using AI. This is another signal to how important the awareness raising is in ethical use of AI in education among all the involved parties - teachers, students, and society.

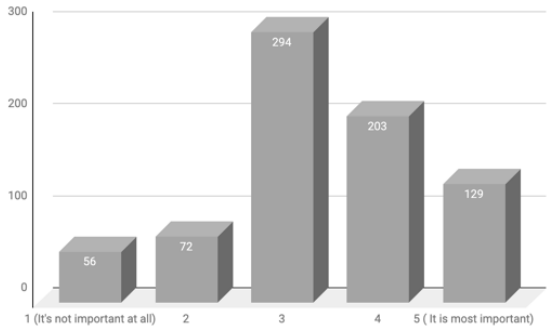

Figure 4. Importance of ethics in using AI technologies in education

The approach to the use of artificial intelligence technologies in education must be based on protecting fundamental European principles and values, to be controlled by the person - human on the loop but not necessarily in, to respect the principles of transparency and responsibility. Practical guidelines are needed for the use of artificial intelligence technologies in education. Because new technologies and artificial intelligence cannot and should not replace the teacher, but AI can allow the educational process to be more individualized, it can also allow education to be very interactive.

4. CONCLUSIONS

The results of the survey show that the students who participate in the survey: (a) correctly understand the essence of artificial intelligence; (b) they are convinced of the usefulness of the application of artificial intelligence technologies in their daily activities and strongly believe that it improves them; (c) are not entirely clear about the utility of artificial intelligence in learning and teaching; (d) do not show understanding of the ethical use of AI in education. The latter reduces the positive influence of the perceived usefulness of artificial intelligence in the learning process on student attitudes.

The results can contribute to the research trends in AI technologies in and for education. They raise the issue on whether the students are ready to be part of education enhanced by AI referring to how important ethics will be in the process. The results can be used as a reference point for future research in other countries, but one thing must be admitted: raising awareness on ethical use of AI technologies among students must begin.

Artificial intelligence has great potential to transform education and training for students, teachers and school staff. It could help reduce early school-leaving, compensate for learning difficulties and support teachers with differentiated or individualized learning through language learning apps, text-to-speech generators, learner mentors and more.

Different applications and software solutions will help, on the one hand, to adapt the learning process to the needs of the individual student, on the other hand, to help those children who have special needs or to reduce dropping out of school.

This is a long process that has begun. With each successive step, finding the balance between artificial intelligence learning and preserving natural social relationships is closer.

What is needed are not ready-made solutions, but a comprehensive vision for the development of education supported by AI technologies and a personal approach to each institution. It is in this way that AI can make education better, cheaper and more accessible.

It is necessary for policymakers to work in the direction of popularizing the benefits of the application of AI in the learning process among learners and teachers. A legislative framework for legally regulating the use of artificial intelligence technologies, including the ethical use of artificial intelligence in education, would be an appropriate act.

ACKNOWLEDGEMENTS

We are expressing our gratitude to all Bulgarian students who participated in that survey and gave their honest opinions. We highly appreciate the support of all Bulgarian teachers and school principals.

The authors would like to thank the Research and Development Sector at the Technical University of Sofia for the financial support.

REFERENCES

Artificial Intelligence for Europe (2018). Available at: https://ec.europa.eu/transparency/documents-register/detail?ref=COM(2018)237&lang=en (Accessed: October 3, 2022).

Benjamin Cheatham, Kia Javanmardian, and Hamid Samandari (2019) *Confronting the risks of artificial intelligence*, *McKinsey Quarterly*. Available at: https://www.mckinsey.com/capabilities/quantumblack/how-we-help-clients (Accessed: February 10, 2022).

Bostrom, N. (2014) *Superintelligence: Paths, Dangers, Strategies*. London, England: Oxford University Press.

Burnham, D. (1983) *The rise of the computer state*

Cannarsa, M. (2021) "Ethics guidelines for trustworthy AI," in *The Cambridge Handbook of Lawyering in the Digital Age*. Cambridge University Press, pp. 283–297.

Century (2019) *Century* Available at: https://www.century.tech/ (Accessed: October 3, 2022).

Chen X., Xie H., Zou D., Hwang G.-J. (2020) "Application and theory gaps during the rise of Artificial Intelligence in Education," *Computers and Education: Artificial Intelligence*, 1. doi: j.caeai.2020.100002.

Chen, L., Chen, P. and Lin, Z. (2020) “Artificial intelligence in education: A review,” *IEEE access: practical innovations, open solutions*, 8, pp. 75264–75278. doi: 10.1109/access.2020.2988510

Commission expert group on artificial intelligence (ai) and data in education and training (E03774) (2021) *Europa.eu*. Available at: https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?do=groupDetail.groupDetail&groupID=3774 (Accessed: October 3, 2022).

Content Science (2017) *Content technology fact sheet*, *Content Science Review*. Available at: https://review.content-science.com/content-technology-fact-sheet/ (Accessed: October 3, 2022).

Dai, C.-P. and Ke, F. (2022) “Educational applications of artificial intelligence in simulation-based learning: A systematic mapping review,” *Computers and Education: Artificial Intelligence*, 3(100087), p. 100087. doi: 10.1016/j.caeai.2022.100087.

Duggan, S. (2020) *AI in Education: Change at the Speed of Learning –, UNESCO IITE*. Available at: https://iite.unesco.org/publications/ai-in-education-change-at-the-speed-of-learning/ (Accessed: October 3, 2022).

European commission (2021) *regulation of the european parliament and of the council laying down harmonised rules on artificial intelligence (artificial intelligence act) and amending certain union legislative acts*. Available at: https://eur-lex.europa.eu/resource.html?uri=cellar:e0649735-a372-11eb-9585-01aa75ed71a1.0001.02/DOC_1&format=PDF.

Galaz, V. *et al.* (2021) “Artificial intelligence, systemic risks, and sustainability,” *Technology in society*, 67(101741), p. 101741. doi: 10.1016/j.techsoc.2021.101741

Gardner, H., (2010) Multiple intelligences. *New York.-1993*.

Gardner, H., (2012) The theory of multiple intelligences. *Early professional development for teachers*, *133.*, ISBN 1-8536-792-8

Information system “Infostat” of the National Statistics Institute of Bulgaria Nsi.bg. Available at: https://infostat.nsi.bg/infostat/pages/module.jsf?x_2=140 (Accessed: October 3, 2022).

Ivanova, K. *et al.* (2020) *Artificial Intelligence in and for Education in Bulgaria-Measures for Achievement Reliable Intelligent Growth*.

Jobs, S. (July-August 1981) “When We Invented the Personal Computer…,” *Computers and People*.

Kahn, K. and Winters, N. (2017) “Child-friendly programming interfaces to AI cloud services,” in *Data Driven Approaches in Digital Education*. Cham: Springer International Publishing, pp. 566–570.

Legg, S. and Hutter, M. (2007) “A collection of definitions of intelligence,” *Frontiers in Artificial Intelligence and applications*. doi: 10.48550/ARXIV.0706.3639

Marr, B. (2018) *How is AI used in education--Real world examples of today and a peek into the future*. Forbes Magazine.

Ministry of Education and Science of Bulgaria (2020) *Artificial intelligence in education and science (Ideas for the development and use of AI in education and science in the Republic of Bulgaria)*. Available at: https://www.mon.bg/upload/23352/MON+AI+Doc .pdf.

Roll, I. and Wylie, R. (2016) “Evolution and revolution in artificial intelligence in education,” *International journal of artificial intelligence in education*, 26(2), pp. 582–599. doi: 10.1007/s40593-016-0110-3.

Ross, J. N. *et al.* (2022) “The power behind the screen: Educating competent technology users in the age of digitized inequality,” *International journal of educational research*, 115(102014), p. 102014. doi: 10.1016/j.ijer.2022.102014.

Seldon, A. and Abidoye, O. (2018) *The Fourth Education Revolution: Will Artificial Intelligence liberate or infantilise humanity?* Buckingham, England: University of Buckingham Press.

Stephen Lucci, D. K. (2016) *Artificial Intelligence in the 21st Century*. Dulles Town Center, VA: Mercury Learning & Information.

Todorova, M. (2019) *Artificial Intelligence. A brief history of development and ethical aspects of the subject*. Sofia: East-West.

Vincent-Lancrin, S. and R. van der Vlies (2020), "Trustworthy artificial intelligence (AI) in education: Promises and challenges", *OECD Education Working Papers*, No. 218, OECD Publishing, Paris, https://doi.org/10.1787/a6c90fa9-en.

West, D. M. (2018) *How artificial intelligence is transforming the world*

Whitley, E. and Ball, J. (2002) “Statistics review 4: Sample size calculations,” *Critical care (London, England)*, 6(4), p. 335. doi: 10.1186/cc1521.