European Journal of Contemporary Education
E-ISSN 2305-6746
2025. 14(1): 3-12
DOI: 10.13187/ejced.2025.1.3
https://ejce.cherkasgu.press

The Problems of Contemporary Education

Perceptions of Neural Network Use in Higher Education: Case Study

Svetlana Dzhaneryan [a, *], Alina Kima [a], Larisa Gutermana [a], Marine Esayan [b]

[a] Academy of Psychology and Pedagogy, Southern Federal University, Rostov-on-Don, Russian Federation
[b] Faculty of Psychology and Pedagogy, North-Caucasus Federal University, Stavropol, Russian Federation

Abstract

The integration of artificial neural networks (ANNs) into various fields, particularly education, has recently garnered considerable attention because of their potential to improve learning processes and optimize administrative tasks. This article aims to explore the potential of neural networks in the context of higher education, based on a case study conducted in Southern Federal University. The study employed a mixed methodological approach combining quantitative surveys, pedagogical experiments, and qualitative interviews. The study involved 132 3rd and 4th-year university students divided into a control group (CG) and an experimental group (EG). EG students were subjected to educational processes involving ChatGPT and other ANN-based tools, while CG students adhered to traditional teaching methods. The obtained data were analyzed using mathematical statistics, including Pearson's χ2 test, to compare the digital skills and perceptions of the two groups.

According to the results, EG students significantly improved their digital skills compared to CG students. Students generally had a positive opinion about ANNs, recognizing their ability to facilitate learning and save time. However, concerns about the reliability and potential biases of the information provided by ANNs were also noted. The study concludes that ANNs have significant potential to improve the quality of higher education by enhancing learning efficiency and reducing administrative burden. Recommendations for the implementation of ANNs in higher education are provided. The findings show that neural networks in higher education have great potential to improve the learning process.

* Corresponding author
E-mail addresses: swetdjan@sfedu.ru (S. Dzhaneryan)

Keywords: artificial neural network, learning, students, teachers, evaluation system, learning success.

1. Introduction

Today, neural networks (NNs) are popular and are used in many fields, including education. UNESCO's program document "ChatGPT and Artificial Intelligence in Higher Education: Quick Start Guide" (Lukina et al., 2025) presents several initiatives. First, NNs can be used to improve and increase the efficiency of individualized educational processes. Students can use NNs to gain insight into alternative solutions to problems, improve their knowledge through a Socratic dialog with the NN, and review their existing knowledge to fill in the emerging gaps (Polozhentseva et al., 2024; Radhakrishnan, 2023). Instructors can use NNs to create new exercises and approaches and assess students' knowledge in a more efficient and automated way. Second, NNs can be used as an auxiliary tool in scientific research. Although NNs are hardly capable of generating original content and new concepts, a researcher can use them to search for the right formulations of ideas they have already thought of, generate unusual research topics, and find archives and data sets for the study. Third, NNs can solve a plethora of problems in educational administration. They can be used to answer applicants' many questions during the admissions process, help students register for courses and portals, send reminders about pending tasks, and translate materials into the language of the incoming international student.

Another advantage of using NNs in this area is that they are available around the clock and can provide support at any time. NNs improve the accessibility of education. Foreign learners can use them to create texts in different languages they are just learning.

Today, NNs are commonly used by scientists and engineers for research and development of software or systems related to that research. Hence, it is crucial to learn the basics of NNs and be able to apply the knowledge to solve problems that may arise in the future. Students need to understand the potential of NNs and their potential applications (Santos, 2024; Lamar, Roach, 2019).

Experts (Jaruga-Rozdolska, 2022; Radhakrishnan, 2023) question the feasibility of using NNs amid a complete reformatting of the labor market, where many professions are at risk of extinction or a substantial reduction of the human role in the labor process, and the creation of new creative content. The scientific community is already imposing restrictions on scientific papers generated in whole or in part by NNs or their derivatives.

According to studies, NNs are data processing systems that try to mimic the features of the human brain and its learning process (Lukina et al., 2025). They are parallel and distributed data processing systems designed to exploit and model the features and functions of the human brain (Wasik et al., 2018). NNs can learn in their environment and improve process performance through learning. NNs are capable of receiving and discovering new information and using it to improve their problem-solving capabilities (Fiore, 2019).

Literature analysis shows significant interest in NNs and their place in education. With the increasing use of artificial intelligence (AI) in education, the number of published studies in this area has grown. The findings of X. Chen et al. (2022) demonstrate an upward trend in the academic community's interest in using AI for educational purposes. Major research topics include intelligent tutoring systems for special education; natural language processing for language education; intelligent analysis of educational data for performance prediction; discourse analysis in computer-aided collaborative learning; NNs for learning assessment; and recommender systems for personalized learning (Bosov, 2022; Rybakova et al., 2024).

N. Valko and V. Osadchyi (2020) consider the problems connected with implementing the educational process based on modern information technologies. According to N.G. Repkina (2016), the main purpose of digital technologies in education is to achieve a significant level of individualization of the learning process, considering the individual characteristics and capabilities of its participants. The realization of such an approach is made possible by applying elements of the NN theory in the learning process. I.R. Khabibullin et al. (2023) note that NNs can be used to build a model of the learning process to significantly strengthen the teacher's control over it. NNs can be adapted to the specific learning tasks and the individual characteristics of students and instructors.

The problem of learning success is one of the most topical in education. The possibilities of its computation are a promising area for scientific research and practical application (Shamsutdinova, 2022). R.L. Ulloa Cazarez and C. Lopez Martin (2018) address this problem by proposing three types of NNs for predicting student performance constructed from standardized

variables. Statistical comparison of the NNs' prediction accuracy with statistical linear regression demonstrates that the three NNs have a higher prediction accuracy. Therefore, the NNs are proposed as a technique for early prediction and identification of students at risk of failure.

A study by C.F. Rodriguez-Hernandez et al. (2021) notes that further conceptual and methodological understanding of NNs in education is needed to advance their systematic implementation. The results suggest that NNs can be systematically implemented to categorize students' academic performance. Prior academic achievement, socioeconomic background, and high school performance characteristics are the most important predictors of students' academic achievement (Kazachenok, 2020; Ling et al., 2024).

Researchers T. Saito and Y. Watanobe (2020) note that NN implementation will be incomplete if it does not provide effective tools to those students who want to improve NN work processes or opportunities to redesign them for other tasks, which vastly expands the horizons of their application and implementation prospects. E.G. Rincon-Flores et al. (2020) provide several examples of learning tools that can be used to work with different types of NN models and learn the basics of NN using visual interactive tools that allow creating custom NNs and working with the already existing ones fairly easily. Using these tools, users can understand and learn the mechanisms of a typical NN by using the features of different models and the corresponding learning algorithms (Guslyakova et al., 2025; Okewu et al., 2021).

When considering NNs in education, it is important to mention their hands-on and most popular manifestation at present, chatbots. The most popular of them is ChatGPT, a chatbot with a conversational AI interface developed in November 2022 by OpenAI Lab. ChetGPT is one of the most advanced AI programs (Tlili et al., 2023). C. Kooli (2023) notes that while ChatGPT's primary function was to mimic human conversation, its capabilities go far beyond that. It is already clear that ChatGPT is a revolutionary tool when it comes to AI-based conversational bots. Using natural language processing and generative AI backed by deep learning, ChatGPT can produce human-like text and maintain a conversational style that enables more realistic dialogs (Pesonen, 2021).

Chatbots are becoming a trend in many fields including medicine, products and services (Castrillón et al., 2020), and education (Akhmetshin et al., 2021; Golubeva et al., 2023), indicating that they have the potential to change the way students learn and search for information (Tolmachev et al., 2022).

Introducing NNs in the learning process at educational institutions is relevant, which raises the need to analyze the existing capabilities of these digital tools and identify the main prospects for their application in higher education.

2. Methods

To achieve the purpose of the study, a mixed-methods research design was employed. The method used to collect data for the study was the analysis of scholarly sources from Research Gate, Google Scholar, and Scopus. The main research methods included a survey, a teaching experiment, and a follow-up interview with the participants of the pedagogical experiment, which were carried out during the second semester of the 2022-2023 academic year.

The total sample of subjects comprised 132 3rd- and 4th-year students, including 71 control group (CG) and 61 experimental group (EG) students. CG students were taught using traditional methods, while EG students were taught with the support of neural network tools, primarily ChatGPT.

A structured questionnaire comprising two closed-ended questions was developed for the study:

1. "Which digital tools do you use most frequently during your studies?" (Multiple choice, 8 predefined options including mobile applications, search engines, digital libraries, chatbots, neural networks, online learning platforms, statistical tools, and video resources.)

2. "How would you rate your level of digital skills from 1 to 5, where 1 is very low and 5 is very high?".

In the questionnaire, "chatbots" referred to AI tools with a conversational interface (e.g., ChatGPT), while "neural networks" referred to non-chatbot applications of ANNs such as image recognition systems, automated scoring models, or adaptive learning platforms. Although the questionnaire included only two questions, they were specifically designed to capture both usage patterns and perceived digital competence, which were the central focus of the pedagogical experiment.

Subsequent processing of the results of the pedagogical experiment was carried out using mathematical statistics methods. The task was to identify differences in the distribution of certain features (level of digital skills) when comparing two empirical distributions. For this purpose,

we applied Pearson's χ2 test. The measurement scale had five categories ("very low", "low", "average", "high", and "very high"), hence the number of degrees of freedom was v = 4.

The null hypothesis H0: there are no differences in the self-assessed level of digital skills in the CG and EG.

Alternative hypothesis H1: there are significant differences in the self-assessed level of digital skills in the CG and EG.

To clarify the issues related to the use of NNs in teaching, an additional interview was conducted with EG students. The first interview question concerned the use of NNs and their derivatives in teaching. The next interview question was formulated as follows: "In your own experience, how do you see the perspectives of chatbots and neural networks in learning and social life?".

3. Results

Responses to the question "Which digital tools do you use most frequently during your studies?" were collected before the pedagogical experiment. Table 1 presents the distribution of responses in both the control (CG) and experimental (EG) groups.

Table 1. Digital tools most commonly used by students

No.	Digital tools	Share of respondents, %	
		CG Respondents	EG Respondents
1	Mobile applications	84.1 %	79.8 %
2	Search engines	81.8 %	82.4 %
3	Digital libraries and databases	52.3 %	54.7 %
4	Chatbots (e.g., ChatGPT)	29.5 %	27.2 %
5	Neural networks (e.g., automated scoring, AI tutors)	29.5 %	31.4 %
6	Learning platforms (e.g., Moodle, Coursera)	11.4 %	10.5 %
7	Statistical data analysis tools (e.g., SPSS, R)	6.8 %	8.1 %
8	Videos on video hosting sites (YouTube, etc.)	4.6 %	3.8 %

The respondents' answers suggest that the most popular digital learning tools are mobile applications and search engines. In second place are digital libraries and databases, and in third place are chatbots and NNs, which indicates their growing popularity. Further research is needed to determine the dynamics of this process.

Responses to the question "How would you rate your level of digital skills from 1 to 5, where 1 is very low and 5 is very high?" before the pedagogical experiment are presented in Table 2.

Table 2. Self-assessed level of digital competence of participants in the survey before the pedagogical experiment

Rating	Share of respondents, %	
	CG	EG
1	0	0
2	4,5 %	5.2 %
3	25.1 %	23.9 %
4	52.3 %	51.7 %
5	18.1 %	19.2 %

As we can see, respondents in both groups rate their digital skills and digital competence highly. These results are unsurprising because during the time of forced distance learning the level of digital competence among participants in the educational process increased. Them being constantly online and performing educational tasks that in most cases required understanding digital interaction tools.

From the table of χ2 values for the significance level α = 0.05 and v = 4 degrees of freedom, we obtain the critical value of χ2crit = 9.488. Since the value of the test before the pedagogical experiment χ2 < χ2crit (2.132 < 9.488), i.e., falls outside the critical zone, at the start of the experiment the CG and EG had no significant differences by the level of digital competence.

Responses to the question "How would you rate your level of digital skills from 1 to 5, where 1 is very low and 5 is very high?" after the pedagogical experiment are summarized in Table 3.

Table 3. Self-assessed level of digital competence of participants in the survey after the pedagogical experiment

Rating	Share of respondents, %	
	CG	EG
1	0	0
2	4.1 %	0
3	24.6 %	20.3 %
4	52.3 %	56.1 %
5	18.8 %	23.6 %

The calculation of $\chi 2$ for the CG and EG after the pedagogical experiment shows that $\chi 2 > \chi 2crit$ (16.317 > 9.488). This gives us grounds for rejecting the null hypothesis H0. Accepting the alternative hypothesis H1, we can assert that these samples have statistically significant differences.

After the pedagogical experiment, the following answers on NNs and their derivatives in teaching were obtained during interviews with EG students (Table 4).

Table 4. Categories and statements regarding the use of neural networks in education

Category	Subcategory	Statement
Availability and response speed	Quick retrieval of information	The positive points are that the answer was found quickly; if I made mistakes in the tasks, the chatbot explained what kind of mistake it was and why; there was a selection of subjects (math, chemistry).
	Time-saving functionality	Finds information quickly, text uniqueness is 100 %. It is very convenient and time-saving, performs tasks well and accurately, but performs poorly in creative matters (e.g., create a thing that doesn't exist yet).
	Analysis of extensive information	It helps me with writing reports, analyzing large texts (I ask it to write brief theses), and also assisted with creative tasks.
Language Capabilities	Multilingual support	I was thrilled to find out that ChatGPT supports Russian, which made it much easier to work with. This bot has made it much easier to discover hard-to-find material. However,
Limitations and Concerns	Doubts about accuracy	Generally positive, but you have to keep in mind that a chatbot often makes mistakes and you should always check for the validity of its statements. Therefore, without your own knowledge, chatbots will not be of much help. The negative aspect is that some information is incorrect and the bot makes grammatical and lexical errors. There is a possibility of inaccurate or partially inaccurate presentation of information.
	Experience of tautology	There was some tautology in the output.
	Experience of mistakes	I'm not sure of the validity of what it finds, I still have to check it myself.

Students are generally positive about such technologies, as they provide opportunities for more effective learning and save time. Among the negative aspects of this technology, they note the partial unreliability of information and some tautology in the text. Especially concerning is the possibility of mistakes in answers to questions.

Responses to the interview question regarding the prospects for chatbots and NNs in learning and society's life are presented in Table 5.

Table 5. Respondents' answers on the prospects of chatbots and NNs in education and social life

Category	Subcategory	Statement
Transformative Potential	Expansion of applications beyond learning	A good example would be a psychological aid chatbot. It would provide support to people when they cannot turn to a specialist for help.
	Integration into everyday life	These technologies (neural networks in particular), given their convenience and efficiency, will become part of the educational process and everyday life, just as the Internet once did.
Learning Enhancement	Simplified access to knowledge	It is a unique experience that requires no direct contact with a live person. A chatbot can respond to a query instantly. In my opinion, this will allow us to avoid "rote learning", keeping notes, writing essays and term papers. These technologies greatly facilitate the assimilation of material and the search for it. Neural networks make it ever easier to find the information you need, as well as complete almost every possible task, if you get the wording right. Learning has become much easier. I think it's promising.
	Reduced cognitive load	They will make some aspects easier, for example, finding information. But the person has to have developed critical thinking and be able to analyze the given answer.
Risks and Ethical Concerns	Misuse by uninformed students	The uninformed part of students (90 %, myself partly included) may misuse them when writing essays, answering various questions, etc., i.e., wherever they can.
	Reduced critical thinking	We will start to think less and slowly lose our intelligence.
	Unclear future outcomes	Today, I can see vast, large-scale prospects for the development of this sphere. Of course, we cannot say what it will all lead to and what consequences it will bring, but we can already say that this is the future, a certain leap in the evolution of technology, and this sphere will only continue to evolve and develop.

4. Discussion

The responses obtained in our investigation of the prospects of using NNs and their derivatives in the educational process allow us to make the following generalizations. For most respondents, the use of NNs and their derivatives, particularly chatbots, is a desirable prospect and they note many positive factors for education and learning. These can be psychological aid bots and search engines, although these technologies are merely assistants and the person still needs to develop critical thinking and their views on the world around them.

Many researchers are also interested in the prospects of introducing NNs and their derivatives into the educational process of universities. Thus, the ethicality of using NNs and AI in the educational process is a debatable issue in the context of our research.

C. Kooli (2023) remarks that there has come a new era of education and research based on chatbots and AI, the application of which is associated with several challenges and limitations, primarily moral. C.F. Rodriguez-Hernandez et al. (2021) discuss the potential uses of AI and chatbots in academia and their impact on science and education from an ethical standpoint,

identifying the benefits and limitations of AI and chatbots and their role in supporting human experience and judgment. I.R. Khabibullin et al. (2023) emphasize the need to adapt to the new reality of AI and chatbots in education, in which greater awareness, the adoption of appropriate legislation, and stronger moral values will protect the education system.

The use of chatbots in assessment and examinations also raises the question of the role of technology in education. It is important to recognize that one of the main values affecting the quality of education is the relationship between the student and the teacher, which acts as a factor affecting learning success (Malika et al., 2022; Ybyraimzhanov et al., 2019). Introducing modern chatbots as an alternative to teachers has more questionable points than positive ones (Shamsutdinova, 2022). In support of this point of view, we should cite a study by N.G. Repkina (2016), which states that the application of chatbots in assessment and examinations favors technological solutions over traditional pedagogical methods, which can lead to the devaluation of teachers.

Among the ethical concerns associated with chatbots in education are the potential substitution of human relationships (especially communication) and the threat to learning experiences (Kazachenok, 2020; Togaibayeva et al., 2023). This is especially important in counseling and mental health, where students may seek emotional support from chatbots instead of qualified professionals. I.R. Khabibullin et al. (2023) show that although chatbots are deemed helpful by students, they are not perceived as a substitute for human support.

Another moral challenge is the possibility of bias in chatbots (Ulloa Cazarez, Lopez Martin, 2018). AI systems are as unbiased to the extent that the data they learn from is unbiased. If the data used to train chatbots is biased, chatbot responses may also be biased. This can lead to unfair assessment results and potential discrimination and inequality in education.

Chatbots have become a promising educational tool that can enhance learning by providing personalized and immediate feedback to students. Nonetheless, using chatbots in education also raises moral issues, one of which is a failure to uphold the principles of academic integrity in teaching and research activities (Yespolova et al., 2019). The temptation to trust NNs to write an essay or a more substantial paper or to create a presentation or a bank of ideas is quite significant, so every student needs to be extremely responsible about using NNs in the learning process. Students should clearly understand that an NN is meant to be an assistant, not a tool for completing assignments or writing papers. Regardless of specialty, the student's primary goal is to gain maximum knowledge and experience with relevant tasks (Ybyraimzhanov et al., 2022).

Based on the conducted review of studies, we developed a series of recommendations for the implementation of NNs in the higher education system:

1. It needs to be clearly understood what categories of participants in the educational process (students, teachers, administrators) of the higher education institution need to be prioritized in implementing NNs and to what extent. Relying on these results, it is possible to determine the most sensitive limits of needs for these technologies and allocate resources.

2. It is important to determine the limits of the university infrastructure in the context of NN application and the extent to which the staff are trained to work with such systems. Progressive ideas are often met with resistance on the part of personnel (due to their lack of understanding of the positive effects of their use and the opportunities to improve their work). It is important to implement accessible courses, workshops, or online resources to familiarize the staff with the possibilities provided by the higher education institution for using NNs in the learning process (authorizations, technical capabilities, etc.) and with the toolkit of these systems itself.

3. The introduction of NNs into the educational process requires continuous improvement. It is important to adopt this approach to developments in this area and the already available tools. Participants in the educational process should be provided with the most relevant NN models for familiarization and use.

4. Naturally, one of the most pressing issues that can hinder the introduction of NNs in the university educational space is the ethics of applying these technologies. Like any relationship within society, relationships in the sphere of NN application need to be regulated. Modern universities need a flexible approach to NNs and their derivatives in the educational process. The first step towards the rational use of NNs in the educational space of a particular institution may be the introduction of a regulation/code on the use of NNs and their derivatives in the educational process, where the institution's governing body will clearly define the limits of the use and application of NNs and the results obtained from them in educational activities within their area of expertise. Such documents will help to legalize the use of NNs within the ethical limits of

the educational environment and open up prospects for further development of the regulatory and legal components of this process.

5. Students present the leading force that drives the education system towards reforms and improvements. Therefore, it is crucial to involve students, especially those in relevant specialties (as most classical and polytechnic universities have computer science departments or faculties) to introduce NNs and their derivatives into the educational process. Because modern students are constantly spending time in the digital environment, they can propose unconventional solutions to the application of NNs in education, and such a resource should be utilized in the development of the national higher education system. One of the effective ways to generate new ideas and approaches is joint projects and competitions for the best solutions in the use of NNs and their derivatives in the educational process.

6. The results and achievements of NN implementation should be shared with the academic community and the public. Higher education institutions can provide free access to the results of NN implementation in their educational environment (which can be achieved with cloud services and open repositories) and thus maintain interest in the developments, work, and experience of the educational community and all parties interested in NNs.

5. Conclusion

Summarizing the results of this study, we should note that the use of NNs in higher education has the potential to significantly improve the learning process. Using NNs in higher education is still in the development stage, but some successes have already been documented.

One of the promising directions of NN applications is the automation of student assessment. Creating NNs capable of independently assessing students' assignments and giving grades can significantly reduce the load on teachers and make the assessment process more objective.

NNs in higher education can improve curriculum planning and class scheduling. NNs can aid in determining the optimal sequence of courses and distributing the learning load among students. Feedback chatbots and their analogs can be an effective tool to significantly reduce the workload of teachers and support the staff of university departments on the path of optimizing managerial and educational processes.

Hence, NNs in higher education have great potential and can help achieve better learning quality outcomes. However, additional research is needed to realize this potential and implement valid NNs understandable not only to a few specialists but to most participants in the educational process (students, teachers, and administration). To successfully implement NNs in higher education, several technical and ethical issues need to be addressed: establishing rules for the use of these tools by students, both in the context of academic honesty and in compliance with other rules and principles relevant to the academic community, ensuring the protection of privacy, and preventing the possibility of misusing NNs. NNs cannot completely replace the human factor in higher education. The utilization of NNs should be focused on improving the quality of learning and contributing to students' development rather than replacing lecturers.

This study has several limitations. First, the focus of the article was on a single university, lack of probability of sampling and validation of the research instruments, which may affect the generalizability of the findings. Nonetheless, the findings offer valuable preliminary insights into the integration of neural networks in higher education and can serve as a basis for more comprehensive future research.

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