Education in the Age of Artificial Intelligence

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Abstract **– The age of artificial intelligence (AI) is just around the corner. This article presents the AI-based technologies that represent a significant change for the learning and teaching process. The article describes the potential of personalised learning, automated assessment, chatbots, predictive models, intelligent robots, and virtual and augmented reality for education, by reviewing scientific literature. Nowadays, knowledge of these technologies is essential for teachers. In this article we conducted a qualitative survey involving teachers. The aim of our survey is to assess the perceptions of educators about the use of AI in education. Our results show that educators are open to these technologies regardless of generation and discipline. The study summarizes the appropriate use of these technologies, the role of teachers, their attention to students and their active communication, as only this can lead to effective education in the age of artificial intelligence.**

Keywords **– Artificial intelligence, education, artificial intelligence enchanted learning, future education.**

1. Introduction

Artificial intelligence (AI) and other AI-enabled technologies have been developed and their popularity and innovation are gaining traction today to facilitate human life and contribute to human progress.

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In our fast-paced world, ideas and persistence are synonymous with success. There is a need for concise, short presentations and plenty of practical experience. The need to use time as concisely and quickly as possible has become so important that today, especially the younger generation, regrets the time needed to present the history of ideas or theory that is essential for understanding [1]. This dynamic way of life is something we experience in everyday life and it is also true for education. Students are impatient, often bored with explanations in class, and this is also true for home learning, as they do not like excessively long tutorial videos. This is largely due to the fact that people are used to fast, experiential and generally high-quality content, and video content, in line with the trend today of TikTok videos, delivers a large amount of impulses in a short period of time, losing the motivation to consume longer - more detailed content.

Our study explores the role of AI in education. The aim is to discuss motivational options that in this accelerated world are a good option for both student learning and teacher teaching. In addition to international research findings, the paper presents the results of our own survey. The survey was carried out among teachers from different institutions to investigate the potential of and openness to AI. In the content of our work, we will first briefly introduce artificial intelligence in Section 2, and then in Section 3 we will present its potential in education, supported by the results of international research. Section 4 presents the research methods. Section 5 presents the results of the survey. Finally, in Section 6, conclusions are drawn from the results and discussed.

2. Artificial Intelligence

We would like to start this section with an interesting train of thought, focusing on the very concept of AI. Instead of artificial intelligence, some scientists prefer the term augmented intelligence. This designation, however, continues to perceive the human brain as the source of actual intelligence. However, it also describes computers and computer programs with intelligent functions that people can use to develop or extend their intellectual capabilities [2].

Therefore, these computer systems are used to perform tasks that are more difficult for humans, including performing intelligent tasks that are linked to the human mind, which can be interpreted in their final form as computer programs. The idea that machines have the same properties as human intelligence. We now live in a world where we cannot tell whether the person we are communicating with is a real person or a virtual device - think of chatbots, which can even be used in education. A concrete example is ChatGPT, one of today's leading artificial intelligence systems, which also has its own potential and threats for education [3]. Indeed, these technological developments demonstrate that we are witnessing the development of deep learning in science [4]. AI can be understood as intelligent software and is found in this form in most solutions. However, it is task-dependent which algorithms to use when building an AI. Thoughtful research and consideration will help us choose the best way to solve a given problem. To mention a few of these options, Tajti's study [5] presents a valuable source:

- semantic web
- graph search algorithms
- decision tree
- fuzzy systems
- intelligent agents
- evolutionary algorithm
- neural networks

3. Artificial Intelligence in Education

There are many ideas and researches on how AI can be used in education, most of which have already produced demonstrable results. In terms of the potential of today's technologies, we should strive to extend the reach of AI to these different technologies, including the handheld devices that students use every day (smartphones and tablets), wearable devices and robotics [6], [7]. The education system focuses on the product to the process and goes beyond knowledge to self-management, cooperation and motivation. This means that the primary role of the teacher is no longer to have all the knowledge and to present and transfer this knowledge to the learners in the form of teaching materials. Instead, their role is to support students in becoming independent and collaborative thinkers. Self-reliance in the digital age is essential, and this includes the ability to search for, find and use information appropriately.

In the following, we will present AI-based technologies that will be the subject of a later section in our survey.

3.1. Personalised Learning

In some ways, the traditional educational system limits personalised learning. This is mainly because, if we are talking about ordinary students who do not have any learning disabilities, and there is no other expectation, they have to learn the same material in one lesson. Learning from a textbook, they have to do the same tasks in the same order. It is natural that in larger groups, the teacher does not have the possibility to come up with a unique curriculum for everyone. Many up-to-date neuroscience studies have shown that each brain is "uniquely wired" and therefore "learns differently". The educational potential of artificial intelligence thus offers great opportunities for implementing such a personalised learning system [8]. E-learning and Information and Communication Technologies (ICT)-based education and training are becoming increasingly common. Several research studies confirm that personalisation in education is becoming a target for e-learning [9]. In modern e-learning, there are several trends that enable adaptive e-learning in a digital environment. These include the large amount of learning material on the Internet and the possibilities to decompose it, and the high degree of data correlation. Adaptive learning is one of the most promising uses of AI in education. Adaptive learning is a learning model that takes into account the individual needs of the learner to design individual learning paths that will increase the learner's level of knowledge in the most optimal way [10]. Using artificial intelligence-based approaches, such as learner models, pedagogical models and learning domain models, we can create more personalised, inclusive and therefore more effective learning environments [11], [12]. Adaptive learning systems appeared in the 1990s, when the Internet started to develop. In the United States researchers were inspired by intelligent tutoring system [13]. Brusilovsky *et al.* collected practical information from learners to analyse and then develop a personalised user model of learning ability and cognitive level [14]. At the time, learners' learning level was only separated into good, average, and poor groups according to their learning level. Thus, the learning content and learning pathway was matched to each type of student. This is a very rough personalised education, with a similar concept to classroom teaching. An adaptive learning system adapts to the needs and learning styles of learners and implements differentiated or personalised learning. Then it modifies the learning model according to the learning outcomes [15], [16]. In previous research we have outlined the design and yield of a possible intelligent tutoring software [17].

Following the software development, we are currently in the pilot phase, where we also try to synchronously guide the student on the knowledge path and asynchronously assist the teacher in producing personalised learning materials.

3.2. Automated Assessment Systems

Nowadays, thanks to computers and intelligent systems, paper-based tests and their revision have been replaced by a variety of faster and more convenient solutions. Tests do not need to be distributed to students in printed form (which is another environmental positive for AI) but can be made available to students through different platforms. The inclusion of intelligent systems in the assessment process does not only make it easier to produce, reproduce and access tests, but also automates the assessment process. Such a system allows the completion of a test from a random bank of questions at any stage of a marked day but can limit the number of attempts and the maximum time allowed for the test. It can also provide other useful functions, such as monitoring the rhythm of typing, using key combinations, such as the paste function mentioned above, to eliminate the possibility of cheating. Remote proctoring is an existing AI platform that allows teachers to remotely proctor an online exam. This means that students do not have to physically gather in an exam room to write their essays, but can do so from anywhere, even from home. This reduces the logistical burden of administering and writing exams [8]. With e-learning, several LMS (Learning Management Systems) have been developed, which, in addition to archiving course material, also largely satisfy the automated testing process [18]. Advances in digitalisation have enabled the automatic improvement of multiple-choice, short-answer, computation, classification, categorisation, and pairing tasks already years ago. However, with the use of artificial intelligence, it is now possible to automatically improve essay-type answers. Explanatory answers require more complex checking, as these types of answers need interpretation. China is already developing and testing ways to improve essay-based tests using artificial intelligence. Mainly in improving essays, based on comparing specific topics with controlled sample essays [19]. Furthermore, in Sweden, experiments have been made using neural networks to check essay-based texts [20]. Other proposals have been made to check mathematical concepts and definitions, based on accepting answers based on own words [21]. Artificial intelligence-based automated tests do not only allow for repair, but also for intelligent test generation.

By intelligent production, we mean taking into account a person's level of knowledge and attempting to create personalised tests. Of course, a threshold has to be set in this case too, since it is not acceptable for a student to produce 20% of the expected performance compared to his classmates. The first significant attempt to produce individualised tests dates back to the 1960s. Crowder's programmed teaching with branching works by presenting the student with a short information page followed by multiple questions. Based on the answers given, the program directs the student to a new page [22]. If the student answers correctly, the next page presents new information. If the answer is incorrect, the next page provides feedback to help the student understand the reason for the error. This avoided the "mistake" that, although the student could individually take as much time as they wished to answer a question, they would still have to answer the same set of questions of the same difficulty in the same order. The result of the process was that the system took into account the knowledge of the learners and adapted the path through the curriculum accordingly, so that each learner saw very different pages – questions.

3.3. Chatbots

The problem we have been facing in recent years is that most of the lessons on websites are not adapted to students' cognitive abilities and learning styles [23]. Research by Zhang has shown that the content of the lessons is too monotonous [24]. By this is meant that for many educational websites, the knowledge content is usually composed of chapters copied from textbooks. This does not constitute a forward-looking educational innovation, but merely gives the impression of reading an electronic version of a textbook. The disadvantage of this phenomenon is that, since they are not equipped with intelligent technology, they cannot be adapted to stimulate students' desire to learn. Therefore, a further problem may be the simplicity of systems based on Q&A (question and answer). Some of the simpler Q&A platforms include forums, email, and various chat tools. Their disadvantage is asynchronous communication, as the questioner's, in our case student's, desire for knowledge cannot be satisfied there and then. This may reduce their interest. The aim is to build a more flexible and practical Q&A platform, which, guided by AI, acts as an intelligent expert chatbot to examine the keywords of the questioner and, after interpretation, to answer his questions by extracting them from the database available to him. Of course, the teacher can still override and check, but the AI can guide the student in real time to the path that would help them find a solution or understanding.

The artificial intelligence with the greatest potential of our time is ChatGPT, which is capable of realising such an intelligent Q&A platform. With its built-in language model, it can process a wide range of knowledge and answer questions quickly and accurately. With the help of billions of websites, books, scientific publications and other resources it uses, it can provide students with reliable and accurate answers in most cases. As it is an interactive chatbot, it allows students to ask questions at any time and get immediate answers to the questions they have. It can also provide students with reliable, interactive and personalised educational material that will help them to expand their knowledge and learn effectively [25]. However, we should remember, that the information generated by ChatGPT is not always accurate, and since its release it has been able to generate information that is not real. The use of intelligent chatbots, like many other technologies, is a two-edged sword. It allows students to substitute intelligent tools for independent work, which can hinder the development of their creativity, their ability to formulate and thus their vocabulary.

3.4. Predictive Models

Predictive models are tools that can make predictions about future events by learning from and analysing past data. These models use data analysis and machine learning techniques to analyse past data and then try to predict future events based on that data. Artificial intelligence offers the possibility to collect and analyse data and to create intelligent learning content. Data collection can be done in several ways. One way is to monitor the activities of learners in a virtual learning environment [26]. Big Data can be used in education in many ways. It can be used to obtain information about the strengths and weaknesses of an educational system, which can reveal subsequent improvement paths. Through these improvements, we can achieve better learning and teaching performance [27], [28]. Predictive models enable educational institutions to predict student performance and, on this basis, to develop personalised learning plans. Predictions can also be used to improve student preparedness, which can contribute greatly to student achievement and successful learning. International research results confirm that the use of student analytics and tools for educational data mining have assisted individual students in reviewing their accomplishments, anticipating the additional support and attention required by students, aiding teachers in devising supportive interventions, and enhancing existing courses or curricula. For example, machine learning techniques were utilized to automatically boost user and group models by observing the previous behaviour of students and supplying training examples for predicting future actions. This process mapped individual student and group models into patterns of users with shared interests or skills [12]. Ukrainian scientists try to predict the final grades of students in higher education using recurrent neural networks [29], [30], [31]. It can be said that artificial intelligence-based programmes provide useful feedback for teachers and students alike. These systems have and can continue to achieve positive results in online education and in e-learning. They are able to monitor students' performance and, if necessary, alert teachers immediately and in a timely manner about potential learning problems. Last but not least, they help students to select the right courses, based on their strengths [31]. In sum, machine learning can help to make recommendations to students for selecting courses and even universities. It harnesses students' achievements, aspirations and preferences to find institutions where they can best develop. For example, Chen *et al.* suggest that students' demographic characteristics and grade data can be analysed from a small number of writing assignments [32]. Their study describes this using a regression method that can help predict students' subsequent performance. They argue that data mining is also shown here to be an effective tool to provide a better understanding of learners, revealing curriculum development directions that educators need to take for more effective teaching and learning.

3.5. Intelligent Robots

Combining robotics and AI can create technologies designed to support education [7]. Intelligent teaching robots can be used in any classroom. In Thailand, a teaching robot is used to keep students motivated. The robot is able to simulate different emotions and can also tell stories, read or even recite to children. It is also able to answer certain questions, thus communicating with students in an interactive way [28], [33]. Sullivan *et al.* conducted robot programming training for preschool and primary school students [34]. The results of the experiment were positive. Children are interested in courses in artificial intelligence, digital tools and programming. Learning feels more like play than a duty, with tools and in an environment where they feel comfortable [35]. Intelligent robots, as classroom mobile teaching assistants, could be envisaged in the future. Timms' study calls this type of robot a Cobot (Collaborative Robot) [7]. The assumption is that the Cobot would be able to move around the classroom while students work on their projects, would also recognise the face and voice of each student, would be able to point or gesture, and would be able to make facial expressions.

This would improve interaction with students. In Japan, a robot called Saya is already being used in classrooms to perform disciplinary tasks. Saya can speak in several languages and a series of motors in its head stretch its soft synthetic skin, allowing it to display emotions ranging from happiness and surprise to sadness and anger on its "face". However, Saya knows little more than saying students' names and issuing basic classroom control commands such as "Silence!". The Aldebaran Robotics company's Nao robot has been used in classrooms to help students learn to write the letters of the alphabet [36]. In terms of appearance, it has a basic human form, but its limbs are short and non-human-sized. The importance of a human-like appearance has already been examined by Kiesler [37]. The results of the study showed that people prefer to interact with a robot than with software on a screen. Robots have already been used in playful and experiential education. They already play a role in teaching the basics of programming in mainstream schools. With the Dash robot, students can play games and learn symbolic notation of instructions, while developing logical and programming thinking. It also allows longer and more complex programs. It is also capable of creating and integrating procedures and sensors [38]. This means game-based and experiential learning that helps the student to better retain the information. In studies of game-based education, it has been shown in several aspects that students can acquire better and more permanent knowledge [39], [40], [41]. It can be said that the introduction of educational robots into classrooms has already started and research shows that there is a future for implementing AI in educational robots.

3.6. VR and AR Technologies

VR (Virtual Reality) and AR (Augmented Reality) technologies allow educational material to be made more interactive and presented in a more lifelike way for students. Such technologies generally use a combination of sensors, devices, and software that allow the creation of virtual environments in which users can move around, interact with objects and gain experiences that they would not be able to have in real life or in that particular situation within the educational institution. Such technologies provide clear opportunities for learners to learn experientially [32]. The student moves from being a passive observer to an active participant in the virtual world. Virtual space provides the opportunity to move within it and to rearrange objects by enabling interactions. The virtual world encompasses the objects around the user and all their properties: size, location, shape, and other visual properties. A Hungarian development used in education is Leonar3Do. Leonar3Do is an integrated software and hardware platform for creating 3D interactive spaces and simulations. It develops three-dimensional thinking and spatial vision. VR technology is an exciting trend in education. Our previous research confirms that students have shown a clear interest in the educational use of VR, especially in geography, biology, and history lessons [42]. AR and VR technologies enable the integration of artificial intelligence, which can help to provide learners with personalised learning experiences. AR applications can help students understand more complex concepts. They allow students to see concepts through 3D models, which make them more understandable. An example is the difference between a two-dimensional square in a plane and a cube viewed in three-dimensional space. The potential use of VR at the university level can be linked to medical studies, where simulations of surgical operating theatres are used to train medical students, especially for complex surgeries such as brain tumour surgery [43]. AI-based VR and AR developments are constantly evolving. In the future, we can expect to see more new applications and opportunities in this field of AI, which will further aid education and medicine, as well as industrial applications. One of the most recent announcements is Apple Vision Pro, which is expected to take our experience of AR technology once again to a new level. With the help of Siri, an intelligent assistant developed by Apple, the user can even experience an intelligent augmented reality.

4. Methodology

The survey was conducted in educational institutions in Slovakia and Hungary in spring 2023. The survey instrument was a questionnaire consisting of two sections. The first section was designed to assess, in addition to the demographic data of the trainers, the educational level of the institution and the field of study in which they currently work. The second section assessed the knowledge of AI technologies among the teachers. The respondents were briefly introduced to the AI-based tools listed in Section 3. Our questionnaire assessed what technologies the instructor had heard of and which of the listed ones could be used in everyday teaching in their discipline. Finally, we explored the openness of the instructors to the general use of AI in education. Our survey clearly shows that educators, regardless of generation, are open to the use of innovative tools and see the potential of AI in education.

5. Results

The first part of our questionnaire measured the demographics of the respondents. A total of 75 teachers participated in the survey. 59% of the respondents were female and 41% were male.

The teachers who completed the questionnaire covered the fields of abstract, applied, humanities, social and natural sciences. We sought to ensure that our survey covered all educational levels and generations. 42% of the respondents were teaching in primary schools, 34% in secondary schools and 24% in universities. Some of the respondents who completed the questionnaire taught in two types of institutions and were counted accordingly in the statistical analysis. Most of the respondents were from Generation X and Y, but also included Baby Boomer and Generation Z educators.

After providing the demographic data, the respondents were given a 1- to 1-paragraph introduction to the AI-based technologies and their potential in education, as discussed in Section 3. The next part of our survey assessed the teachers' knowledge of the subject. Our question focused on exploring which AI-enhanced technologies the respondent had heard of before. Figure 1 clearly demonstrates that, in the majority of cases, teachers had already heard of the technologies discussed in Section 3.

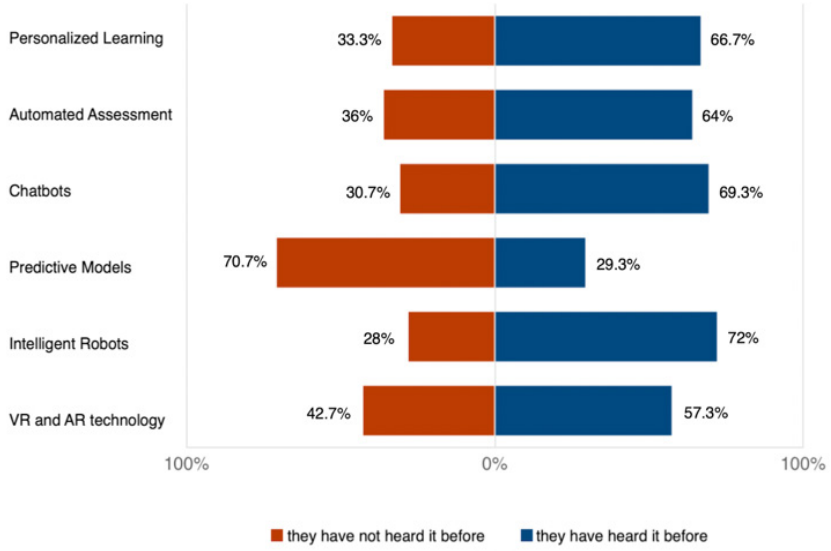

Figure 1. Awareness among teachers of specific AI technologies that can be used in education

We extended our research to examine how generational differences affect our results. Our survey shows that the teachers who completed the questionnaire were familiar with the tools mentioned above with roughly similar frequency, regardless of generation. For all generations, the survey showed positive feedback from more than half of the respondents. For Generation X and Y teachers, who dominated the respondents, 65% of the former and 51% of the latter had heard of some of the AI-based teaching tools. To our surprise, 62% of the Baby Boomer generation, who seem the furthest removed from computer technologies, were also no strangers to these technologies.

A further question of our survey asked whether the respondent could imagine using any of the AI-based technologies listed above in the subject area they teach and, if they could, whether they would use them in their everyday teaching. Respondents were asked to indicate their answers on a four-point Likert scale, as follows: no, rather no, rather yes, yes. As can be seen, teachers have a rather positive attitude towards AI and are even willing to use it in practice.

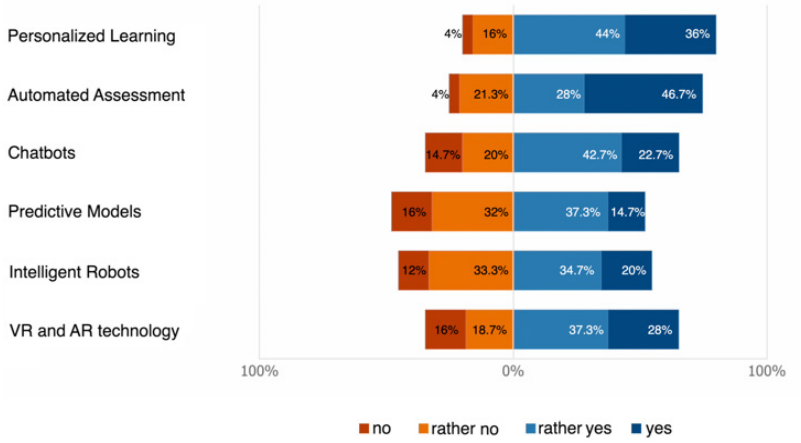

Figure 2. Distribution of the use of AI technologies in education

Figure 2 clearly illustrates that personalised or adaptive learning and automated assessment systems are the segments of the application of artificial intelligence in education that teachers would be most open to. In contrast, the use of predictive models and intelligent robots is the most divided among respondents, with only half of respondents able to envisage their use in everyday education.

In the next section, we asked teachers to rank AI-based technologies according to what they think are the most effective in education. We evaluated the ranking results based on three criteria. First, we looked at the overall ranking. Then, classes were created by field of study to determine which AI technologies were considered by respondents to have the greatest potential in which field of study. Finally, we examined the ranking results by educational level to see which technologies are most likely to be envisioned by educators in primary schools, high schools or universities in terms of practice.

Although, as already indicated in the second figure, this case clearly confirms that personalised learning is considered by teachers to be the most effective use of AI in education. This was so clearly demonstrated that no one ranked this technology last. The second most used technology chosen by respondents was automated assessment. This was followed by chatbots, and finally intelligent robots and predictive models were ranked last by educators. As shown in Figure 3, the use of VR and AR augmented with AI was almost evenly distributed across the rankings, with the effect of this being seen when examining the use of these technologies within fields of study.

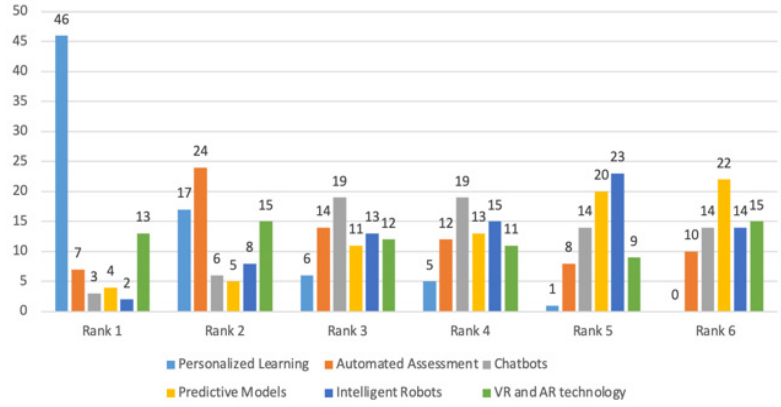

Figure 3. AI technologies ranked by respondents

In the rest of our survey, we analysed which scientific fields would make the most use of each AI technology. Our results show that teachers in the humanities, applied sciences, and natural sciences would be the most likely to use personalised learning. VR and AR technology was the second most common technology in the ranking, with teachers in the humanities being the most likely to use it, but there was also interest in other fields. The use of automated assessment systems is most realistic for teachers in applied science. Similar interest was shown in chatbots and predictive models by educators other than social science teachers. Teachers of abstract and humanities were interested in intelligent robots.

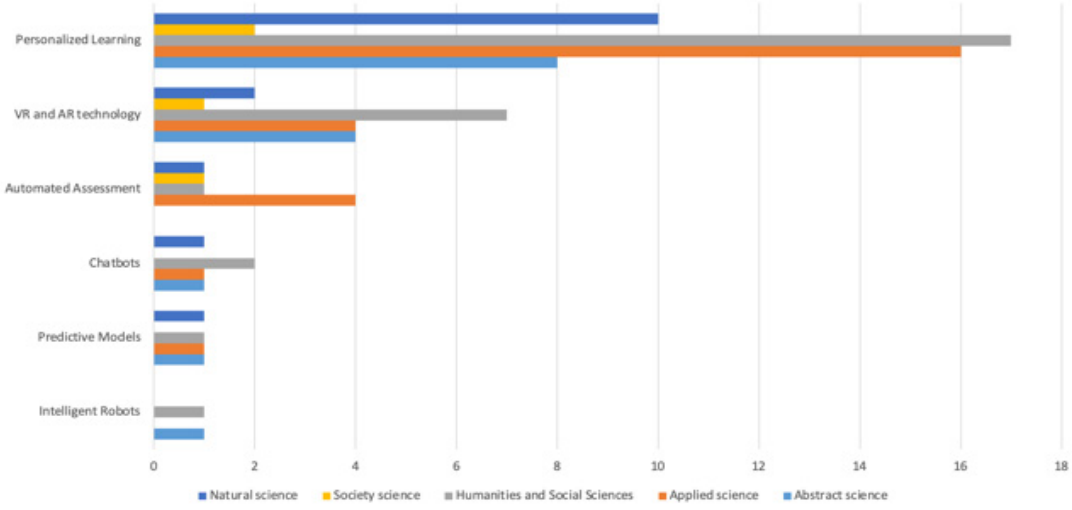

Figure 4. Most commonly used technologies by field of study

As mentioned earlier, our third aspect of the study focused on educational institutions. We looked at the level of educational institutions at which the technologies chosen as the top-ranking technologies are most likely to be imagined by teachers. Personalised learning was almost equally distributed among the respondents. Nearly 70% of those working in primary schools, 55% of those teaching in high schools and 63% of those working in universities envision implementing this technology as their primary AI tool. The use of automated assessment systems is seen as important mainly by university teachers, which could also mean automated improvement of dissertations. For primary school teachers, chatbots and predictive models have taken a back seat. However, they ranked higher for secondary school and university teachers. The assimilation of intelligent robots and virtual reality into education is seen as most realistic in primary schools, with 21% of respondents.

The final question of our survey focused on the openness of educators to the use of AI in education in general, regardless of the specific technology or tool. A majority of 75% of respondents were open to using AI in everyday education. We further explored the frequency of respondents by cross tabulation analysis, where we measured openness to the use of AI by gender, generation, and educational institution. The analysis proved that there was no significant difference between the data we assessed, as the Chi-square test (for total) and the Fisher's Exact test (for gender) were all above the 0.05 significance level, so the strength of the Phi and Chramer's V relationship were not considered. Our results are illustrated in Table 1.

Table 1. Results of the cross-tabulation analysis

Cross-tabulation analysis by gender					
	Yes		**No**		**Total**
	N	**%**	**N**	**%**	**N**
Man	25	80.6%	6	19.4%	**31**
Woman	31	70.5%	13	29.5%	**44**
Total	**56**	**74.7%**	**19**	**25.3%**	**75**
Pearson Chi-Square			**0.318**		
Cross-tabulation analysis by generation					
	Yes		**No**		**Total**
	N	**%**	**N**	**%**	**N**
Baby Boomer	6	85.7%	1	14.3%	**7**
X Generation	24	75.0%	8	25.0%	**32**
Y Generation	24	72.7%	9	27.3%	**33**
Z Generation	2	66.7%	1	33.3%	**3**
Total	**56**	**74.7%**	**19**	**25.3%**	**75**
Pearson Chi-Square			**0.892**		
Cross-tabulation analysis by school type					
	Yes		**No**		**Total**
	N	**%**	**N**	**%**	**N**
Primary school	24	77.4%	7	22.6%	**31**
Primary and Secondary school	2	100.0%	0	0.0%	**2**
Secondary school	15	65.2%	8	34.8%	**23**
Secondary school and University	2	100.0%	0	0.0%	**2**
University	13	76.5%	4	23.5%	**17**
Total	**56**	**74.7%**	**19**	**25.3%**	**75**
Pearson Chi-Square			**0.627**		

6. Conclusion

Artificial intelligence has great potential for the future and this is also true for education. In our study we have outlined the most important areas and technologies where AI will bring about major changes in the learning and teaching process. Machine learning and data analytics will enable education systems to understand better the individual needs of students. Therefore it is important that students learn to take advantage of the technologies available to them. At the same time, students need critical thinking and deeper understanding in order to correctly interpret and use AI technologies and the information they provide. In this aspect too, teachers have a vital role to play in the future of education. They need to help and supervise students to use the potential of AI in an appropriate and ethical way. Our survey showed that teachers, regardless of age and discipline, are open to systems that support intelligent teaching. This is a positive development, as educators in today's digital world should not exclude students from these technologies but find ways and directions where they can use them to make the educational process more colourful and effective. Active communication and collaboration between teachers and students are the key, as it is only through a joint effort that they can take advantage of digital technologies. All this is essential for effective education in the age of artificial intelligence.

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