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ARTIFICIAL INTELLIGENCE APPLICATION IN EDUCATION: FINANCIAL IMPLICATIONS AND PROSPECTS

Abstract. Modern education systems face new possibilities of application of innovative technological decisions in education that promote adaptive learning systems. Nowadays artificial intelligence becomes the central element of these systems and the basic tool to obtain competitive advantages on education services market. Thus, the aim of our research is to determine main trends, challenges and opportunities in application of artificial intelligence in education, exploring financial and social benefits, prospects and threats of that process. In order to achieve main aim of the research, some general and specific methods, such as content analysis, synthesis, abstraction and logical-graphic structuring, were used. Main trends are presented from three points of view: new horizons of teaching and learning opportunities, new threats for teaching and learning opportunities, and new financial and economic opportunities. Despite the social threats of AI usage, such as risks of human teacher unemployment and social interaction destruction within the learning process, market of AI for education systems steep increase. The highest rates of growth are typical for Asia-Pacific region, particularly for fast-growing economies such as China, and South Korea; North America market for AI in education still maintains the lead. Comparing trends in AI spread in education with financial successes of these countries we conclude that AI use in education systems can mitigate social drawbacks via greater accessibility for knowledge, higher quality of the educational process, individual and country competitiveness increase. Consequently, investments in innovation and promising AI programs in education remain a priority for economic growth and demand further support of educational policy makers.

Keywords: artificial intelligence, financial education, investments in education, intelligent learning system (ILS).

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ЗАСТОСУВАННЯ ШТУЧНОГО ІНТЕЛЕКТУ В ОСВІТІ: ФІНАНСОВІ НАСЛІДКИ І ПЕРСПЕКТИВИ

Анотація. Розглянуто нові можливості застосування інноваційних технологічних рішень у сучасних освітніх системах, зокрема й у фінансовій освіті, що сприяють розвиткові адаптивних систем навчання з використанням штучного інтелекту (ШІ). Сьогодні штучний інтелект стає центральним елементом цих систем і основним інструментом для отримання конкурентних переваг на ринку освітніх послуг.

Тому метою дослідження є визначення основних тенденцій і можливостей застосування штучного інтелекту в освіті, вивчення фінансово-економічних та соціальних переваг, перспектив, а також викликів, що супроводжують процес імплементації штучного інтелекту в освітні системи. Для досягнення мети дослідження були використані загальні та специфічні методи, такі як контент-аналіз, синтез, абстракція та логіко-графічне структурування.

Основні тенденції систематизовані з урахуванням трьох вимірів: нові горизонти викладання та можливості навчання, нові загрози для викладання і навчання, нові фінансово-економічні можливості. Незважаючи на соціальні загрози використання ШІ, такі як ризики втрати роботи викладацького складу, погіршення соціальної взаємодії в процесі навчання, ринок ШІ для систем освіти стрімко зростає. Найвищі темпи зростання характерні для Азійсько-Тихоокеанського регіону, особливо для таких країн, що швидко розвиваються, зокрема Китай і Південна Корея. При цьому лідерами за темпами зростання ринку ШІ в галузі освіти залишаються країни Північної Америки. Порівнюючи тенденції поширення ШІ в освіті з фінансово-економічними успіхами цих країн, очевидно, що використання ШІ в освітніх системах може пом'якшити можливі негативні соціальні недоліки за рахунок зростання доступності знань, підвищення якості навчального процесу, підвищення конкурентоспроможності на індивідуальному та макроекономічному рівнях. Отже, інвестиції в інноваційні та перспективні програми ШІ в освіті залишаються важливим вектором забезпечення економічного зростання і вимагають подальшої підтримки при плануванні та реалізації освітньої політики.

Ключові слова: інвестиції в освіту, інтелектуальні навчальні системи, фінансова освіта, штучний інтелект.

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ПРИМЕНЕНИЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В ОБРАЗОВАНИИ: ФИНАНСОВЫЕ ПОСЛЕДСТВИЯ И ПЕРСПЕКТИВЫ

Аннотация. Рассмотрены проблемы и тенденции применения искусственного интеллекта (ИИ) в образовательных системах. Целью исследования является определение основных тенденций и возможностей применения искусственного интеллекта в образовании, финансово-экономических и социальных преимуществ, а также вызовов, которые сопровождают процесс имплементации ИИ в образовательные системы. Для достижения цели исследования использованы общие и специфические методы, такие как контент-анализ, синтез, абстракция и логико-графическое структурирование. На основании тенденций распространения ИИ в образовании в сочетании с финансово-экономическими успехами стран сделан вывод о том, что использование ИИ в образовательных системах может смягчить негативные социальные последствия за счет роста доступности знаний, повышения качества учебного процесса, повышения конкурентоспособности на индивидуальном и макроэкономическом уровнях. Таким образом, инвестиции в инновационные и перспективные программы ИИ в образовании остаются важным направлением обеспечения экономического роста.

Ключевые слова: инвестиции в образование, интеллектуальные обучающие системы, финансовое образование, искусственный интеллект.

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Introduction. The future of higher education is inextricably linked to the development and corresponding increase in the capacity of new intelligent machines capable of operating large amounts of information, self-study and improvement. Artificial intelligence has become a new focus of the international competition of countries on the educational market, therefore the world has already seen the first interactive assistants and adaptive training programs that allow artificial intelligence to personalize the educational process and simplify certain technical tasks. This may be the beginning of

the revolution in one of the most valuable sectors of the economy, where educators work alongside smart machines. Currently developed countries not only provide the younger generation with basic knowledge of artificial intelligence, but also successfully use it to improve the quality of education, seeing it as a reliable assistant, rather than a threat of devastating character. The relevance of our research is based on the need to respond future changes in the educational system.

Research analysis. The analysis of recent research and wide range of papers has shown the mixed opinions regarding the using advisability of artificial intelligence for educational purposes. The opinions of economists and education market analytics included mainly positions of supporters [6; 13; 25; 26], however contradict points of view should be mentioned too, for instance [12]. Nowadays AI algorithms help to raise the level of education by collecting, analysing and correlating every interaction that occurs in the physical and virtual classes, helping teachers solve specific problem areas of each student. As Seligman research has revealed, the integration of machine-to-person processes has not been understood deeply enough, therefore, in our research we address the following scientific problem: what are the problems of integration of machine-to-person interaction and personal training with promising technologies of individual education [23].
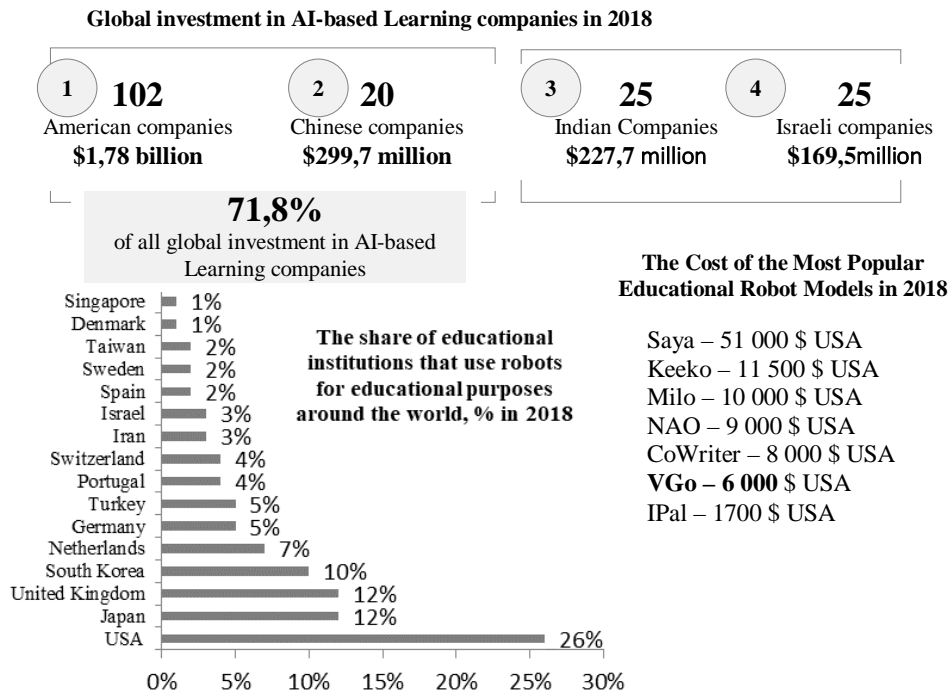
Artificial intelligence (hereinafter — AI) supporters [13; 14; 16; 19; 26] believe there is a huge potential benefit, and they argue that it is important that the teacher's profession was involved in this process from the very beginning. So, in one of the reports «Artificial Intelligence and Life in 2030. One hundred years of study of artificial intelligence» [3] it is noted that learning based on the applications of virtual reality will become an everyday practice. Great success is expected for the education of the future, as specialists will learn more about where the latest technology may turn out to be useful. According to the authors of the article [1], there will always be a role for educators in the field of education, but this role may change due to new technology in the form of intelligent computing systems. Artificial intelligence can take on a number of tasks to help students improve their learning, and can even replace real learning. In most cases, he will change the role of the teacher into the role of facilitator. As people live and work together with more and more intelligent machines, our educational systems will have to reach levels that nobody has ever achieved. Real progress will require the development of infrastructure for AI that resembles a market developed for applications and smartphones and will meet the unified international data standards [20].

The purpose. The aim of our research is to determine main trends, challenges and opportunities in application of artificial intelligence in education, exploring financial and social benefits, prospects and threats of that process.

Research results. AI should be defined as the ability of machines and systems to receive and apply knowledge, as well as conduct intellectual behaviour. This includes various cognitive tasks (for example, tracking, oral processing, reasoning, learning, decision making) and demonstration of the ability to move and manipulate objects accordingly. Intelligent systems use a combination of large analytical data, cloud exchange, communication between machines and computers, and the Internet work and study. Its functions are represented by some physical entities, robots that are capable of analysing a large set of data much faster than people.

There is no doubt that AI has become a new focus of international competition. The market for AI in education is estimated to grow at a significant rate during the forecast period from 2018 to 2025. The geographical analysis of AI in education market is based on dividing world market into four segments: North America, Europe, Asia-Pacific, and the rest of the world. The segment of North America is expected to dominate the market owing to early adoption of technologies such as AI, machine learning, digital learning, and others. North America segment of the market so far has been leading in innovations and technological advancements, which can be attributable to high investments in research and developments in the field of AI technology. In the AI technologies for education North America is predicted to maintain the lead [17]. The Asia-Pacific segment of the market is expected to grow at a significant pace during the forecast period, fuelled by fast-developing economies such as India, China, and South Korea. According to [4], market for intelligent education systems in education in 2018 amounted to over 375 million dollar and is expected to grow by 2808.5 million dollars by 2025.

Artificial intelligence has occupied its own niche in the education systems of many developed countries. The leader is the USA, with 26% of its educational organizations, the second and third position occupied by Japan and Great Britain, Germany and Turkey with the 5% indicator close that group of countries (*Fig. 1*).

Global investment in AI-based Learning companies in 2018

(1) **102**	(2) **20**	(3) **25**	(4) **25**
American companies	Chinese companies	Indian Companies	Israeli companies
$1,78 billion	**$299,7 million**	**$227,7 million**	**$169,5million**

71,8%
of all global investment in AI-based Learning companies

The share of educational institutions that use robots for educational purposes around the world, % in 2018

Singapore — 1%
Denmark — 1%
Taiwan — 2%
Sweden — 2%
Spain — 2%
Israel — 3%
Iran — 3%
Switzerland — 4%
Portugal — 4%
Turkey — 5%
Germany — 5%
Netherlands — 7%
South Korea — 10%
United Kingdom — 12%
Japan — 12%
USA — 26%

0% 5% 10% 15% 20% 25% 30%

The Cost of the Most Popular Educational Robot Models in 2018

Saya – 51 000 $ USA
Keeko – 11 500 $ USA
Milo – 10 000 $ USA
NAO – 9 000 $ USA
CoWriter – 8 000 $ USA
VGo – 6 000 $ USA
IPal – 1700 $ USA

Fig. 1. **Infographics of the impact of artificial intelligence on the education market**
Source: Developed by the authors based on [4; 17].

The global market of educational and training robots has witnessed the emergence of new start-ups with huge funding. The majority (61.5%) of all global investments in educational companies with artificial intelligence in 2018 came to 102 US companies, which collected in total $ 1.78 billion.10.3% of that investments or in terms of value is $ 299.7 million came to 20 Chinese representatives. The top three are locked by India with an interesting portfolio of $ 227.7 million. Israel caught up favourites with $ 169.5 million [4]. The investments inflow has been linked to growing government initiatives to support digitalization, automation and the increasing deployment of cloud services in these countries. The surge in private investments from CRV, Google Ventures, and Madrona Venture Group into exponential innovations has helped increase consumer demand for educational robots for children and strong corporate demand for informational service robots, manufacturing of those robots is approaching mass type production.

Despite the rather high price for the corresponding robot models, for example Saya — 51 000 USD, Keeko — 11 500 USD, the demand for that robots grows steadily. The most wanted in all developed countries are robots designed to teach children how to code. The market's competitive landscape is very dynamic due to the presence of a large amount of big and small players, the main ones are SoftBank (Japan), ROBOTIS (South Korea), PAL Robotics (Spain), Hanson Robotics (Hong Kong), QIHAN Technology Co. (China), DST Robot Co. (South Korea), Probotics America (USA), Wonder Workshop (USA), Aisoy Robotics (Spain) and BLUE FROG ROBOTICS (France). Educational robotics companies such as Wonder Workshop, Modular Robotics and Makeblock have received the largest investments in the last five years (see *Fig. 1*).

Some universities use the original form of AI: Watson supercomputer, first launched at Deakin University in Australia, which collaborated with IBM to be the first university in the world to implement it. This supercomputer combines intelligent analysis and sophisticated analytic software to answer questions of users, uses 90 servers with a combined data warehouse with more than 200 million pages of information and processed in accordance with six million logical rules.

Using Watson in massive open online courses is a step towards making virtual learning partners public and an example of the future impact of AI on the profile of workforce in higher education. This changes the structure of service quality, time dynamics at the university and the structure of its workforce [21].

In 2015, the Technical University of Berlin began using computer chatbot called Alex which helps students to plan their courses. This bot introduces student questions to search queries, like a human advisor, but it has all the information right away. Human advisers should look for it on various online systems. The system is able to answer pragmatic questions about courses and specialties, but cannot answer the questions at a wider level [19].

The countries of Asia-Pacific region — Japan and China use such systems to teach students foreign languages (*Table 1*). 45 million Chinese students already rely on AI to learn English. In 2017, Liulishuo, a Chinese start-up that based on advanced artificial intelligence to study foreign languages, has received $ 100 million in funding and has already started to get profit from 600,000 paid subscribers [14]. A government plan released by the National Council of the country has shown that artificial intelligence education is a significant part of a national strategy. It is a key element of the broader development «roadmap», the main target for China is to become a global centre of innovative investment projects for $ 150 billion by 2030.EdTech-based project promotion initiatives have been joined by Chinese tech giants Baidu, Alibaba, and Tencent (BAT), who, accompanied with education professionals, are exploring different opportunities to stimulate innovation through education using artificial intelligence.

Table 1

Initiatives for the using of educational robots in educational institutions all over the world

	Country	Government initiatives
1	Japan	In 2004, one of Tokyo's schools was first tested on an android-type robot that was able to express 6 emotions
2	France	Educational humanoid-type robots of own production, since 2008, are used in universities and laboratories of the country and neighbouring countries
3	China (2009)	Since 2009, more than 600 kindergartens across the country have started using robots to teach children spoken language and educational programs. In 2018, more than 200 schools were equipped with Keeko robot-teachers
4	South Korea	In 2010, as part of a large-scale robotics teaching project, 29 robots were used in 21 schools in Daegu, and in 2015, in 5,000 kindergartens in the country to study English.
5	United States	In 2011, the largest ECOT virtual school in Ohio was established and began to use artificial intelligence in education. Currently, humanoid type robots are used by educational institutions of 27 countries
6	United Kingdom	Since 2012, schools have been using Milo robots to assist children with disabilities. They have more than 400 schools that teach thousands of students with autism now
7	Israel	The first official science and technology lessons robot made in 2012 for students in grades 5-6. Starting in 2016, bots are used in digital kindergartens
8	Australia	Deakin University of Australia became the first university in the world to use the Watson humanoid bot. Since 2013, the government has launched an initiative to use Telepresence robots to educate children in remote classes
9	UAE	Merryland International School in Musafa launched 30 the most modern robots with integrated intelligence in 2014
10	Germany	In Germany began to test robots for teaching migrant children in 2015, and later as virtual assistants for university students
11	Switzerland	The robot was first used in 2015 to help children ages 6 – 8 to improve their handwriting skills
12	Singapore	According to PlayMaker Programs 160 preschools in the country began using no-screen robots to help children prepare for STEM school subjects in 2016
13	Finland	Elias pilot project, a robotic math and language teacher who understands and speaks 23 languages, was launched in the country's primary schools in 2016
14	India	Affluent families have begun to use "social robots" to communicate with children, satiate their curiosity, develop creativity and logical thinking since 2017. The government purchased Alexa robot to train children from the most remote areas in 2018
15	Belgium	The government of Flanders signed a contract with the British platform Century Tech, which operates on the basis of artificial intelligence, in 2019. It is planned to use the system at 700 municipal schools and universities in the region.

Source: Developed by the authors based on [3; 15].

The Japanese Ministry of Education also succeeded in launching a pilot project worth about 250 million yen ($ 227,000) in 2018 to compensate the shortage of English teachers and improve the learning of students by providing 500 classrooms with speaking robots [26].

Similar initiatives are being implemented by South Korea, which uses English-language *Engkey* robots with an avatar-face that make class students more active in engaging and giving children an interest in what they are learning. In 2009, the government supported a four-month pilot program in which it invested 1.37 million dollars (ca. 1.24 million euros) for the development of robots, helping to master English, mathematics and other subjects [10]. The strategic priorities of South Korea are the export of training robots to member states of ASEAN organisation and the development of customized training programs using AI. The best international experience about how to use of intelligent educational systems in education and more data on countries is described in *Table 1*.

Private investors are involved in the research of the effects of AI on changing the face and functions of education. Technology giants *Amazon*, *Google* and *Facebook* invest millions of dollars in AI products in education, which have well proven themselves for multibillion-dollar companies like *Knewton*. Thus, the *XPrize Foundation*, which develops *Strong Competitions* contests to promote «radical advances in favor of humanity» within the framework of the Global Learning project, offered a 10 million dollars grant to a team which will develop the best basic training program that can replace a teacher for children with adaptivity in modern gadgets. Bill Gates, who is the main proponent of the use of AI in education, has allocated more than 240 million dollars to fund research in this area. B. Gates thinks that AI will improve education in many ways, and individual learning will be more beneficial [5]. The Chinese giants *Lenovo*, *Huawei, Alibaba, Tencent*, as well as other companies in this field show increasing interest in technologies that are becoming popular. In May 2016, the *Lenovo Group* announced ambitious plans to establish a fund of 500 million dollars in USA, which will finance the activities of promising virtual reality and artificial reality technologies [24].

AI has become a strong focus of the international competition of countries in the educational market: developed countries began to introduce AI technology in preschools teaching and at an early stage of elementary school. The role played by private initiatives in the processes of the influence of artificial intelligence on the changes of educational functions is fast-growing what sets new baseline for any new player in the market. Experts of International Labour Organization suggest that basic AI tools should be provided as open source in order to limit market dominance of first movers. Authors emphasize that ''*keeping access to basic AI functions as a public good will be essential in maintaining a competitive environment and preventing further industry concentration*'' [11, p. 22]. According to this research, important aspect of AI adaption is market dominance, which in educational practices means information management with risks of selective information sharing, propaganda and other inconsistencies in information management technologies.

Given the above, it would be advisable to highlight the positive and negative aspects of using the AI by stakeholders (*Table 2*).

Table 2

The pros and cons of using artificial intelligence to all interested stakeholders

	PROS	CONS
Universities	Possibility of personality validation and verification, remote control of exams, protection of academic integrity of the university's online programs Solving the problem of protection for students' personal data Setting up productive work with students It will help to turn universities into canters of lifelong learning They learn and work more quickly in certain directions comparatively with teachers	Low confidence to new intellectual learning systems Some problems in evaluating students' creative work; Bots are still unable to properly provide the upbringing process and discipline during the class Computer systems may experience errors (virus attacks, crashes)
Students	Ability to monitor progress in the acquisition of knowledge and skills Facilitates the process of distance learning Helps to better integrate with new technologies and develop learning materials	It does not properly encourage or motivate to study Moral consequences in changing relationships between teacher and student

	Gaining continuous access to training and using its more flexible forms The ability to use digitized assistant 24/7	
Teachers and lecturers	Ability to manage student's audience, create tasks and content on smart devices Helps continually improve training courses Ability to analyse, advise and transparently evaluate learning outcomes Providing feedback and writing assignments Helps keep track of student performance and identify outsiders Will help to preserve and multiply strong aspects of the teachers or lecturer's activity	AI quick responds, not distracted or tired AI may be the reason for increasing the requirements to the level of professional competence by the management of the educational institution AI can replace the teachers themselves
Parents (as consumers of educational services)	Provides real-time feedback Get information about progress quickly Creating opportunities for personalized learning and support for children with autism Education may become more accessible to low-income families	Dehumanization through constant communication with bots

Source: Compiled by the authors, based on [2; 5; 8; 9; 11; 18; 20; 22; 23; 27—32].

The analysis of AI related publications has shown that there are different opinions regarding the feasibility of using AI for educational purposes. The opinions of economists and market analysts on this subject have been divided. In academic circles there is a group of scholars who are rather sceptical about the usage of intellectual education systems in educational institutions, highlighting that the demand for cheaper educational solutions will transform the educational technology industry into a market sector that is beginning to be broken up. Leading scientists [12] warn the academic community about the dangers of using AI for educational purposes. They say that it is «too smart» and there are concerns about data security and confidentiality. Some teachers are also afraid that their role may be diminished by this technology or that it can be used as an «internal spy» to control their work [12].

The work of the Oxford philosopher Nick Bostrom [7] is significant in this regard because it provides a general understanding of how intelligence will change in the near future. According to Bostrom [7], even with a variety of improvements, the human brain will not be able to compete with machines.

A number of weaknesses and threats may arise in the near future, particularly [24]:

1) The cost of installing research and development makes an ILS an expensive proposition. Thus, it is expected that only well-funded educational institutions will be able to take advantage of their benefits.

2) The lack of computing power: computational collective intelligence requires a very large number of calculations, which need to be done very quickly, using a great deal of processing power. As data volumes continue to grow with the automatic creation of increasingly complex algorithms, a bottleneck can slow down progress.

3) The lack of a clear business model that would make the relationship between AI technology and education more transparent.

4) Maintenance and further training of machines require more investment, and only a few educational institutions can afford it.

5) The computer cannot motivate and calm students who failed to perform the task properly and encourage them to perform the task repeatedly.

6) The computer is not able to evaluate the work of creative students, whose thinking goes beyond the traditional questions and answers.

7) If AI benefits only the students with access to specific advanced technologies, then it may marginalize some groups.

As the analysis of defined threats show, the threats are social interaction related, therefore supporting statements that AI will never change human teacher. One of the best courses for action

still is seen human teacher who used AI tools in order to effectively personalize subjective learning process.

Even though estimations of financial problems blocking the implementations/arising because of AI implementation are brought into consideration, market reports show that market of AI for educational purposes is strong and growing and despite development of sceptic scenarios in recent years, AI has still found its own niche in the educational systems of many developed countries [11].

Conclusions. The discussion among modern researchers about the value and harm of AI is very intensive and actual today. Some regions in the world (e.g. China and India) consider AI based education systems the only ones capable of contributing to solving the problem of access to equal and quality education. Therefore, in high population countries AI adaption will meet a fast growth.

Increased efficiency of the use of intelligent learning systems will provide not only greater accessibility but also higher quality of the educational process due to the ability of the system to adapt to personal learning needs of each individual learner. Nevertheless, human teachers are not going to be pushed away and lose their jobs, because a considerable part of teaching is social interaction (such as encouragement, emotional support, etc.)

Investment in innovation and the evaluation of promising programs will be a priority for philanthropic and business circles, as well as for national educational policy makers. Necessity for open source AI tools is rather novel view on AI technologies, but has strong basis, therefore technologies, policies and adaption strategies in this area should be researched in depth.

Further scientific discussion will be related to the exploring mechanism by which computer systems can perform tasks that require human intelligence and how they can be more usability for the learning process.

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