Artificial Intelligence in Personalized ICT Learning

Krasheninnik Iryna Volodymyrivna[1], Chorna Alona Vitaliiivna[2], Koniukhov Serhii Leonidovych[3], Liudmyla Ibrahimova[4], Serdiuk Iryna[5]
konukhov@mdpu.org.ua
[1-5]Department of Informatics and Cybernetics Melitopol State Pedagogical University of Bogdan Khmelnitsky, department of Informatics and Cybernetics, Melitopol, Zaporizhia region, Ukraine

Summary
Artificial Intelligence has stimulated every aspect of today's life. Human thinking quality is trying to be involved through digital tools in all research areas of the modern era. The education industry is also leveraging artificial intelligence magical power. Uses of digital technologies in pedagogical paradigms are being observed from the last century. The widespread involvement of artificial intelligence starts reshaping the educational landscape. Adaptive learning is an emerging pedagogical technique that uses computer-based algorithms, tools, and technologies for the learning process. These intelligent practices help at each learning curve stage, from content development to student's exam evaluation. The quality of information technology students and professionals training has also improved drastically with the involvement of artificial intelligence systems. In this paper, we will investigate adopted digital methods in the education sector so far. We will focus on intelligent techniques adopted for information technology students and professionals. Our literature review works on our proposed framework that entails four categories. These categories are communication between teacher and student, improved content design for computing course, evaluation of student's performance and intelligent agent. Our research will present the role of artificial intelligence in reshaping the educational process.

Keywords:
Artificial Intelligence, education, vocational education

1. Introduction

Artificial Intelligence (A.I.) gains rapid response in all aspects of human life. Day to day life has become changed after the wide-spreading adaptability of A.I. Researchers and A.I. scientists are making their unstinting efforts to make human life more comfortable and technologically advanced by using A.I. tools and techniques. Education is a sector that warmly adopts Information Communication Technology (I.C.T.) landscapes; A.I. is one of the most used I.C.T. paradigms in the education industry[1, 2]. I.C.T. in the education sector has been hyper adopted has been widely adopted. For instance, practical computer education has been declared compulsory in primary schools [1].

Furthermore, Learning Management systems (L.M.S.) are widely adopted by an increasing number of educational institutes throughout the globe [3]. From the past decade, an enormous increase in the use of Massive Online Open Courses (MOOCs) demonstrates society's acceptability of online learning phenomena. These MOOCs s not only facilitate students by learning new technologies but also brighten their resumes by giving them a certificate, Nano degree and even diplomas. Along with MOOCs,s massive online tutoring platforms like preply, khan academy, code hero etc., indicate that the market trend of online learning is increasing. During health emergency conditions of the last couple of years, online learning tools like zoom, M.S. Teams, Google meets etc., are more prevalent. This lockdown condition completes the term of online learning popular among all countries globally. African governments and underdeveloped Asian countries also adopted online learning mechanisms during the covid situation; hence students of all countries are familiar with the online learning paradigm. Along with online learning services, Artificial Intelligence, Virtual Reality (V.R.), and Augmented Reality (A.R.) have also been adopted progressively in the education domain. V.R.'s use cases in the learning process are widely seen in a medical study. Where simulations of surgical theatre are used to train medical students, particularly for complex surgery like brain tumour operation etc., A.R. apps are widely adopted in a simulation of intensive complex subjects. The use of the A.R. app to 3D and 4D modelling has started developing to facilitate model designs[4]. Individualization of the training process has been a big challenge since the start. Making such a system that understands the learning needs of each individual and being tailored is the primary goal of adoptive leering. A.I. is playing a positive role in the individualization of training of students [5]. Along with I.C.T. students, their fresher professionals also need an intelligent system that can understand each professional's learning needs and help them excel in their skills. We considered essential items of the learning process: the content that needs to be learned, the teaching methodology, the student assessment criteria, and intelligent agents (Fig. 1). We present the items as mentioned above in section III in detail.

Manuscript received February 5, 2022
Manuscript revised February 20, 2022
https://doi.org/10.22937/IJCSNS.2022.22.2.21

This paper's primary goal is to individualize future I.T. person training. We will develop a methodology to tailor the training process of vocational training students, particularly students from the domain of information technology. We will present background and domain knowledge in section II. Sections III will focus on our designed framework of narrative overview. In section IV, we will offer a discussion of our literature review. At last, we will conclude our research for future researchers.

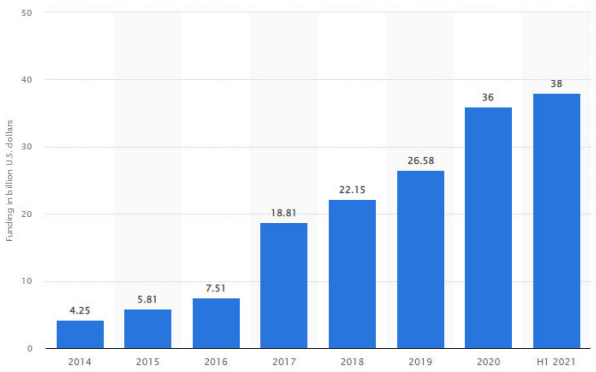


Fig. 1 Funding of A.I. startup companies worldwide [6]

2. Background

This section will present preliminary information about Artificial Intelligence branches used in education like machine learning, reinforcement learning, neural networks, etc. This discussion will help readers grasp technical knowledge of A.I. branches and their possible use in education. Also, we will discuss so far investigated use of A.I. subdivisions in education.

2.1 Algorithms

Algorithms are an indispensable element of A.I. The history of A.I. starts from the history of algorithms. Algorithms are formally defined as an approach to solving problems stepwise. The terms algorithms were firstly presented by muslin scientist Musa abulkhawarzmi in 850 A.D. [7]. Currently, many algorithms have been designed to solve numerous accurate word problems. The canvas of algorithms spans from simple sorting algorithms to complex D.N.A. algorithms [8]. Development of A.I. cannot be possible without having in-depth knowledge and skill of algorithms. The role of algorithms in education is broad, from learning algorithms basics to developing novel and efficient algorithms.

2.2 Machine Learning

The early stage of A.I. involves instructing how to complete a brilliant job. Machine learning in advance promises to make computer programs so intelligent that it does not need to train for the next step; instead, machine learning algorithms teach themselves with the help of an input training set. Nevertheless, machine learning algorithms need extensive input data to predict its further step. Machine learning plays its unsurpassed role in the education industry, like other areas, to improve the efficiency of leaner and learning software[9]. Abundant applications of today's world are leveraging machine learning techniques. Self-driving cars, natural language processing applications, stock exchange forecasts are examples of machine learning applications[10]. The widespread nature of machine learning makes it as popular as it seems to be a competitor technology of A.I.; in essence, it is the subfield of A.I.

Machine learning can be further distributed into supervised learning, unsupervised learning and reinforcement learning.

Supervised learning deals with input data and labels. The input data values are given pre-defined tags, supervised learning algorithm, in turn, become able to predict the future label of similar data. One easy example of supervised learning is Facebook's photo recognition algorithm.

In contrast with supervised learning, Unsupervised learning does not have labels of data values. An unsupervised learning algorithm attempts to reveal a hidden pattern from the data cluster. D.N.A. recognition and human signature recognitions are examples of unsupervised learning applications.

Reinforcement learning can be assumed the most powerful category of machine learning that deals with continuously changing data. In both supervised and unsupervised learning, the algorithm needs to transform itself by the programmer as the data changes. In contrast, reinforcement learning algorithms self-change from the feedback of previous execution.

2.3 Artificial Neural Network

An artificial Neural network (ANN) is a kind of A.I. working as a human brain. ANN have different variants like Deep Neural Network (D.N.N.), Convolutional Neural Network (CNN) etc. These all broadly fall into the category of Deep Learning, an advanced form of machine learning. To understand ANN, let's take an example. Suppose we have two sets of values, one of them contain temperature values in Celsius degree and the other one is in Fahrenheit. Our ANN algorithm will design a network from each value in the first data set to each of the second data set to find a relation between them. ANN is quite

different from programming algorithms with a pre-defined function and need some input values and take output after performing that functionality (Fig. 2).

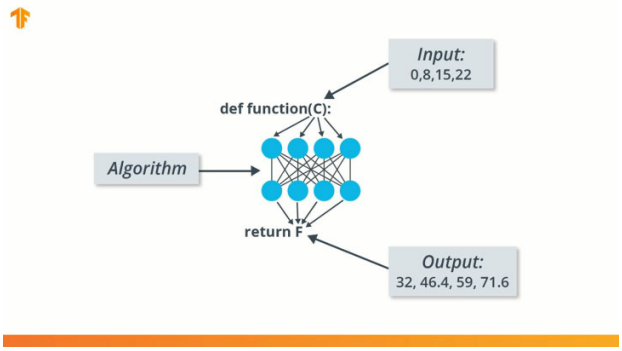


Fig. 2 Example of neural networks

2.4 A.I. in education

This section will reveal how A.I. plays its part in the education sector. Along with everyday use of A.I. in the education sector like the timetable, staff scheduling, facilitation management, A.I. can work as a decision-making tool for executive decision-makers and student learning. The history of A.I. in the education area can be started from the first teaching machine by Sidney Pressey in 1924. That machine works to help students find correct answers to multiple-choice questions. Skinner teaching machine in 1954 can bethink as the next step to A.I. in education. Skinner machine is the first commercial machine for the education sector. This machine was based on the idea that the human mind constantly changes its response to an external element. These machines are composed of mostly fill in the blanks worksheets. If the student gave the correct answer system will ask the following question; otherwise, it is reinforced by providing the correct answer.

3. Methodology

This section will describe the methodology we adopted for the literature review of the topic mentioned above. For a narrative overview, we choose electronic databases like Google Scholar, Scopus, A.C.M. digital library, Elsevier etc., for searching research papers of our interest. We also search from some specific journals editions and conference proceedings whose topic matches with A.I. in the education sector. For example:

- Keywords use used for searching our related research papers are following:
  - Artificial intelligence in education
  - A.I. in education
  - Adaptive agent for the educational process
  - A.I. in vocational training

Table 1: Journals as a data source

Title	Indexing
I.C.T. in Teacher Education	A.C.M.
Journal of E-learning and knowledge society	Scopus
International Journal of Artificial Intelligence in Education (IJAIED)	Springer link
Computer and education	Elsevier
Computers and human behaviour	Elsevier

In contrast to the systematic mapped study, we did not follow a static approach; instead, the method we observed is a narrative overview.

3.1 Inclusion/exclusion criteria

We use the following constraint to narrow down our search as exclusion criteria.

- Research papers that are not published in the English language
- Book chapters
- Research papers from standalone/bogus journals
- Research papers that discussed education policy without use of A.I.

As inclusion criteria, we use the following factors in mind

- Research papers from S.S.I. or I.S.I. indexed journals
- Conference proceeding with S.S.I. indexed data source
- Research papers that use A.I. terminology in the education domain
- Research papers published after 2009

3.2 Model framework

In this section, we will present our proposed framework of narrative overview. Fig 3 illustrates our model. In this model, we choose the following part that, in our best knowledge, can be affected by A.I. Since our focus is on individualization of I.T. persons, we keep in mind I.C.T. education rather than general education.

- Content
- Intelligent agent
- Teaching method
- Communication

Content, as its name suggests, needs to learn. In our case, content is any topic related to I.C.T. It can be from any computing domain that can span from basic programming knowledge to extensive complex computing content like parallel or distributed programming or mathematical modelling of research areas.

The intelligent agent here refers to smart software/hardware used in the learning process. It can be a Chabot, Robot, web-based learning management system, or any online assessment software. Teaching methods are techniques and policies adopted by the tutor to teach students I.C.T. technology. The teaching method has two prospective, one of which is related to the learner, deals with an individual's capability of learning a new subject, and the other is content that needs to be taught (Fig 3). Communication is the backbone of any learning paradigm. It refers to communication between learner and teacher; without it, the teacher can complete no learning process. In an intelligent education system, it can be referred to as classrooms of MOOCs s.

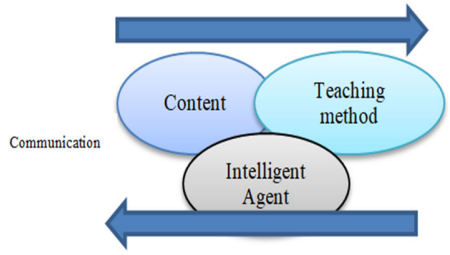


Fig 3: Our proposed model framework

In the proceeding section, we will present findings related to our proposed framework.

4. Results and discussions

This section will discuss our findings from the narrative overview according to the proposed model. This overview is a stat of art about A.I. as an emerging technology to teach an individual. Since our focus is to individualize the training process of I.T. professionals, we focus only on the work that deals with I.T. courses and students. We categorized our data according to the categories mentioned above.

4.1 communications

Communication between students and teachers is the backbone of teaching circumstances. Feedback is as important as delivering a lecture [11]. Since many students teach in a classroom, feedback to an individual student is a cumbersome task. Numerous universities proposed an Intelligent Learning Environment (I.L.E.) approach, a complex system, a merger of L.M.S. and e-learning techniques. I.L.E. is fundamentally an approach to improving students capability of learning throughout their study life. The elementary idea of that approach is to help a student get knowledge related to any particular study area. This idea of improving student capacity of learning from prior experiences with the help of A.I. leads to phenomena of Intelligent Tutoring System (ITS). ITS demonstrates satisfactory results of improving students' ability to learn I.C.T. courses more than traditional classroom study [4]. James carbon, in the 1970s, presents the first idea of I.T.'s with his phenomenon that the computer can act as a teacher[12]. ITS provide excellent results in several fields like match, physics, chemistry, medicine and computing[13]. presents various examples of different learning systems like AutoTutor [14], Beetle II[15], why2-Atlus[12],etc. table 2 presents some famous ITS along with their targeted student's domain.

Table 2: Some famous ITS

#	ITS	Target students
1	Beetle II	School student
2	EER-Tutor	University student
3	Auto Tutor	College students
4	Stoic Tutor	I.T. professionals
5	Chicago	University students

The basic idea behind all ITS are they imprison the data about students, response. Afterwards, this data is used to develop a tailored model for an individual student. This model tries to help students according to their knowledge, motivation and emotional need. In [16], the described the significant functions of ITS as selection, evaluation, suggestion and updating. These functions mentioned above can be considered cognitive models for individual students. Machine learning-based algorithms are very commonly used in ITS—van Lehn in his research [17] taxonomies tutoring system as two systems. One is the Intelligent Tutoring System, as we are using this term as ITS from a past section. Another one he called Computer-Based Instruction (C.B.I.). C.B.I. is based on evaluating each question attempted by the student. This evaluation takes place by a lecturer. In contrast, ITS works as simultaneous tasks attempted by students; this is a continuous task of guiding students perceives that several approaches are so far developed in terms of ITS [18]. For instance, Adaptive Control on Thoughts-rational (ACT-R) uses human reasoning based on the subjects rule. Knowledge Space Theory (K.S.T.) imitates the tutor expertise closely to evaluate students' knowledge on that particular topic. In contrast to ACT-R, it is not based on human cognition; instead, this is a computer-based evaluation system that assesses students' knowledge. In a nutshell, ITS is an attempt to emulate a real teacher action of providing one-to-one counselling with a student. Here one important factor is the interaction between A.I. and human teachers who need more attention. For instance, the impact of interaction with a human is different from interaction with the computer. This research challenge is widespread and can be solved by the immense survey from all students of all ages and intellectual levels. Since, in our research, we

are focusing on computer-based education, these experiments can be confined to a particular study area.

4.2 Assessment

One task of ITS is to answer the students, questions of students scheduled tests. Along with this, ITS also find study gaps of students' knowledge in their study area. The difference between a human teacher and ITS in assessment procedure is that I.T.S. has to work on its pre-defined knowledge. ITS creates an evaluation model, and based on this model; other students are evaluated; that is also called relative marking. One example of ITS evaluation is technology-enhanced labs. In that kind of lab, students are equipped with tablets and perform all classroom activities while teachers can control their movements. One leverage of this system is that it overcomes students, stress and fear of exams. In [19] author proposed an Intelligent Pupil Analysis (I.P.A.). I.P.A. assesses students' performance by a subsystem of decision support system, and other intelligent systems hence can be assumed as a system of systems. In [20], the author proposed various evaluation tools to evaluate students' performance, knowledge and potential. Early Data Mining (E.D.M.) is an exciting approach that investigates the causes of students failure [21]. This exploration helps their tutor to decide for overcoming their shortfalls. Along with traditional data mining tools, it provides psychological metrics to understand students' behaviour better. This psychology-mining method works on dividing pupils into groups of a specific order. This order is a famous personality test order called Myres and Briggs indicator.

Table 3: Myeres-Briggs type indicator

Sensing - Intuition	action-orientation
Thinking - Feeling	decision making basis
Judging - Perception	decision preparation kind

Being efficient and consistent in applying the same criteria for different students is the fundamental strength of A.I

4.3 Teaching Method

One challenge of teaching methodology is that the learning capacity of each individual varies. This concern leads to intelligent students' boredom while slow learners face difficulty in learning new terms and technologies. A.I. promises to overcome this difficulty with the help of personalized learning. Personalized learning is a branch of A.I. that customized learning content according to the need of individual students by measuring its intellectual level [22]. Personalized learning plays its role to overcome students learning difficulties by managing educational content according to their needs.

Personalized learning helps a lot, particularly during exam periods. Although personalized learning was mainly developed for students of k-12 level yet various universities also leverage personalized learning for their students [22]. Ohio state university leads personalized learning for their students and got 20% up-gradation of students' intellectual level till 2019. Personalized learning can result better by combining gamification techniques to produce better outcomes [23]. Gamification is the term that means using gaming strategies in the non-gaming environment [24]. The leader board feature of gamification helps improve individual students' progress by balancing students' speed of learning.

Personalized learning, along with its admiration, also faces some criticism. Alife Kohn, an American educationist and human behaviour expert comments, that the "learning process is no need of any technology rather a passion for learning in the real instinct of learning process" [27]. Other critics of personalized learning settled that intellectual student never needs any technology. Instead, their curiosity is the key to learning. They learn everything they need according to their study requirement by themselves. Personalized learning is a business strategy by software companies of selling their software rather than aim to help students.

4.4 Intelligent Agent

Robotics is another teaching methodology aid along with personalized learning software's. Before the past couple of decades, robots were assumed to be fiction, presented by movies, but the recent era proved that robots are a massively helpful tool in all facets of life; education is one of those aspects. Numerous industries widely adopt AI-enabled robots, and the education sector is one of them. Although horizon to be discovered in AI-Robotics technology, it has been so mature to help students learn their study material.

AI-Robotics, same as personalized learning, criticism that machines can not behave like human teachers. Since with phenomena that learning capacity of each student is different, the teaching method should be other according to each student need.

Students' learning capability is stimulated by various social and psychological factors and mental capacity. For instance, some students may disturb by social family breakups. Furthermore, parents of different students have different interest levels in their Child's study. These factors, as mentioned above, cause a challenge to make a generic software or hardware that can act as a good teacher.

A.I. teachers are a far way to handle such uneven situations. Table 4 and Table 5 presents some robotics tools designed to teach school level students.

Table 4: Some personalized learning tools

Title	Objective	Target audience
Knewton [25]	Knewton give stuents recommendation on base of their learning style. This works on analytic-basis to create content for each student according to their need.	College and University Students
Highlight	Highlight tracks performance of individual student. It is a cloud-based platform.	College /University Students
Immersive reader [26]	A Microsoft contributed personalized learning system for students effected from dyslexia. It can also be used for normal students	Students with dyslexia/dysgraphia
Watson Education Classroom	It is a cloud-based platform particularly designed for college or university teachers to improve their teaching performance	College/University Students
Cerego	Cerrego claims to help students that get rid of books. It is also best personalized learning tool for employees	Companies/ Universities

Table 5: Some robotics tools for school students

Title	Objective	Target Audience
Cubelets	Cubelets helps children to learning coding, designing and other skills. It teaches students by assembling the blocks.	Children with age of 4 years and above
Ozorobot	This is a tech program, promising to teach student, the mathematics, computer science and other science subjects, not only in class rooms but also in afterschool's and at homes.	School level children
Root	Root is particularly designed for student that are interested in learning coding.	School level children
NAO	This robot program is developed for particular students, suffers from autism	Autism children
mBot	mBot is a robot, designed for teaching robotics itself. It teach students about coding, electronics and other essential content related to robotics	Children of all level

This paper aimed to investigate so far work on A.I. in education. We focus mainly on the individualization of computer science students and professionals to excel in their skills with the help of AI-enabled tools and techniques. Along with the review of existing Literature, we proposed a framework about the learning process.

We conduct a narrative overview-based literature review based on our proposed framework. Over review make the picture clear about current promises and challenges of A.I. in education. Since we focused on computing education, only our narrative overview investigate trends of leveraging A.I. in the individualization of I.T. students and professionals. The educational paradigm is reshaping itself by a continuous increase in the quality of education. From our review, it is clear that A.I. cannot entirely replace human teachers, yet many cushions are available to improve students learning process. An immense contribution has been made so far in this research area, spanning from intelligent tutoring systems to AI-robot for teaching. Gamification with existing A.I. technology leads this effort to come close to its destination. The first attempt of A.I. in the education spectrum is the development of massive online courses for online learning. The intelligent system can help mitigate the assessment of students' assignments and detect the gaps between teacher and student. Afterwards, evaluating the learning process has been made pretty easy with the help of intelligent systems like intelligent tutoring systems and computer-based instruction. Although the aforementioned innovative system can quickly evaluate students' exams, they have some shortfalls, such as some possible correct solutions from these systems. Using these systems without a human mentor does not lead to a perfect assessment of the student. One other advantage of intelligent tutoring systems is that they work as a personal tutor by making the digital profile of each pupil, overall performance of the classroom. Furthermore, these digital profiles can also help executives make quick decisions about students. Personalized learning environments improve students' performance drastically and can be helpful for students with some physical disorders like autism or dyslexia. Making content according to each student needs is another plus of a personalized learning system. In other words, they can play a significant part in the individualization of content according to each student. Along with their leverages, a personalized learning environment cannot omit the need for a human tutor who can understand students' social and psychological needs. In a nutshell, A.I. has significantly been involved in the education system to help in content development, student assessment, communication and personalization. Our research will help a future researcher find a research gap in the topic of A.I. in computer education.

References

[1]Rose, C. P., Martinez-Maldonado, R., Hoppe, H. U., Luckin, R., Mavrikis, M., Porayska-Pomsta, K., McLaren, B., & du Boulay, B. (Eds.).: *Artificial intelligence in education: 19Th international conference, AIED 2018, London, UK, June 27-30, 2018, proceedings, part II* (1st ed.). In: Springer International Publishing (2018)

[2] Ikedinachi A. P. WOGU, Misra, S., Assibong, P. A., Olu-Owolabi, E. F., Maskeliūnas, R., & Damasevicius, R.: *Artificial intelligence, smart classrooms and online education in the 21st Century: Implications for human development*. In: Journal of Cases on Information Technology, vol. 21(3), pp. 66–79. https://doi.org/10.4018/jcit.2019070105 (2019)

[3] Popenici, S. A. D., & Kerr, S.: *Exploring the impact of artificial intelligence on teaching and learning in higher education*. In: Research and Practice in Technology Enhanced Learning, vol.12(1), pp. 22. https://doi.org/10.1186/s41039-017-0062-8 (2017)

[4] Wang, D., Han, H., Zhan, Z., Xu, J., Liu, Q., & Ren, G.: *A problem solving oriented intelligent tutoring system to improve students' acquisition of basic computer skills*. In: Computers & Education, vol. 81, pp. 102–112. https://doi.org/10.1016/j.compedu.2014.10.003(2015)

[5]Renz, A., & Hilbig, R.: *Prerequisites for Artificial Intelligence in Further Education: Identification of Drivers, Barriers, and Business Models of Educational Technology Companie*s. In: International Journal of Educational Technology in Higher Education, vol. 17, no. 1, doi:10.1186/s41239-020-00193-3. (2020)

[6] *Total funding of AI startups worldwide 2014-2021*.: In: Statista. Retrieved January 14, 2022, from https://www.statista.com/statistics/621468/worldwide-artificial-intelligence-startup-company-funding-by-year/(n.d.).

[7] Mehri, B.: *From Al-Khwarizmi to algorithm*. In: Olympiads in Informatics, vol. 11(2), pp. 71–74. https://doi.org/10.15388/ioi.2017.special.11(2017).

[8] Chassignol, M., Khoroshavin, A., Klimova, A., & Bilyatdinova, A.: *Artificial Intelligence trends in education: a narrative overview.* In: Procedia Computer Science, vol. 136, pp. 16–24, doi:10.1016/j.procs.2018.08.233. (2018).

[9] Kucak, Danijel, et al.: *Machine Learning in Education - a Survey of Current Research Trends*. In: Proceedings of the 29th International DAAAM Symposium 2018, DAAAM International Vienna, 2018, pp. 0406–0410. (2018)

[10] Stilgoe, J.: *Machine learning, social learning and the governance of self-driving cars*. In: Social studies of science, vol. 48, no. 1, pp. 25-56, https://doi.org/10.1177/0306312717741687 (2018)

[11] Ma, W., Adesope, O. O., Nesbit, J. C., & Liu, Q.: *Intelligent tutoring systems and learning outcomes: A meta-analysis*. In: Journal of Educational Psychology, vol. 106, no. 4, pp. 901–918, doi:10.1037/a0037123. (2014)

[12] VanLehn, K., Jordan, P. W., Rosé, C. P., Bhembe, D., Böttner, M., Gaydos, A., Makatchev, M., Pappuswamy, U., Ringenberg, M., Roque, A., Siler, S., & Srivastava, R.: *The architecture of Why2-atlas: A coach for qualitative physics essay writing*. In: Intelligent Tutoring Systems (pp. 158–167). Springer Berlin Heidelberg. (2002)

[13] Xing, B., & Marwala, T.: *Implications of the fourth industrial age on higher education.* In: Tạp Chí Nghiên Cứu Dân Tộc, vol. *23*. https://doi.org/10.25073/0866-773x/87(2018).

[14] Graesser, A. C., D'Mello, S., Hu, X., Cai, Z., Olney, A., & Morgan, B.: *AutoTutor*. In: Applied Natural Language Processing (pp. 169–187). IGI Global (2012)

[15] Dzikovska, M. O., Moore, J. D., Steinhauser, N., Campbell, G., Farrow, E., & Callaway, C. B.: *Beetle II: A system for tutoring and computational linguistics experimentation*. In: Proceedings of the ACL 2010 System Demonstrations, pp. 13–18 (2010)

[16] Koedinger, K. R., Brunskill, E., Baker, R. S. J. d., McLaughlin, E. A., & Stamper, J.: *New potentials for data-driven intelligent tutoring system development and optimization.* In: AI Magazine, vol. 34, no. 3, 2013, pp. 27–41, doi:10.1609/aimag.v34i3.2484.

[17] VanLEHN, K.: *The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems*. In: Educational Psychologist, no. 4, pp. 197–221, https://doi.org/10.1080/00461520.2011.611369 (2011)

[18] Sabo, K. E., Atkinson, R. K., Barrus, A. L., Joseph, S. S., & Perez, R. S.: *Searching for the two sigma advantage: Evaluating algebra intelligent tutors*. In: *Computers in Human Behavior*, vol. 29, no. 4, pp. 1833–1840, doi:10.1016/j.chb.2013.03.001 (2013)

[19] Kaklauskas, A., Vlasenko, A., Raudonis, V., Zavadskas, E. K., Gudauskas, R., Seniut, M., Juozapaitis, A., Jackute, I., Kanapeckiene, L., Rimkuviene, S., & Kaklauskas, G. *Student progress assessment with the help of an intelligent pupil analysis system*. In: Engineering Applications of Artificial Intelligence, vol. 26, no. 1, pp. 35–50 https://doi.org/10.1016/j.engappai.2012.01.006 (2013)

[20] Yang, F., & Li, F. W. B.: *Study on student performance estimation, student progress analysis, and student potential prediction based on data mining*. In: Computers & Education, vol. 123, pp. 97–108. https://doi.org/10.1016/j.compedu.2018.04.006 (2018)

[21] Costa, E. B., Fonseca, B., Santana, M. A., de Araújo, F. F., & Rego, J.: *Evaluating the effectiveness of educational data mining techniques for early prediction of students' academic failure in introductory programming courses*. In: Computers in Human Behavior, vol. 73, pp. 247-256 https://doi.org/10.1016/j.chb.2017.01.047 (2017).

[22] Pane, J., Steiner, E., Baird, M., & Hamilton, L.: *Continued progress: Promising evidence on personalized learning*. In: RAND Corporation (2015)

[23] Hutchins, D.: *How artificial intelligence is boosting personalization in higher education.* In: Technology Solutions That Drive Education. Retrieved January 15, 2022, from https://edtechmagazine.com/higher/article/2017/11/ai-boosts-personalized-learning-higher-education(n.d.).

[24] Caponetto, I., Earp, J., & Ott, M.: Ga*mification and education: A literature review*. In: European Conference on Games Based Learning, Academic Conferences International Limited, vol. 1, p. 50. (2014, October)

[25] Upbin, B.: *Knewton is building the world's smartest tutor*. In: Forbes Magazine (2012)

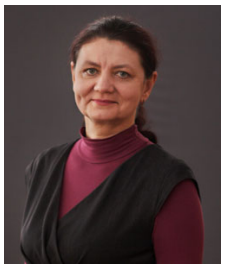
[26] Zhou, M.: *Towards a poetics of immersion in lyric translation: Aesthetic illusion and the translator as immersive reader in English translations of classical*

Chinese ci poetry. In: *Target.* International Journal of Translation Studies, vol. 30, no. 3, pp. 383-407, (2018).
[27] Kohn, A.: *Four reasons to worry about "personalized learning*. In: Tech and Learning, vol. 35, no. 9, pp. 14-15 (2015)

Krasheninnik Iryna received the Master in Education degree from Melitopol state pedagogical institute (Ukraine) in 1998. She received PhD in Education / Pedagogics degree in 2020. She has been working as a lecturer and educational manager from 1998. Nowadays, she is at the Department of Computer Science of Bogdan Khmelnitsky Melitopol state pedagogical university. Her research interests include professional training of IT specialists, personalization of training, adult education. She is an editor of scientific journals.

Serhii Koniukhov received the Master in Computer and Intelligent Systems and Networks degree from Sevastopol State Technical University (Ukraine) in 1996. He received the Candidate of Pedagogical Sciences degree in 2019. He has experience working as a software engineer, educator and researcher. Nowadays, he is a Senior Lecturer at the Department of Computer Science, Bogdan Khmelnitsky Melitopol state pedagogical university. His research interests include Computer Science, software engineering and professional training of programmers.

Alyona Chorna received her bachelor's and master's degrees in 2011 and 2012, respectively. From 2014 to 2020 worked as an assistant at the Department of Informatics and Cybernetics.In 2020 - the worst teacher of the department. In 2021 she defended her PhD dissertation. Research interests: information and communication technologies, lego robot, pedagogical experiment, distance learning, project management, training of software engineers. She is a member of the Girls in IT organization.



Iryna Serdiuk graduated in 1991 as a systems engineer, graduating from the Kharkiv Institute of Radio Electronics (now the Kharkiv National University of Radio Electronics). Since 1992 he has been a software engineer at the Department of Informatics and Computer Engineering.Since 2008 she has been the head of the laboratory of technical means of teaching information and computer center.Since 2017, a leading engineer of the Center for Educational Distance TechnologiesSince 1995 he has been working as an assistant at the Department of Informatics and Cybernetics of the Bohdan Khmelnytsky Moscow State Pedagogical University. She is a member of the Girls in IT organization.

Ibrahimova Liudmyla in 2011 a master's degree in "Professional training. Computer technology in management and learning. " From 2004 to 2012 he was a lecturer at the Department of Informatics and Computer Monitoring of the Melitopol Institute of Economics and Social Technologies of the Open International University of Human Development "Ukraine". From 2012 to 2014 he was a senior lecturer and acting head of the Department of Economics and Computer Systems of a separate unit of the Zaporizhia Institute of Economics and Information Technology in Melitopol. From 2014 to 2018 he was a senior lecturer at the Department of Computer Science, Tavriya State Agrotechnological University. From 2018 to present he is a senior lecturer at the Department of Informatics and Cybernetics of Melitopol State Pedagogical University named after Bohdan Khmelnytsky. In 2021 she received a doctorate. Research interests: C # programming, students' formation of algorithmic thinking, information coding, cryptography.