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EDUCATIONAL SOFTWARE AND ARTIFICIAL INTELLIGENCE: STUDENTS' EXPERIENCES AND INNOVATIVE SOLUTIONS

Abstract. The digitisation of education systems has been a growing trend in recent years. Artificial intelligence (AI) enables the development of new educational software that can even create adaptive - personalised learning plans for students. Such new software can be invaluable for improving the efficiency of the educational process, improving communication between teachers and students, and facilitating a better understanding of educational material. It is therefore important to make use of the tools already available in the educational process. Alongside teachers, students are the ones who are an integral part of the educational process and it is they who become active users of this software. The aim of our research is to assess students' interest in educational software. The study involved a quantitative survey involving a total of 500 students from different educational institutions covering primary, secondary and higher education, as well as Generation Z and Alpha. The survey gave students an insight into the concept of artificial intelligence. In addition to the openness to educational software, our study investigated the relationship between the students' attitudes towards artificial intelligence and their previous use of educational software. Our results show that students are keen to use educational software, and the majority are open to using artificial intelligence-based educational software. Our conclusions point to the need for educators to implement these software in their pedagogical practice whenever possible when shaping future teaching methods. Therefore, based on international literature, this study presents 15 educational software solutions that, through their intelligent features, accelerate and simplify the teaching process while supporting differentiated and more personalized education. The aim of this study is therefore to familiarise the reader with the potential of educational software and to encourage educational institutions and teachers to use this type of software on a daily basis.

Keywords: artificial intelligence; educational software; educational platforms; learning tools; innovation; automated education.

1. INTRODUCTION

Educational software is an application designed to support the educational process. These software applications usually process educational material in an interactive way and help students to acquire new knowledge. Some constructivist studies focus on the process of learning and emphasise the need to design learning environments appropriately and support the development of computer-based educational applications [1]. Other research emphasises the need for students to actively access knowledge rather than passively absorb it [2]. This active participation is mainly based on the experience gained through experimentation, for which appropriate educational software and platforms can be the perfect tool [3], [4]. We would also stress the word "appropriate" because, if these systems are designed and implemented correctly, they can help to increase learning freedom [5], [6]. As we can see, digital education and the knowledge of how to use digital tools is becoming more and more widespread in education. But digital trends are changing rapidly and always present new opportunities and challenges. It is therefore important that students continuously develop their digital skills and are able to adapt to new technologies. For this reason, some studies suggest that students' knowledge in the use of digital technology should be built through the use of computer tools rather than solely through computer-based learning programmes [7]. Computer tools are software or applications designed to assist users in performing specific tasks or functions. In contrast, computer-learning

programs are software designed to provide instruction or education, often interactive, with the goal of teaching users new skills, knowledge, or information.

Analysis of recent studies and publications. The use of digital technology in education is widespread. A number of proposals and models (TAM - Technology Acceptance Model) have been developed to understand and adopt such technologies in education [8]. The study of Rugube and Govender presents a technology acceptance evaluation of a software design model applied in higher education. They used least squares structural equation modelling in their analysis. Their study partly investigated the usefulness, user experience and adoption of educational software. Their results conclude that technology tools in education are useful in the learning process [9].

The study of Zhang et al. proposes an interactive intelligent teaching framework supported by artificial intelligence to improve student interaction and student academic performance. Their paper focuses on intelligent tutoring systems for use in higher education. They investigated the use of artificial intelligence to improve student-teacher interaction. Their results show that with AI this interaction showed an improving trend [10].

The paper of Xu and Ouyang provides a comprehensive overview of studies in the field of STEM (Science, Technology, Engineering and Mathematics) education facilitated by artificial intelligence. Their work mainly addresses research questions such as what forms of AI are most often found in STEM learning and what impact such systems have on STEM education in general. Their article also points to the shortcomings of the field, where many studies only emphasise technology rather than educational context [11].

Cen et al.'s study investigated the user-centred approach to designing AI-based educational software. The survey was conducted among secondary school students and teachers. Their study found that the usefulness and ease of learning of AI-based educational software significantly influences ease of use, and consequently ease of use significantly influences satisfaction. The relationship between the four variables was mainly investigated through regression analyses. Their paper also discusses a user-centred design methodology for AI-based educational software, based on which the authors propose a new New Design for the user flow of Blockly-Electron software [12].

Several studies show that the use of smart and innovative technologies is most noticeable in higher education. However, the 2nd International Workshop on Education in Artificial Intelligence K-12 (EduAI) aims to discuss how best to implement AI education at the K-12 level. One of the main topics offered by the Workshop is Software and hardware tools in AI education and how those tools could improve teaching. The Workshop proposes to bring together experts in education and complex systems thinking. The vision they outline is that a thorough knowledge of the principles and concepts of AI, the ability to apply AI techniques and methods to real-world problems, and the ability to coordinate and apply AI-based solutions are essential. In addition to this, the researchers agree on the need to involve and educate not only students but also teachers and parents in the automation process provided by AI [13].

There is a large literature on the manifestation of artificial intelligence in education. Some studies specifically analyse the impact of some AI-based software on learning. However, in the context we have built up, we have not found a similar approach or a study that provides a comprehensive, summarised description of the relevant AI-based educational software and its characteristics.

The goal of our research. This article focuses on educational software, in particular the potential of artificial intelligence (AI) -based educational software. The aim of our study is to show that in our modern world, students are looking beyond static textbook content to innovative and interactive learning tools, are eager to work with educational software, and are open to the inclusion of AI in the learning process. In this context, we conducted a survey

among students, examining their relationship with educational software and their openness to intelligent educational software.

RQ1: In which subjects did students most often use educational software?

RQ2: Are educational software an effective learning tool for learners?

RQ3: Are students open to learning with intelligent educational software?

RQ4: Is there any measurable relationship between the openness to using AI-based educational software and the learning tools the student has previously used?

The results of our survey suggest that educational software is playing an increasingly important role in the educational process. For this reason, the remainder of our paper reviews international literature to provide insights into the potential of some of the intelligent educational software that is currently in active use. Our aim is to encourage teachers to use these educational tools in their everyday teaching in their own discipline, where they have the opportunity.

One primary objective of our work is to survey primary, secondary and university students about their experiences with educational software. We also investigate how open students would be to the practical application of innovative educational tools such as artificial intelligence, teaching robots, or virtual reality. Responses will be collected through a questionnaire, and then the research questions will be answered through statistical tests using SPSS. Then, innovative educational software that support education through intelligent features, including personalised learning, will be presented. By presenting this software, we aim to inform the reader about the possibilities of innovative digital teaching tools that can be applied in their own discipline. The structure of our thesis is described below. Section 2 of our study presents the research methods. Section 3 presents the results of our research, which was carried out among students in primary, secondary and higher education. Section 4 presents the potential of educational software based on international literature. Based on the results of our survey, we make recommendations for AI-based educational software already in practice. Section 5 summarises, describes future research directions and concludes the paper.

2. METHODS

Our study presents the results of a qualitative survey. The survey used a three-phase questionnaire to measure, in addition to students' demographic data, their experiences with educational software and their potential from the students' perspective. We also looked at students' learning habits, where we tried to place the frequency of use of educational software against other learning tools. In the final section of our questionnaire, we assessed students' openness to the use of innovative technologies in education. Our questions gauged students' interest in the use of educational software using artificial intelligence, robotic tools and virtual reality in education. We also examined whether there is any measurable correlation between the uptake of innovative tools and previous learning habits. The survey used mostly frequency analysis and cross tabulation analysis. By involving several educational institutions in the survey, we tried to get the questionnaire completed by students in primary, secondary and higher education. Our results show that students prefer to use educational software and are open to the use of artificial intelligence. We also draw on international publications to review the role of educational software and present some examples of AI-based educational software that we recommend for use in everyday education. For ease of overview, we also compare the software in aggregate.

3. THE SURVEY RESULTS

A total of 500 students participated in the survey. The primary instrument was a questionnaire consisting of three sections, for which a total of 460 valid responses were received. 44% of the respondents were male and 56% female. The distribution of students by educational institution was as follows. A total of 186 valid responses were received from primary school students, 181 from secondary school students and 93 from university students. Our questionnaire focused on students' experiences and interests in educational software. In the following, we present our results grouped according to our research questions.

3.1. Assessment of the use of educational software within subjects

The survey revealed that 76% of respondents had used educational software, in our case 347 students. We therefore looked at which subjects students had already used educational software for. The survey was carried out in Hungarian educational institutions in Slovakia, so we interpreted the questions on language teaching separately for Slovak, Hungarian and foreign languages (English, German, Spanish). Within the statement of this article, we have summarised the frequency of educational software used for languages. The survey clearly showed that languages, computer science and mathematics were the subjects for which educational software was most frequently used. The full report can be seen in Figure 1.

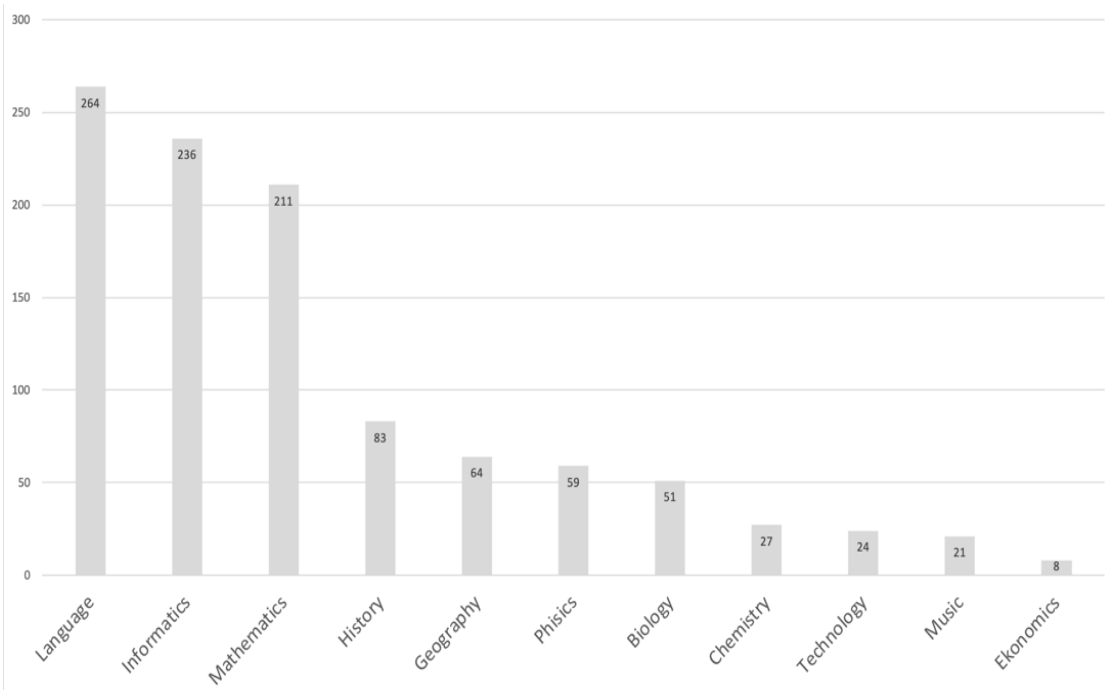

Figure 1. Frequency of using educational software by subject

3.2. Assess the effectiveness of educational software

Students using educational software were asked additional questions that measured the effectiveness of the educational software. In total, three statements were presented to the students. Students were asked to provide their answers using a four-point Likert scale, with a choice of: disagree, rather disagree, rather agree, agree. Our results are shown in Figure 2. As can be seen, students who had used educational software tended to describe its impact on their learning more positively, with 91% and 89% respectively. What was clearly shown, however, is that although they prefer to use educational software for learning, a majority of 60% are reluctant to learn only with educational software.

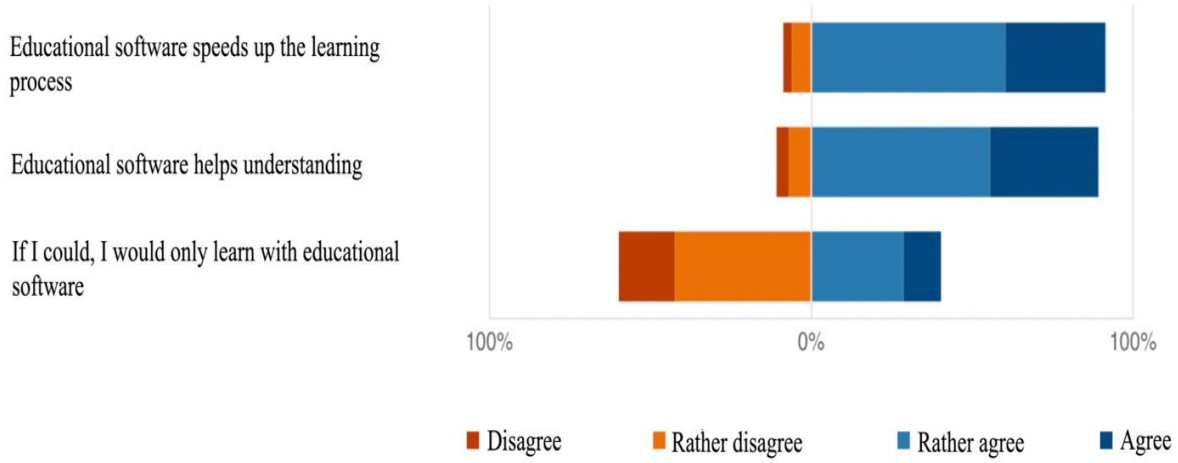

Figure 2. Students' attitudes towards educational software

We then looked at where educational software ranks among learning tools. Students were asked to rank each tool according to the one they found easiest to learn with individually. In addition to instructional software, the options included instructional videos, notes, textbooks, scientific articles, teacher-edited learning materials, and explanations from other students. Students overwhelmingly identified their own notes as the most useful learning tool. This is followed by the teacher's take-home material, which may include printed documents and presentations. In third and fourth place were digital tools, meaning tutorial videos and educational software. The last three were peer explanations, textbooks and scientific publications. Figure 3 illustrates the striking differences between the various tools.

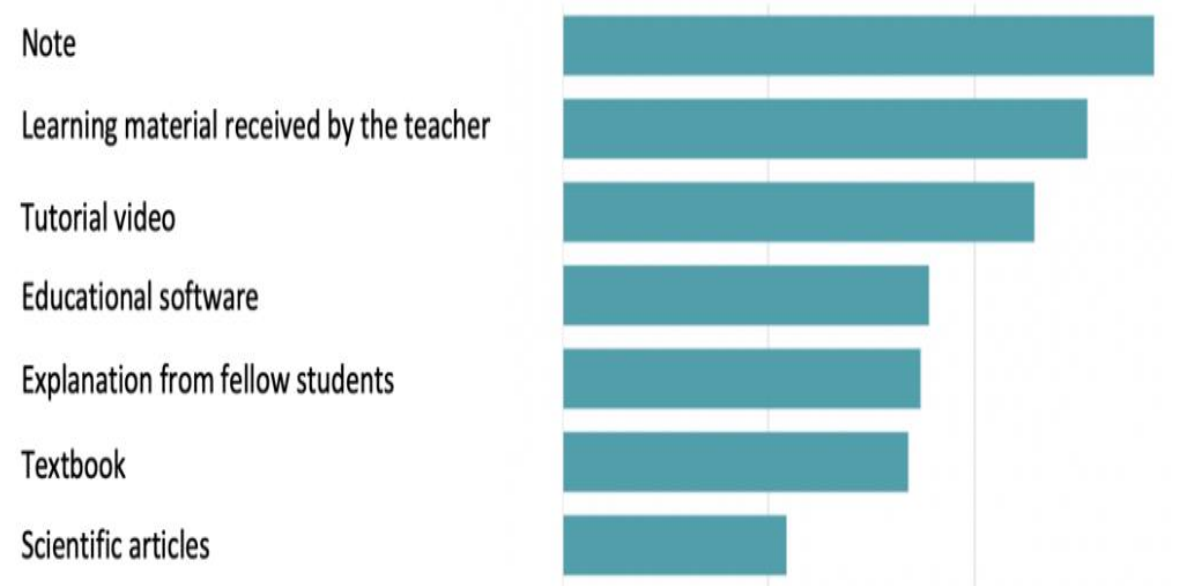

Figure 3. Educational tools ranked by students

In addition Figure 4 visualises the detailed ranking performed by each student.

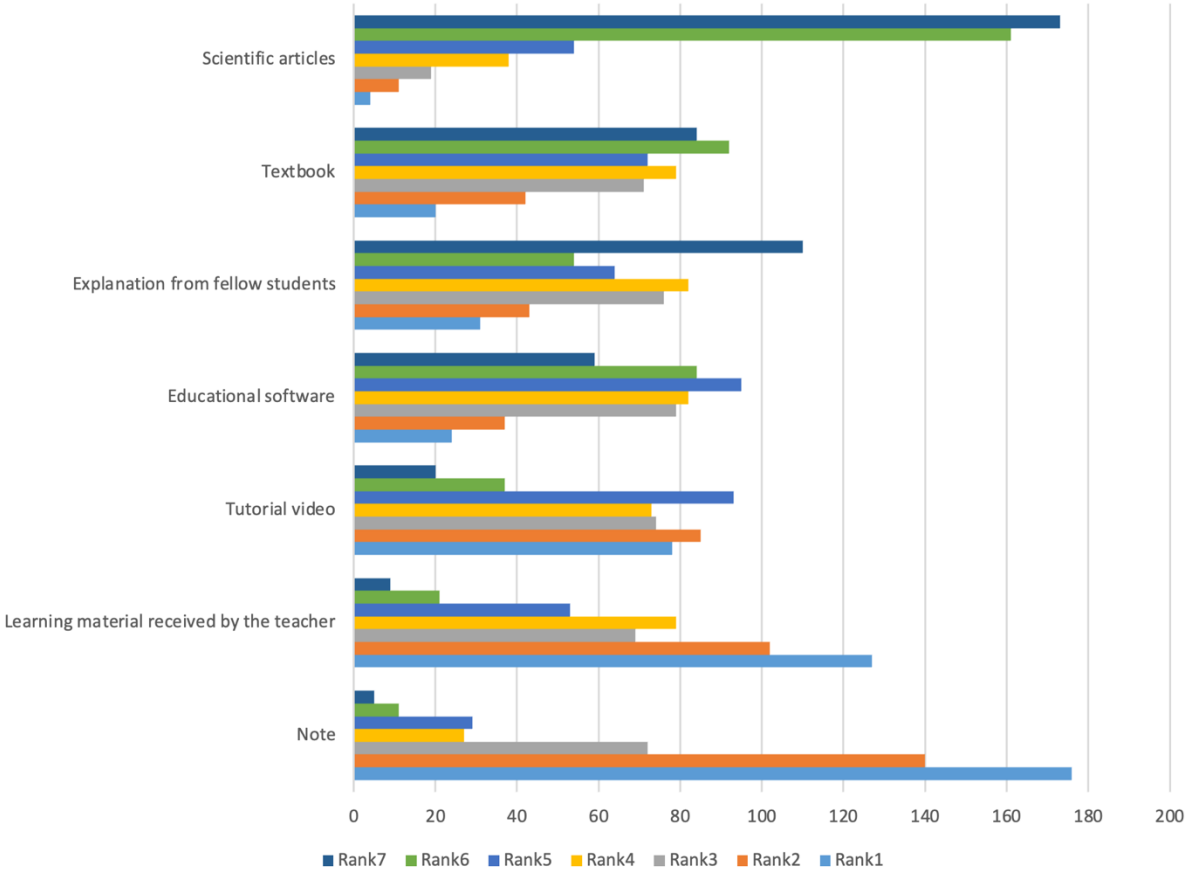

Figure 4. Frequency of educational tools ranked by students by ranking

The survey revealed that the most frequently used educational software is GeoGebra and PhET Colorado, which processes and simulates different learning materials. In addition, the LMS systems were the most commonly used by students for their additional digital learning activities, with EduPage, Google Classroom and Moodle being the most common.

3.3. Assessing openness to innovative educational technologies

The final section of our questionnaire assessed students' general openness to AI software, educational robots, VR and AR (Virtual Reality and Augmented Reality) technologies. Prior to the survey, students were given a presentation on the technologies involved. The presentations were enriched with presentations, videos and real experiments using tools such as the VR Shinecon glasses or Quincy the speaking robot for drawing. These presentations were especially important for younger primary school students to be aware of the concepts before answering our questionnaire. The frequency analysis showed that 70% of students would be open to learning with intelligent software. At a similar height, 72.2% would be open to incorporating virtual reality into the educational process. However, less than half of the students want to learn with educational robots (45.7%). The results were further examined using a cross-tabulation analysis, where we analysed the relationship between students' educational level and their openness to each educational tool. Our results show that there is no significant relationship between each level of education and students' openness to. Our results are illustrated in the first table.

Table 1

Cross-tabulation analysis results by school level

School Type		Would use AI in education				Would use Robots in education				Would use VR or AR in education				
		Yes		No		Yes		No		Yes		No		
		N	%	N	%	N	%	N	%	N	%	N	%	Total
Primary School		120	64.5%	66	35.5%	78	41.9%	108	58.1%	135	72.6%	51	27.4%	**186**
Secondary School		132	72.9%	49	27.1%	81	44.8%	100	55.2%	62	74.6%	46	25.4%	**181**
University		66	71.0%	27	29.0%	51	54.8%	42	45.2%	135	66.7%	31	33.3%	**93**
Total		**318**	**69.1%**	**142**	**30.9%**	**210**	**45.7%**	**142**	**54.3%**	**332**	**72.2%**	**128**	**27.8%**	**460**
Chi-Square		**0.199**				**0.199**				**0.378**				

We also examined whether there was any measurable relationship between openness to using AI educational software and whether the student had used educational software before. In the cross-tabulation analysis, the Chi-squared test was set at $p < 0.05$, so that a weak relationship was found according to the Phi and Cramer's V indicators of 0.220. Our results are illustrated in the second table.

Table 2

Cross-tabulation analysis results by software use and attitude towards AI

Used educational software before	Would use AI-based software				
	Yes		No		
	N	%	N	%	Total
Yes	260	74.9%	87	25.1%	**347**
No	58	51.3%	55	48.7%	**113**
Total	**318**	**69.1%**	**142**	**30.9%**	**460**
Chi-Square	**< 0.001**				
Phi and Cramer's V	**0.220 - weak relationship**				

Overall, students are no strangers to educational software. They have a positive attitude towards their use. The increasing use of artificial intelligence can only enhance the effective use of these learning tools. For this reason, the rest of this article explores the potential of AI-based educational software in education.

4. ARTIFICIAL INTELLIGENCE-BASED EDUCATIONAL SOFTWARE AS LEARNING TOOLS – A REVIEW AND PROPOSALS

Educational software can generally be divided into two types. One group is software from the logistical educational perspective, which helps teachers to prepare teaching materials, monitor student performance and, last but not least, to carry out administrative tasks. Very good examples are Learning Management Systems (LMS), whose features greatly speed up the work of teachers. Another group is software used by students. These include online learning platforms, digital learning materials and adaptive learning software. Their primary purpose is to help students understand the material, maintain their interest and motivation, and personalise the learning process.

To be successful in the educational process, an educational software must have several important characteristics.

- **Adaptability:** good educational software should be able to adapt to the different learning styles and needs of students. Adaptive software should be able to take into account the student's prior knowledge and abilities and create a personalised learning plan based on these [14]
- **Interactivity:** interactivity is a key feature of educational software. Students should be actively involved in the educational process and software should allow students to interact with the learning material [15], [16].
- **Visualisation:** visualising teaching material can help students to better understand and remember the learning material. Good educational software should be able to visualise the content and provide an interactive interface [3].
- **Real-time assessment:** educational software should be able to assess student progress and performance in real time. This allows the student and the teacher to get immediate feedback on understanding and progress [17].
- **Analytical skills:** educational software should be able to collect and analyse data to help teachers and institutions monitor student progress and performance. With analytical data, educators and institutions should be able to manage the educational process more effectively and efficiently [18].
- **User-friendly interface:** the educational software should allow users to navigate the interface easily, access materials and functions easily, and make the whole process run smoothly. In many cases, the software itself can even be a computer game, so that the student receives experiential learning in addition to an attractive interface [19].

4.1. Artificial intelligence in education

Artificial intelligence researchers are using a variety of systems to build the infrastructure for an intelligent society in which human-machine integration is achieved. The most important feature of AI in education is that it provides machines with human-like intelligence and the ability to perform a variety of learning, teaching and instructional management tasks, which can greatly facilitate the task of students and teachers.

Through customisable materials and tracking, AI applications are transforming classrooms and educational administration. Picciano writes in his paper that AI could automate mundane tasks such as simple test improvement, as adaptive tests would generate questions according to the abilities of individual students [20]. Intelligent assessment refers to the autonomous, intelligent evaluation of students' learning process, data on learning behaviour and immediate, personalised feedback. Based on big data technology, it collects the knowledge students have acquired during the learning process. Combined with artificial intelligence technology, it enables comprehensive analysis of individual student learning and the implementation of intelligent assessment [18]. According to several researchers, adaptive learning systems, games and software could provide learners with greater individualisation [19].

Specifically, studies focusing on mathematics education have shown that AI-based instructional systems could help students learn basic mathematical concepts and perform tasks [6]. A personalised learning software can track students' learning behaviour in all directions based on their learning data and manage the learning process. Once the learning status of a student is obtained, it is presented to teachers in the form of learning reports. Based on the learning information, the teacher can gain a deeper understanding of the overall learning status of each student, monitor the learning impact of students in a timely manner, and target help to reinforce student learning in a more personalised manner [18].

This study does not aim to describe AI-based technologies in detail, but merely to give the reader an insight into the areas of education where the greatest benefits of AI can be observed. For general and broader knowledge on the detailed use of AI in education, covering personalised education, automated assessment, chatbots, predictive models, intelligent robots, and AI-driven VR and AR technology, we recommend the following literature [5], [7], [15], [16], [21].

4.2. Proposals for the use of educational software using artificial intelligence in everyday education

In modern e-learning, there are several trends that enable adaptive e-learning in a digital environment: the availability of huge amounts of educational data on the Internet, the possibility of disaggregating educational content and high data correlation. Adaptive learning, one of the most promising areas for the application of artificial intelligence in education, can be interpreted as a training model or concept that uses new technologies to increase the level of knowledge of students, taking into account individual needs and characteristics, and with the possibility of designing an individual learning pathway [16]

Modern intelligent adaptive platforms take into account the huge amount of data that the education system is a source of. The ability to process and analyse this data brings great benefits in changing and adapting the learning process. Here, AI technologies work in tandem with Big Data, data mining, learning analytics methodologies and tools.

Many companies are using artificial intelligence and data analytics to build educational platforms with similar capabilities [22]. The adaptive approach allows for greater training efficiency, as adaptive recommendations allow for the creation of interactive lessons with automatic task checking and feedback. It is a kind of virtual teacher that helps the student to choose individual material to successfully complete the course.

It is clear that students and teachers need better, more personalised support, which can be greatly facilitated by an intelligent or smart educational software. Some researchers argue that perhaps the metaphor of the human tutor has run its course. After all, while the human teacher is often one-person, works for a limited time and in a limited space, interactive learning environments can be collaborative, ubiquitous and portable. Interactive learning environments

have unique capabilities that human teachers do not have, and the next generation of systems will need to take advantage of these capabilities to support learning that can be done anywhere, anytime, by anyone [16].

AI-based educational software provide feedback to both the student and the teacher. Artificial intelligence systems have proven successful in online learning to monitor student performance and provide teachers with timely information about existing problems with course success. Such AI systems create the conditions for effective improvement of the teaching process and timely introduction of relevant changes. AI programmes help students to select courses based on the areas in which they are successful. AI tools and methods enable the creation of complex digital learning environments that are personalised, flexible, inclusive and engaging for students [21].

Intelligent applications can be used to make the learning process more potentially playful and interactive. It is not irrelevant that students can also use these virtual assistants in an out-of-school environment, taking them into their homes, thus creating autonomous learning [16].

Based on the uptake in this area and the results of the survey presented in section 3 , the following are some specific educational software that use AI to support learning and teaching.

4.2.1. ALEKS

ALEKS (Assessment and LEarning in Knowledge Spaces) is an adaptive educational software product offered by McGraw Hill. McGraw Hill is one of the largest educational publishing companies in the world, providing educational materials and solutions to educational institutions. The system uses an adaptive learning approach that continuously monitors student performance and tailors curriculum accordingly. ALEKS uses artificial intelligence-based algorithms to design personalised learning pathways that take into account students' prior knowledge, performance and gaps. ALEKS intelligence uses machine learning based on Knowledge Space Theory to efficiently develop and maintain a detailed map of each student's knowledge. The Knowledge Space Theory learning method employs a structure through which learners are guided through the subject matter via a knowledge-based system. Additionally, it periodically reassesses the learners' knowledge [23].The system asks students different questions, and the algorithms use these questions to determine the next steps in the curriculum, so that they are optimal for the learner. Within the ALEKS system, students receive immediate feedback on their performance and can study the curriculum recommended by the algorithms. The adaptive system allows students to learn at their own pace and to work only on topics they do not yet know. ALEKS is mainly used for teaching mathematics, statistics and chemistry, but it also includes lessons and tests for other subjects, such as physics or even programming within computer science. The software is mainly used in the United States and the United Kingdom [24]. Anderson and his colleagues' studies also address the practical applicability of ALEKS. They examined the effectiveness of the ALEKS system as a strategic intervention method for improving the mathematical skills of students facing difficulties in non-school environments. In the study, students were randomly assigned to a classroom, where one group worked individually with the ALEKS system, while the other group was taught by teachers in interactive classes. The results of the first year showed that students randomly assigned to the ALEKS system significantly outperformed the teacher-assigned students on state assessment tests they used. Another conclusion drawn from their results is that students using ALEKS required significantly less teacher assistance to complete daily tasks [25] [26]. Apart from its impact on academic outcomes, Khazanchi quasi-experimentally examined the effect of ALEKS on the affective commitment and cognitive commitment of 9th-grade students [27]. Cosyn and colleagues' study focused on analyzing the internal metrics of the ALEKS system, including its effectiveness in predicting students' performance on a given task or readiness to master new

content [23]. Yilmaz investigated in his dissertation how ALEKS influenced high school students' computational skills. The analysis results indicated that ALEKS instruction statistically improved students' end-of-year mathematical outcomes [28]. Additionally, the meta-analysis results of Ying and colleagues suggest that ALEKS is as good as, but not better than, traditional classroom instruction. Their conclusions imply that ALEKS can be applied to assist teaching and learning at various levels of educational settings since its effectiveness has been found comparable to traditional classroom instruction. ALEKS can be applied for classroom learning, homework assignments, or preparation for courses and competitions. However, potential challenges include determining the appropriate dosage and optimal duration of ALEKS use, which effectively aids students' learning [29].

4.2.2. Carnegie Learning: Cognitive Tutor - MATHia

Carnegie Learning is a leading provider of K-12 educational technologies, curricula, and professional learning solutions, aimed at facilitating the teaching of mathematics, world languages, and literature through their CLEARMath, CLEARLiteracy, and CLEARLanguages products. Carnegie Learning provides solutions to educational challenges through formative assessment and adaptive learning. Their most significant software is MATHia, formerly known as Cognitive Tutor. Previously, Cognitive Tutor was shown to be effective in one of the largest randomized experiments with educational software, as evidenced by significant improvements in learning among large groups of high school students from various regions of the United States in the second year of its introduction compared to a control group using traditional textbooks [30], [31]. The software analyses the student's responses and helps them in areas where they appear to be underperforming. It ensures that students improve their results through practice exercises. The artificial intelligence in Carnegie Learning's software helps to personalise instruction by identifying the student's level of knowledge in a given subject. The system can also identify students' individual needs and adapt to their learning styles. The software not only helps students but also teachers by providing a record of student performance. This allows teachers to provide personalised feedback to students. It is primarily designed to support the teaching and learning of mathematics. MATHia encourages students to reflect on their work, weigh hypotheses and conclusions from various perspectives, and deeply understand mathematics. Carnegie Learning's software emphasizes problem-solving and builds cognitive models of individual students' abilities to provide appropriate pacing and tasks for each learner [32].It covers a range of topics including algebra, geometry, trigonometry and elementary probability. Ritter and Fancsali advocate for blended learning. Their recommendation is to use the software for approximately 40% of the time (two instructional hours per week) and textual materials for 60% of the instructional time [33]. Carnegie Learning software is used in the United States [34].

4.2.3. ChatGPT

ChatGPT is a GPT-3.5 (Generative Pre-trained Transformer) based model developed by OpenAI. It is an artificial intelligence model that uses neural networks for deep learning and natural language processing (NLP). Its data extends until September 2021, so it only has knowledge up to that time. Its artificial intelligence is based on the understanding and generation of human language. It is able to provide answers to specific and circumscribed questions, generate content and provide assistance on various topics. From an educational point of view, ChatGPT can save a lot of time for the teachers, as it can produce worksheets, practice exercises, tests or even course materials in a matter of moments. Of course, the authenticity of the data provided by ChatGPT is not 100%, which is why it is important that those who use its help know the field of expertise of the questions they are asking and can correct the text generated by the chatbot if necessary. From the learner's point of view, ChatGPT offers a great

opportunity to acquire new knowledge, fill in gaps in the curriculum by generating immediate answers for personalised questions. ChatGPT can complement the work of teachers, as students can ask a question to the chatbot at any time of the day and get an immediate answer to their question, satisfying the student's thirst for knowledge. This would not be possible on a simple Q and A (Question and Answer) platform, where most of the time the questions are not answered in synchronous time. Furthermore, recent research has investigated whether educational institutions can use ChatGPT not only for knowledge supplementation, but also to help students with mental hygiene and counselling [35]. In any case, from both the instructor and student perspective, we should be careful to use the chatbot within the limits of its capabilities. Therefore, it is also essential to train instructors and to educate students properly in order to respond to the impact of ChatGPT on the educational environment [36]. As it is the most advanced and popular chatbot of our time, we asked ChatGPT itself how it thinks it can be used in everyday education. It answered our question in a few bullet points.

- *„I can help students and pupils in the learning process. I can provide answers and explanations to questions that arise in the subjects.“*
- *„I can help with school or university assignments and homework, giving examples and guidance.“*
- *„I can help you with pronunciation exercises and grammar examples to help you teach foreign languages.“*
- *„I can also help with creative writing exercises, generating prose or poetry.“*
- *„I can also help you to explain historical events and scientific facts, or even help you to write case studies.“*
- *„I can help answer questions and write code on programming, computer science and technology topics.“*
- *„I can also be used to create online tests, quizzes and practice exercises.“*

4.2.4. Century Tech

Century Tech is an adaptive learning platform that uses artificial intelligence to monitor student progress and tailor learning materials. Ma's description delineates how its learner behavior-trained recommendation systems offer personalized learning opportunities for each student in case of Century Tech. Clustering frameworks identify necessary guidance for distinct learner groups, while natural language processing enhances predictive modeling utilizing rich repositories of quality content and texts sourced from students and teachers [37]. Century clustering framework identifies the guidance needed for different learner groups, using natural language processing to improve predictive modeling. The platform collects data on student learning, including answers and time spent on questions. The system analyses this data and makes predictions about the student's knowledge level, based on which it recommends a personalised learning path for the student. These are suggestions for future tasks the student should do next. The platform also recommends tailored learning material based on interests, so students are more likely to maintain their interest in the material, which keeps them motivated. The system also provides teachers with useful information on students' progress and learning. Century Tech is suitable for teaching multiple subjects. Thanks to adaptive learning, the use of the platform can be particularly effective in lower-performing subjects, as the system helps students to find their own learning pace and style. Finnegan, a teacher at Charlton High School, describes CENTURY as follows: "*CENTURY is an online learning tool for students. It integrates artificial intelligence with the latest research in learning science and neuroscience.*

The platform identifies each student's strengths, knowledge gaps, and misconceptions. Students can log in and complete tasks recommended for them by the advanced recommendation engine or tasks defined by teachers. This allows students to take control of their own learning, while teachers receive real-time data on their progress, enabling them to quickly identify which students need support or further challenges" [38]. Used in many countries, including the United Kingdom, India, Nigeria, China and the United States [39].

4.2.5. ClassCraft

ClassCraft is an educational software that makes the classroom experience fun for students. The application allows teachers to motivate and personalise learning in a playful way, while integrating RPG (Role-Playing Games) analysis into school life. Using ClassCraft, students create their own character that they can develop and customise, while in the classroom they receive 'rewards' and 'punishments' based on their achievements and behaviour in class. The system automatically tracks students' performance, and teachers can monitor students' progress and identify cases where students need help. ClassCraft uses artificial intelligence to analyse the data. The app suggests adaptive learning pathways for both students and teachers based on student performance, learning style and behaviour. Teachers can tailor the platform to their own curriculum and the needs of their classes. According to the research by Papadakis and Kalogiannakis, ClassCraft is not tied to specific school subjects, and the duration of the game depends on the teacher's expectations. ClassCraft is a game designed to help students have fun, promote teamwork, and become better learners. The study presented an experimental teaching intervention. Their results showed that ClassCraft did not positively influence overall student performance; however, it had a positive impact on their commitment [40]. The results of Sipone and colleagues' survey indicate that the use of ClassCraft raised students' awareness of how they could become active participants in behavior change [41]. Observations by Sanchez and colleagues suggest that depending on the integration context, not all students experience ClassCraft equally. These observations support a gamification model that considers students' experiences rather than solely examining the game itself, reinforcing that the game is consistent for the player. It can be inferred that the gaming experience depends on various factors, including the institutional acceptance of the game, the available resources in the classroom, and how the teacher introduces and implements the game [42]. Classcraft can have positive effects not only on students but also on teachers. The results presented by Krishnan and colleagues demonstrate the improvement of English language teachers' competencies through the integration of Classcraft in online gamified learning. The online gamified learning module designed and developed on Classcraft helped teachers elevate their competencies from at least B2 level to C1 level [43].ClassCraft is currently used in education in many countries, including the United States, Canada, the United Kingdom, Australia and New Zealand [44].

4.2.6. Connect

Connect is an education platform that uses artificial intelligence to support online learning and increase the effectiveness of education. It is also one of the McGraw Hill products mentioned earlier. The software has several features, including digital learning materials for students, online tests and assignments, and tutorial tools for preparing and assessing course materials. The Connect software's artificial intelligence manifests itself in a number of ways, such as analysing and interpreting data generated by students and teachers. The system monitors the performance and learning habits of individual students and recommends personalised learning paths based on artificial intelligence uses adaptive learning. The tool also offers assessment and feedback features to help teachers track student performance and provide

personalised feedback. The platform supports the teaching of a wide range of subjects, including economics, health, engineering, science and social sciences. The platform is used in several countries, mainly in the United States. Previous research by Babtain found that students who used McGraw Hill Connect did not show significant positive results compared to students who did not use the software [45]. However, the study was conducted on a relatively small group and we recommend that the experiments be continued on larger groups.

4.2.7. Coursera

Coursera is an online platform that hosts numerous reputable Massive Open Online Courses (MOOCs) offered by renowned universities [46].The platform uses adaptive learning to personalise education and increase learning efficiency. Coursera uses algorithms to evaluate the assignments and tests that students complete, which the system then uses to make recommendations to students on which additional courses or modules to take. In addition to taking into account student achievement, attention and interest levels, the system provides students with personalised recommendations that can help them develop further learning paths. In addition, Coursera's artificial intelligence allows course instructors to monitor student activity and optimise course materials based on progress. It can be used in medicine, science, social sciences, but also in arts, humanities and economics. Long's work, which examined quantitative and qualitative data, revealed that overall satisfaction with Coursera courses was relatively low. Furthermore, most learners were dissatisfied with their learning experiences on the platform, primarily due to inadequate assessment, lack of support and interaction with instructors, and insufficient plagiarism control. Additionally, a moderate correlation was found between learners' satisfaction and the perceived usefulness of Coursera courses [47]. In contrast, Thao Ho and colleagues investigated the practical applicability of Coursera within the framework of a Vietnamese university. The study's results indicated that the learning content of Coursera Massive Open Online Courses and the online responsiveness of Coursera staff had a significant impact on student satisfaction [48]. According to Coursera, the platform is available in more countries and some courses are fully translated into multiple languages.

4.2.8. DreamBox Learning

DreamBox Learning is an adaptive maths teaching software that uses artificial intelligence based adaptive learning to design and tailor individual learning paths for students. The first step of the software is a test, during which algorithms assess the student's level of mathematical knowledge, including strengths, weaknesses, and missing skills and knowledge. The algorithms then personalise the student's learning path and recommend tasks that are tailored to the student's individual needs and learning style. DreamBox Learning's artificial intelligence therefore focuses on adaptive learning, allowing students to progress at their own pace and only move on in a topic once they have fully understood it. The algorithms also track student performance and use the data to refine the learning path and curriculum to ensure the effectiveness of the learning process. The adaptive learning platform offered by DreamBox Learning is specifically designed for teaching elementary mathematics. The educational software is used in the United States and Canada [49].

4.2.9. Duolingo

Duolingo is an educational software using artificial intelligence, developed to facilitate language learning. The artificial intelligence they use is the Large Language Model (LLM), specifically the artificial intelligence model called "Birdbrain". It is used to predict the most likely way to complete a text, for example a sentence. This is the same technology that works

on phones when it comes to suggesting the next words in text messages. The software supports different languages and uses an adaptive learning system that analyses the answers provided by the user and personalises the learning process based on the results. The software tries to assess the learners' level of language proficiency and then tailors new learning material accordingly. If learners do well in one subject, they are given more difficult tasks in the next. If they fail, the software reverts to the easier tasks. The software uses the answers to suggest ways to correct mistakes and reminds the student of the words and phrases they have previously learned. The app provides an interactive, playful way for users to learn a language and includes grammar, vocabulary and pronunciation exercises, as well as speaking comprehension and reading tasks. It aims to provide the most effective language learning experience in the shortest possible time. In addition to language learning, it also offers the opportunity to learn about other cultures and countries in the world. In terms of usage, it is an international educational software that supports more than 40 languages, according to the developers. The application is mainly used in the United States, Mexico, Brazil, India, Turkey and Russia. The software is under constant development and expansion. In 2023, our study reached English and German courses through the Hungarian interface. In the Czech interface, only the English course was accessed. On the English interface, on the other hand, we had 40 language learning courses to choose from. Thanks to the cooperation with OpenAI, Duolingo Max can take advantage of the possibilities offered by ChatGPT [50]. Several studies report on the effectiveness of Duolingo. Jiang and colleagues examined the effectiveness of Duolingo with nearly 100 learners. Participants had no prior English language proficiency. The results showed that, on average, students achieved intermediate-level scores in reading and intermediate-level scores in listening comprehension tasks [51]. Another survey investigated the teaching of Spanish and French languages, where learners also had no prior language proficiency. The results indicated that students who completed the beginner level of Duolingo's Spanish or French course achieved Intermediate Low proficiency in reading and Novice High proficiency in listening comprehension [52]. Ajisoko's study examines how the use of Duolingo enhances students' vocabulary. The survey was conducted using pre- and post-testing, and students' responses were examined through a questionnaire survey. The study's results revealed positive responses from the learners. The learners were more motivated to study; they became more skillful as their interest in learning increased; the material was easily understandable; every learner was given the opportunity to practice the material in a fair order; boredom in learning was eliminated; new ideas were encouraged; and it facilitated learners to remember the material by practicing it in everyday life [53]. Ahmed's case study measured the progress of one student who used Duolingo to simultaneously learn Spanish and English for two months. The results showed that Duolingo could facilitate learning both languages for beginners, but there are limitations. One such limitation was that the application generally associates new vocabulary with illustrations. However, there are vocabulary words taught through direct translation without visual representation, so the participant did not know the meanings of many words [54].

4.2.10. Edmentum

Edmentum uses adaptive learning technology, which allows students to progress at their own pace. The software takes into account the learning style and knowledge level of the student and offers them personalised learning pathways. Edmentum also employs machine learning techniques that allow the system to continuously monitor student progress and performance and refine personalised learning pathways based on this. Edmentum also uses automated assessment tools such as built-in assessment tools and automatic feedback. Assessment tools allow instructors to monitor student progress, while automated feedback allows students to receive immediate feedback on their performance and learning outcomes. Edmentum also uses cloud-

based technology, allowing students and instructors to access course materials anywhere, anytime. Edmentum offers digital learning materials and teaching solutions in a wide range of subjects. Edmentum includes lot of courses such as Algebra and Biology, Financial Mathematics, Business English, and Integrated Physics and Chemistry. Available in several countries, including the United States, Canada, the United Kingdom, Australia, New Zealand and South Africa [55].

4.2.11. IBM Watson Tutor

IBM Watson Tutor is an artificial intelligence-based tutoring software that uses an adaptive learning approach to teaching. The goal of Watson Tutor is to facilitate students' engagement with content and self-reflection by allowing students to express their responses in their own words. These activities aim to enhance learning outcomes. The tutor achieves these goals by aligning a series of learning activities following a well-defined dialogue strategy. The activities employed are as follows:

- posing questions, starting with general inquiries and gradually delving into deeper topics, while providing hints along the way and identifying misconceptions;
- responding to students' questions and encouraging exploration by suggesting frequently asked relevant questions raised by students;
- incorporating relevant multimedia content into the conversation to assist struggling learners;
- comparative and contrasting activities aimed at testing students' fundamental conceptual understanding.

The software automatically determines the level and learning needs of students based on their responses and activities, and then offers them unique learning paths. Watson Tutor uses natural language processing and machine learning technologies to create an adaptive learning model for students. The system continuously monitors students' progress and provides feedback on the learning process. Among other things, it helps in teaching STEM (Science, Technology, Engineering and Mathematics) subjects. With Watson Education Classroom, teachers have access to data that helps them understand student needs and personalise learning activities. Teachers can search and share learning content, including lesson plans, tests and worksheets, in an intuitive, teacher-centric interface. IBM Watson Tutor is mainly used in higher education in the United States [56]. Afzal and colleagues surveyed students' opinions to inform future developments of Watson Tutor. The initial survey revealed that initially, the voice-based communication of Watson Tutor was overly monotonous. This was evidenced by less than 50% of respondents considering the application motivating. The survey also highlighted instances where Watson Tutor often did not interpret students' responses correctly, resulting in frustration. Following the enhancements, a subsequent trial showed an improving trend. Nearly 80% of participating students found the Tutor credible, while concurrently, student motivation increased, and the level of frustration decreased [57].

4.2.12. Kidaptive

Kidaptive is an educational platform that uses adaptive learning technology to improve children's knowledge. The basic idea is that the software continuously analyses children's responses and performance, and uses this information to create a personalised learning plan for them. The goal is to provide children with a learning experience that meets all aspects of their individual needs. Kidaptive uses artificial intelligence to analyse data that monitors children's learning habits, skills and mistakes. Algorithms continuously optimise the learning plan and track student performance. The information is then used to give more accurate feedback to students and improve their skills as much as possible. The Kidaptive Learning platform is

primarily designed to teach basic skills and early maths subjects and is therefore recommended for preschool and primary school age. The platform covers topics such as animals, colours, numbers, shapes and time. The main goal of the Kidaptive Learning Platform is to support children's cognitive, language and social development, as well as critical thinking and problem-solving skills. It was mainly used in the United States [58]. Kidaptive builds unique models that adapt and personalize online learning environments. Verhagen's study details how the development team at Kidaptive aided adaptive, game-based learning with rule-based and dynamic Bayesian psychometric models, as well as behavioral models developed based on student responses and behaviors obtained in online learning and testing environments [59]. In 2021, McGraw Hill acquired Kidaptive. Looking ahead, this means further developments and could open new doors to more effective use of personalised learning.

4.2.13. Knewton and Knewton Alta

Knewton is an artificial intelligence-based educational software used in primary and secondary schools to teach maths and language subjects. The software focuses on personalised learning and offers a personalised curriculum based on the learning habits and performance of each student. In Knewton's integrated machine learning technology identifies the personal learning habits and needs of each student based on the answers and other data entered by the student. The software continuously learns from the data throughout the learning process and offers students personalised recommendations for further learning. The Knewton platform enables dynamic design of personalized content combinations tailored to students' preferred learning styles. It allows for various methods to simulate teaching and learning situations and can employ multiple screen shifts and interactions, as well as implement in-class quizzes and commenting applications to fully engage students in learning. Knewton's adaptive platform is capable of providing pre-teaching materials that align with individual students' abilities and interests. While the materials provided may vary slightly, the underlying principles behind adaptive content remain the same. When students encounter difficulties, the system automatically adjusts the difficulty of the content, continuously modifying students' learning materials based on their performance throughout the learning process, providing a personalized learning experience that facilitates and enhances learning efficiency for students [60]. The foundation of Knewton lies in a nonlinear knowledge graph that interconnects concepts. According to Hakkal and Lachen, Knewton identifies and supports the process of continuous personalized learning through real-time tracking and response to learners' interactions (communication, collaboration, and gaming), as well as identifies and bridges knowledge gaps during students' homework, guiding them to where they need to be [61]. Marienko and colleagues' study illustrates that in Arizona, with the assistance of Knewton, the dropout rate decreased from 13% to 6%, and the completion rate of studies increased from 66% to 75%, confirming its effectiveness [62]. Knewton is used by teachers and students in the United States, China, Japan, Korea, Singapore, Brazil and other countries.

Knewton Alta, however, is an adaptive learning platform specifically dedicated to mathematics and statistics courses, which also analyses student responses and tailors the curriculum to the needs of the students. It supports basic, intermediate and advanced level curricula. Covers, among others, basic mathematics, algebra, trigonometry, number theory and statistics [63]. It also covers, although not as widely, other courses such as chemistry, biology, physics and economics. In 2017, several higher education institutions began implementing Knewton's integrated adaptive learning curriculum, Alta. Instructors using Alta create master-level adaptive tasks and static (non-adaptive) tests by selecting learning objectives. Students engage with adaptive tasks and fixed quiz questions, receiving personalized experiences, while Knewton provides various analytical analyses of the results to instructors [64].

4.2.14. Learn with M.E.

Learn with M.E. (Math Educator) is a smart software we have developed that can be used in primary school mathematics education. The software provides practice of the four basic operations and mixed parentheses problems at different levels of difficulty. The potential of the software lies in the fact that it compares the student's results with the sample errors in its database. If it finds a match, it will alert the student in synchronous time to the cause of the error. Students can make multiple attempts to correct and, if necessary, view the full calculation of the correct solution. The software includes a built-in achivement system that motivates students to compute in a playful way. The software creates a digital workbook for each student to archive their progress. The statement is meticulous, as it archives the type of example generated, the level of difficulty, the specific example, the time taken to calculate, the total calculation, the student's result, the reason for the error and the number of attempts. The teacher has access to this workbook. The program clearly shows the exact weaknesses of a particular student, so the teacher can easily develop personalised examples to help the student catch up. The system is based on validation and verification algorithms. Furthermore, it adaptively assesses the student's individual performance and sets the appropriate level of difficulty for the student. The software can run on Windows, macOS with direct path and Linux. The application currently supports five languages: English, German, Hungarian, Slovak and Czech, so it can be used in multiple countries. The practical implications of Learn with M.E. have been examined. The software currently has nearly 330 active users. We introduced Learn with M.E. to a total of 7 educational institutions for students in grades 5 through 9. The latest version of the software, version 1.7, has an accuracy rate of 92%. This means that it was able to identify the cause of errors with 92% accuracy, filtering out invalid calculations, and notifying both students and teachers. As a result, during the survey, 84 students received more personalized instruction. For 61 students, Learn with M.E. improved their mathematical skills during learning [65].

4.2.15. SMART Learning Suite

The software allows teachers to create interactive presentations, activities and exercises to help students learn the material. It includes a number of features that allow teachers to personalise teaching according to students' needs. The software automatically calculates student performance and forecasts their progress. In addition, SMART Learning Suite allows teachers to automatically share results and progress with students and parents. It can be used in many areas of education, such as: science, language learning, social studies, arts and physical education.

The SMART Learning Suite educational software can incorporate various forms of artificial intelligence. It supports multilingualism, adaptive learning, provides immediate feedback to students and accelerates the work of instructors through automated assessment.

The SMART Learning Suite also offers a range of tools and applications that support interactive learning, such as:

- SMART Board - interactive whiteboard: allows teachers to interactively present the curriculum and interact with students.
- SMART Notebook software: allows teachers to create interactive learning materials, games and tests.
- SMART Response: allows teachers to assess student responses instantly.
- SMART amp: allows teachers to collaborate online with their students and other teachers.

These tools and apps are adaptable to a wide range of subjects and teaching styles, allowing the teacher and students to have an interactive and engaging learning experience. The software is used in many countries, including the United States, Canada, the United Kingdom, Australia, Singapore and China [66]. Tsayang and colleagues' study examines the impact of using SMART boards on student learning. The results showed that students perceived the use of SMART boards to have a positive effect on their learning. The study addressed three areas of learning: cognitive, affective, and psychomotor. According to the study's conclusion, the learning experiences facilitated by SMART boards contributed to students' development at various levels of thinking in the mentioned areas [67]. Nichols' work presents the application of SMART Notebook software in music classes. The study evaluates and demonstrates the opportunities provided by SMART Board and Notebook positively. According to the author, teachers can save time by creating visual materials in SMART Notebook and further save time by not having to acquire physical resources or wait for materials to be ordered. The current generation of interactive whiteboards allows multiple individuals to use the touchscreen features simultaneously, meaning multiple students can work on the board at once. This new board technology uses cameras that enable multiple students to manipulate multiple items on the screen simultaneously [68].

4.2.16. Comparison

To provide readers with a quick and easy overview, the table below summarises the software listed above and the features they support, partially support and do not support. Table 3 serves to demonstrate this data.

Table 3

A comparison of the features of intelligent educational software

	Personalised features	**Automated features**	**Interactivity**	**Multilinguality**	**Teacher or parent interface and functions**	**Tracking student results**	**Play elements, achivements and motivation**	**Downloadable desktop application**	**Mobile or tablet support**	**Need a permanent internet connection**	**Registration required**	**Free use**
ALEKS	Yes	Yes	Yes	Partly	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Carnegie Learning	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No
ChatGPT	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Partly
Classcraft	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partly	Partly
Connect	Yes	Yes	Yes	Yes	Yes	Yes	Partly	Yes	Yes	Partly	Yes	No
Coursera	Yes	Yes	Yes	Partly	Yes	Yes	Yes	No	Yes	Partly	Yes	Partly
DreamBox Learning	Yes	Yes	Yes	Partly	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Duolingo	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Partly	Yes
Edmentum	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Partly	Yes	Yes	No
IBM Watson Tutor	Yes	Yes	Yes	Partly	Yes	Yes	Partly	No	No	Yes	Yes	Partly
Knewton and Knewton Alta	Yes	Yes	Yes	No	Yes	Yes	Partly	No	Partly	Partly	Yes	No
Learn with M.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Partly	Yes

SMART Learning Suite	Yes	Yes	Yes	Partly	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partly

Although the target groups of the intelligent tutoring software presented above are different, their technological background, operating principles and algorithms may be close. In the majority of cases, machine learning, including adaptive learning, and natural language processing methods have dominated, which we briefly describe for a better overview, based on the following studies [69] - [73].

Adaptive learning: adaptive learning is a technological approach that allows educational software to dynamically adapt to the individual learning needs and abilities of students. This allows for the development of tailored curriculum designs and the delivery of learning tasks that are appropriate to the students' development. Algorithms used in adaptive learning include k-means clustering or decision trees, which help educational software to identify students' strengths and weaknesses in different subject areas.

K-means clustering is an unsupervised learning algorithm that divides data into K clusters. Each cluster has a cluster center, called a centroid. The equation describing the algorithm and its general operation is outlined as follows [69], [70].

Let $X = \{x_1, x_2, x_3, \ldots, x_n\}$ be the set of data points and $V = \{v_1, v_2, \ldots, v_c\}$ be the set of centers. Then:

$$J(V) = \sum_{i=1}^{c} \sum_{j=1}^{c_i} \left(\|x_i - v_j\|\right)^2 \quad (1)$$

where, $\|x_i - v_i\|$ denotes the Euclidean distance between x_i and v_j, c_i denotes the number of data points within the i^{th} cluster and c denotes the number of centroids in the cluster.

The steps of the algorithm:

1. Randomly select cluster centres c.
2. Calculate the distance between each data point and the cluster centres.
3. Assign the data point to the cluster centre whose distance from the cluster centre is the smallest of all cluster centres.
4. Calculate a new cluster centre.
5. Recalculate the distance between each data point and the newly obtained cluster centre.
6. If no data points have been reassigned, stop, otherwise repeat from step 3.

From an educational perspective, this clustering can be implemented as follows:

- The educational software records data on students' learning performance.
- The system selects characteristics that describe the learning styles or needs of students.
- The K-means algorithm creates groups and places students with similar characteristics in each group.
- The educational software offers personalised learning materials and strategies for each group.
- The adaptive learning system continuously monitors student performance and learning progress. If changes are observed, the system dynamically updates the clusters accordingly.

Decision tree is one of the most common supervised learning algorithms. Decision rules are usually expressed as "if-then-else" statements. Decision trees classify examples by moving from the root which can be interpreted as the main "if" to each leaf down the tree, with the leaves giving the classification of the corresponding examples. Methods for generating decision trees from data, such as C4.5, allow the representation of learning results in a tree [71]. They are mainly used as prediction algorithms. Consequently, educational software can support effective learning by providing more personalised tasks and pathways relative to the expected learning outcomes of students.

In educational terms, this can be implemented in practice as follows:

- Decision trees can help education systems diagnose students' strengths and weaknesses in different subjects or skills.
- Educational software therefore makes it easier to define an individual learning path and curriculum.
- It gives students immediate feedback on their performance and mistakes.
- The result is the automation of the teaching process, which can make learning and teaching faster and more efficient.

Natural language processing: This refers to systems that can interpret and answer human questions. Such systems are called chatbots. The most sophisticated chatbots almost feel as if we are talking to a real person. Neural networks are deep learning techniques that can be used effectively to build such systems. These are artificial intelligence models inspired by the way the human brain works. There are several types of neural networks, the appropriate choice of which depends on the purpose for which we want to use them. They are usually composed of an input layer x, the weighting values w associated with the inputs and an output layer y. If necessary, hidden layers are placed between the input and output layers. Neural networks differ not only in their architecture but also in the way they learn. A distinction can be made between supervised, reinforcement and unsupervised learning [72]. Recurrent, convolutional and transformer networks are the most relevant for natural language processing [73].

The creation and operation of these types of systems are described in the following points:

- Collecting, cleaning and formatting relevant linguistic data.
- Text tokenisation, also known as splitting words into text elements.
- Converting data into word vectors.
- Choosing the right neural network.
- Training the neural network, resulting in optimal connection weights.
- Testing the output of the network, fine-tuning if necessary.
- Creating an easy-to-use user interface through which the user can access the neural network.

From an educational point of view, from the student's perspective, such systems can be used in the form of chatbots, where students can satisfy their thirst for knowledge instantly. From the teacher's point of view, the use of such systems can be useful for the automatic evaluation of written tests.

It can be said that choosing and building the right algorithms is an important step in the development process. The algorithms behind the educational software determine how the software responds to student activity. To achieve successful results, it is essential to involve teachers and education professionals in the development process. Good communication between developers and education professionals can contribute to the creation of successful intelligent educational software that truly meets educational needs and helps students learn more effectively.

5. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

As we can see, Generation Z and Generation Alpha students are open to educational software and the next generation is born into the age of artificial intelligence. This is why it is important that such software supports education in an effective way.

This paper has assessed the students' needs and interests in the use of educational software and has revealed new directions for our future research. In this context, we have described some smart tutoring software. Since the effectiveness of the software presented is largely

concentrated in the United States, future research will seek to assess the extent to which the educational software listed in section 4.2 is proving to be an effective tool in European educational institutions. We will start by testing the software available free of charge. An attempt has already been made to facilitate secondary school programming lessons using ChatGPT. Instead of using the chatbot to generate code, we focused on using the chatbot to help students understand code and functions by generating comments and explanations. This allowed us to work effectively with a larger group, as we didn't have to spend most of the lesson explaining. Each student was given a detailed explanation of a feature they were unfamiliar with using the chatbot. With Learn with M.E., we have already involved more than 300 primary school students in the survey, who have completed nearly 12 000 tasks using the software. Using the latest version, the software has so far shown an 92% accuracy rate in analysing students' tasks. The software has provided students with immediate feedback and correction suggestions for hundreds of incorrect examples. Accordingly, the personalised difficulty level adjustment was determined for hundreds of examples. The results show that some of the students were able to catch up while using the software and did not make the same mistake more than once. For weaker students, the statistical results have allowed teachers to create personalised tasks to address weaknesses. Linguistic colleagues are currently assessing the potential of the Duolingo software for secondary school students. In the future, we aim to test most of the software listed in section 4.2. We intend to substantiate our results with a user questionnaire from the students' side and a SWOT analysis from the teachers' side.

This study, in addition to conducting surveys among students, gathered educational software solutions that can provide more personalized education due to their innovative technological approaches. The study outlined the focuses of various educational software and platforms and summarized researchers' opinions based on their previous findings regarding the advantages and potential limitations of the mentioned software. Since digital technology is part of our everyday lives and students demand innovative educational tools, it is hoped that educators reading the study will take advantage of the opportunities offered by educational software.

Overall, intelligent, or smart educational software has many advantages for education. They enable students to learn more effectively and more easily. Taking our previous examples as a starting point, we can say that the application of AI in education focuses on personalised education, with the resulting increased efficiency, task automation, flexibility and easy accessibility.

Looking to the future, in addition to supporting students, intelligent software as virtual colleagues will also support teachers. However, teachers will continue to play important roles in education, as they will be able to interpret the results of these software and provide further personalised support. They are the ones who help students interpret the data and provide additional information. In addition, teachers will be able to encourage students to engage in critical thinking and problem solving. Educational software therefore complements and supports teachers' work but does not replace it. Teachers must continue to support students and not completely lose the human connections that remain essential in education, even in the age of AI.

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ОСВІТНЄ ПРОГРАМНЕ ЗАБЕЗПЕЧЕННЯ ТА ШТУЧНИЙ ІНТЕЛЕКТ: ДОСВІД СТУДЕНТІВ ТА ІННОВАЦІЙНІ РІШЕННЯ

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Анотація. За останні роки основною тенденцію розвитку систем освіти стає цифровізація. Штучний інтелект (ШІ) дозволяє розробляти нове освітнє програмне забезпечення, яке може створювати адаптивно-персоналізовані навчальні плани для студентів. Таке нове програмне забезпечення може мати неоціненне значення для підвищення ефективності навчального процесу, покращення комунікації між викладачами та студентами, а також сприяти кращому розумінню навчального матеріалу. Тому важливо використовувати вже наявні інструменти в освітньому процесі. Поряд з викладачами студенти є невід'ємною частиною освітнього процесу, і саме вони стають активними користувачами цього програмного забезпечення. Мета нашого дослідження - оцінити зацікавленість студентів в освітньому програмному забезпеченні. Під час дослідження було проведено кількісне опитування, у якому взяли участь 500 студентів з різних навчальних закладів початкової, середньої та вищої освіти, представники покоління Z та Alpha. Опитування виявило уявлення студентів про концепцію штучного інтелекту. Крім відкритості навчального програмного забезпечення, був

досліджений зв'язок між ставленням студентів до штучного інтелекту та їх досвідом з використання освітнього програмного забезпечення. Результати дослідження показують, що студенти зацікавлені у використанні освітнього програмного забезпечення, і більшість з них відкриті до використання освітнього програмного забезпечення на основі штучного інтелекту. Було зроблено висновок, що викладачі мають враховувати впровадження такого програмного забезпечення у своїй педагогічній практиці під час формування майбутніх методів викладання. Крім цього, на основі проведеного аналізу міжнародної наукової літератури представлено 15 освітніх програмних рішень, які завдяки своїм інтелектуальним функціям прискорюють і спрощують процес навчання, водночас підтримуючи диференційовану та більш персоналізовану освіту. Метою проведеного аналізу є ознайомлення читача з потенціалом освітнього програмного забезпечення та заохочення навчальних закладів і вчителів до щоденного використання цього типу програмного забезпечення.

Ключові слова: штучний інтелект; освітнє програмне забезпечення; освітні платформи; засоби навчання; інновації; автоматизована освіта.