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Artificial intelligence in developing doctoral students' research competencies

Inteligencia artificial en el desarrollo de competencias de investigación de estudiantes de doctorado

Iryna Oliinyk
https://orcid.org/0000-0002-1749-1518
econ.biss22@gmail.com
Department of Innovative Technologies in Pedagogy, Psychology and Social Work, Alfred Nobel University, Dnipro, Ukraine.
Olena Bulavina
https://orcid.org/0000-0002-0198-1838
bulavina.olena211@kneu.edu.ua
Department of Pedagogy and Psychology Personnel Management, Sociology and Phycology Faculty, State Higher Educational Institution “Kyiv National Economic University named after Vadym Hetman”, Kyiv, Ukraine.
Tetiana Romanenko
https://orcid.org/0000-0002-9790-2718
tanya.romanenko27@gmail.com
Department of Automation and Computer-Integrated Technologies of the Bohdan Khmelnytsky National University of Cherkasy, Cherkasy, Ukraine.
Anzhelika Tatarnikova
https://orcid.org/0000-0002-6310-8276
angelika.tatarnikova86@gmail.com
Department of Art Studies and General Humanitarian Disciplines, Faculty of Art and Design, International Humanitarian University, Odessa, Ukraine.
Anton Smirnov
https://orcid.org/0000-0002-1562-4591
anton.s.agro35@ukr.net
Kharkiv Institute of Medicine and Biomedical Sciences, Kharkiv, Ukraine.

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Abstract

The study deals with the topical issue of introducing artificial intelligence (AI) into the students’ professional training at the third educational and research level of higher education. The aim of the study is to empirically verify the AI role in building the research competence of future doctors of philosophy (PhDs). The research employed the following methods: monitoring, quantitative, qualitative, comparative data analysis, modelling. The study involved monitoring the development of the students’ research competence of the third educational and research level of higher education according to substantive, design, procedural,

optional, communicative components. The method of using AI in building the research competence of PhD students was developed and tested. The level of research competence increased during the implementation of the method of using AI. So, the growth was the following: substantive – by 7.5%, design – by 10%, procedural – by 8.4%, optional – by 11.4%, and communicative – by 8.5% components. The results of the study can be used in the educational process of higher education institutions (HEIs) to create the content of the training of applicants. The prospect of research is the development of recommendations regarding the use of AI tools in the development of their research skills.

Keywords: academic degree students, academic research, artificial intelligence, higher education institutions, postgraduate studies.

Resumen

El estudio aborda el tema de actualidad de la introducción de la inteligencia artificial (IA) en la formación profesional de los estudiantes del tercer nivel educativo y de investigación de la educación superior. El objetivo del estudio es verificar empíricamente el papel de la IA en el desarrollo de la competencia investigadora de los futuros doctores en filosofía (PhD). La investigación empleó los siguientes métodos: seguimiento, cuantitativo, cualitativo, análisis de datos comparativos, modelización. El estudio implicó monitorear el desarrollo de la competencia investigativa de los estudiantes del tercer nivel educativo e investigativo de la educación superior según los componentes sustantivo, de diseño, procedimental, optativo y comunicativo. Se desarrolló y probó el método de utilizar la IA para desarrollar la competencia investigadora de los estudiantes de doctorado. El nivel de competencia en investigación aumentó durante la implementación del método de uso de la IA. Así, el crecimiento fue el siguiente: componentes sustantivos (7,5%), de diseño (10%), procesales (8,4%), opcionales (11,4%) y comunicativos (8,5%). Los resultados del estudio pueden utilizarse en el proceso educativo de las instituciones de educación superior (IES) para crear el contenido de la formación de los aspirantes.

Palabras clave: estudiantes de grado académico, estudios de posgrado, instituciones de educación superior, inteligencia artificial, investigaciones académicas.

Introduction

In recent years, AI tools have been actively implemented in many types of human activity. It is the leading modern trend. It makes it possible to simplify routine processes and procedures, save the intellectual potential of specialists of modern enterprises and direct it to other more productive areas of activity. AI is considered as an auxiliary tool, a way to optimize human activity. Attitudes toward the use of AI tools in certain areas of human activity range from positive to sharply negative. In particular, the appropriateness of using AI tools in educational institutions is quite controversial, because it often leads to a violation of the academic integrity of all participants in the educational process. This negatively affects domestic academic research, calls into question their authorship, reliability, etc. But AI is a powerful digital innovation of today. Its potential can be used in conducting academic research without violating the rules of academic integrity. It is clear that it is difficult to track the facts of students' use of AI tools when they perform various types of tasks in modern conditions of learning in mixed and distance formats. Everything depends on the students' conscious attitude towards mastering the major. But at different levels of education, the level of students' conscious attitude to the results and content of education is different. In particular, this applies to the academic degree students engaged in research activities, for example, PhD students. The use of AI tools in their activities speeds up the process of finding the necessary information. AI makes it possible to quickly summarize the intermediate results of the research, annotate the selected studies. AI generates probable programmes of individual studies, determine algorithmic procedures for conducting independent studies. It is also possible to outline clear boundaries of research in the chosen direction through the use of AI. These are the areas of research for which there is no risk of violating academic integrity. Research hypothesis: the use of AI contributes to increasing the level of research competence of PhD students.

The aim of the research is to determine the AI role in building the research competence of PhD students. The aim involves the fulfilment of the following research objectives:

- Study the current level of the research competence of PhD students;
- Develop a method of using AI in the building the research competence of PhD students;
- Determine the effectiveness of using AI in building the research competence of PhD students;
- Identify the achieved level of research competence of PhD students.

Literature Review

The training of future scientists, scholars and academicians, in particular PhDs, should comply with the requirements for the quality of education and the achievement of the sustainable development goals (SDGs) of Ukraine. They provide for ensuring the quality of education and science, establishing partnerships in the field of education and science, and introducing innovations (Artyukhov et al., 2022). A variety of innovations are being actively implemented in the modern education and science through total digitalization. One of such innovations is AI tools, which are actively being implemented in educational and scientific practice. Although the period of introduction of AI is insignificant, a contradictory attitude of the scientific and pedagogical communities towards this newest tool was formed. Modern researchers note the negative aspects of the AI use in the training of higher school students. In particular, this is a negative impact on cognitive processes, non-observance of the necessary experience of independent performance of professional tasks by higher school students. It is also excessive use of virtual teaching by the teaching and academic staff, lack of empathy in interpersonal interaction between teachers and students (Galushko & Batmanghlich, 2023). The introduction of AI significantly affects the management of personnel potential not only of an educational institution, but also of any enterprise, institution, and organization. Therefore, it is advisable to use the achievements of AI in the management of the company's human resources (HR). The teaching staff is considered one of the main resources for achieving operational goals, high productivity and the mission of the educational institution in general (Oleynik & Das, 2023). Researchers also point to the empirically proven effectiveness of the AI use in achieving progressive dynamics of development of research competence of PhDs (Almaraz-López et al., 2023; Oliinyk et al., 2024).

PhD students can successfully use AI tools for text generation, data analysis and interpretation, literature review, formatting and editing, peer review (Alqahtani et al., 2023). The researchers study the AI role in the educational process of a higher education institution (HEI) in the context of the attitude of graduate students and teachers to it, the development of management structures and academic culture (Jafari & Keykha, 2024). Some researchers call its use as a platform for personalized learning, ensuring interactive communication between subjects of the educational process (Chen et al., 2023; Zhou, 2023) an absolute advantage of AI in the educational field. In order to eliminate the negative impact of AI on the educational process, in particular on the violation of academic integrity, researchers suggest developing a clear institutional policy for higher education (Spivakovsky et al., 2023). Machine learning is a positive example of the educational and research practice of using AI (Teng, Zhang & Sun, 2023). In general, studies confirm the benefits of using AI for the development of various areas of human activity, in particular for business development, knowledge management (Chen, 2023). ChatGPT is one of the most common AI tools in higher education and education in general. In particular, its effectiveness in teaching programming, developing algorithmic thinking, cooperativeness, critical thinking, etc. was empirically proven (Yilmaz & Yilmaz, 2023). Some researchers allow the possibility of using ChatGPT for students to perform tasks with their subsequent editing (Ibrahim et al., 2023; Farrelly & Baker, 2023). The researchers emphasize the high probability of students using AI, in particular GPT, to distort educational results and deceive academic and teaching staff (Malinka et al., 2023).

However, the use of AI is quite appropriate when building virtual reality simulations. This makes it possible to increase the level of students' professional skills (Liaw et al., 2023; Mousavi Baigi et al., 2023). The above confirms the contradiction of such a phenomenon as AI, but does not exclude the possibility of its competent use in higher education. The training of graduate students in different universities of the world

is also characterized by a number of challenges. This is the devaluation of students' participation in scientific/academic representative events, the consideration of research supervisors of dissertations as facilitators of their academic publications (Horta & Li, 2023). At the same time, an important aspect of the training of future scientists/scholars/academicians is the development of their research competence, the correlates of which are the academic atmosphere in the educational institution, the innovative ability of graduate students. Therefore, the efforts of HEIs should be directed to increasing the efficiency of the research, to solving the problem of low innovative capacity of graduate students (Han et al., 2024). The innovative capacity of graduate students depends on the development of their research and digital skills. They are progressively developing and constitute a solid foundation for building further studies (Galushko & Batmanghlich, 2023; Ochoa-Tataje et al., 2024).

AI plays a significant role in the formation of research competence of PhD students. It provides quick access to any information resources, enables processing large data sets. AI is used to create algorithms, build virtual models of the research. AI personalizes education taking into account the students' needs, interests and research orientation. It enables the exchange of research ideas, automatic verification and correction of author's texts (Oliinyk, 2024; Yilmaz & Yilmaz, 2023). Research competence is interpreted as a complex personal and professional property. It is manifested in the ability to conduct academic research, motivation for research activity, in understanding the specifics of the research, the ability to generate and implement new ideas into practice. The use of AI tools in the formation of research competence of future scientists/scholars/academicians, in particular PhDs, makes it possible to automate certain directions and stages of academic research (Zhytomyrska, 2024). The components of research competence of PhD students include substantive, design, procedural, optional, and communicative (Riabets, 2023).

The analysis of the studies on the AI use in the training of PhD students confirms the appropriateness of its use. But the main condition is the observance of humanistic principles, ethical criteria and norms of justice (Melnykova, 2023). They are related to the concept of academic integrity defined in Article 42 of the Law of Ukraine (Law of Ukraine No. 2145-VIII, 2017). Researchers emphasize the importance of forming an virtuous educational and research space, which is important during the post-war reconstruction of Ukraine (Shablystyi, 2023). And adherence to the principles of academic integrity is an important prerequisite for creating such an environment (Pokotylo & Sylkina, 2023). The introduction of AI tools has a positive effect on the companies' activities as a whole, as it will increase the amount of time for solving strategic tasks (Snopenko, 2021). The AI use will contribute to the development of company's effective HR management strategies (Korolevska, 2023). In general, the studies on the issue under research emphasizes the prerogatives of using AI in building the research competence of PhD students. However, most of the studies search for effective practices in the AI use in the preparation of students at the first and second levels of higher education. The possibilities of AI in building of the of research skills of future graduate students and doctoral students remain unexplored. Possible areas of AI use of building the research skills of PhD students require further studies.

Methods and materials

Research design

The research was conducted in order to determine the AI role in building the research competence of PhD students. It consisted of the following stages: organizational, methodological, empirical, and final. The organizational stage involved determining the aim and objectives of the research and the sampling. At the methodological stage, the author's tools for interviewing respondents were developed. The empirical stage of the study involved determining the current and achieved levels of research competence of PhD students. It also provided for the development and verification of the effectiveness of the method of using AI in building the research competence of PhD students, analysis, interpretation of the obtained empirical data. At the final stage of the research, its results were summed up, conclusions were drawn, and areas for further research were determined.

Sampling

The research involved PhD students of Bohdan Khmelnytsky National University of Cherkasy and Alfred Nobel University. The survey covered 78 (38 – control group (CG), 40 – experimental group (EG)) PhD students. During the formation of the research sample, we were guided by the goal of covering research among PhD candidates to study the AI role of in the formation of research competence of PhD students. The sample included all respondents from the above-mentioned educational institutions who are PhD students and who agreed to participate in the study. The sample size is sufficient for conducting an empirical study at two HEIs. The level of development of the research competence of PhD students, the attitude of the subjects of the educational process to the AI use was taken into account during the research. The survey was conducted using Google Forms. The primary data were proce4ssed in Excel spreadsheets.

Methods

The research methods are: monitoring of the current and achieved level of the research competence of PhD students, quantitative, qualitative and comparative analysis of empirical data, modelling. Monitoring involved determining the level of research competence of PhD students. The development of research competence of third-level higher school students was monitored according to each of its components: essential, design, procedural, optional, communicative. The characteristics of each of the components are presented in Table 1.

Table 1.
Structure of research competence of PhD students

Component	Characteristics
Substantive	The ability of the third-level higher education students to analytically evaluate their research activity
Design	The ability of the third-level higher education students to determine the appropriateness of methods, techniques and means of planning and conducting individual research
Procedural	The ability of the third-level higher education students to search for various information data from various sources, understanding the possibility of their use within the scope of individual research
Optional	The ability of the third-level higher education students to manage the research process with an orientation towards a satisfactory final result, motivation to conduct further research
Communicative	Acquisition of new and expansion of existing professional contacts by the third-level higher education students, development of skills to analyse the relevance of their research and predict its scale

Source: compiled by the author based on (Riabets, 2023).

Quantitative, qualitative and comparative analysis of empirical data was carried out on the basis of processing the questionnaire data. The modelling method was used during the development of the method of using AI in the development of research competence of PhD students.

The author's questionnaire (Appendix A) was used to monitor the development of the research competence of future PhDs. It provides only 20 statements for each of the components of research competence. 1 point is awarded for each affirmative answer. The number of points for each of the components and as a whole is calculated. The levels of development of research competence of future PhDs are determined: high – 16-20 points, medium – 14-10 points, low – 9 or less points. Cronbach's alpha was used to determine the reliability of the author's questionnaires (Cronbach's alpha value – 0.88).

Results

At the empirical stage of the study, the development of the research competence of PhD students was monitored. The monitoring results are presented in Table 2.

Table 2.
Monitoring of the current level of research competence of PhD students, %

Criterion	CG	EG
Substantive	39.5	42.5
Design	52.6	52.5
Procedural	28.9	32.5
Optional	21.1	22.5
Communicative	23.7	25
Mean	33.2	35

Source: created by the author based on survey data of respondents

Table 2 shows that the current level of research competence in third-level higher school students of the CG and EG is the highest for the design and substantive components. This indicates that future PhDs have developed the ability to analytically evaluate their research activities, to determine the appropriateness of methods, techniques and means of planning and conducting individual research. Less developed is the research competence of third-level higher school students in terms of procedural, optional, and communicative components. This gives grounds for asserting that PhD students lack the ability to search for various information from various sources and understand the possibility of their use in academic research. PhD students have a reduced ability to manage the research process with an orientation towards a satisfactory end result. PhD students are not sufficiently motivated to conduct further research; to establish new and expanding existing professional contacts. They need to develop skills to analyse the relevance of their academic research and predict its scale.

The conducted empirical research gave grounds to develop a method of using AI in building of research competence of PhD students. The directions of using AI in this method include the search for information on various resources, the creation of annotated catalogues of works on the issue being studied, and the construction of virtual models of academic research. The method also takes into account the possibility of using AI for the creation of research algorithms, the development of personalized training courses, and the exchange of research ideas. The method also involves the AI use for correlation analysis of empirical data, automatic verification and correction of authored academic texts. These are the areas of AI use that do not contradict ethical norms and do not violate the academic integrity principles. The method of using AI in building the research competence of PhD students is presented in Table 3.

Table 3.
The method of the AI use in building the research competence of PhD students

Areas of AI use	Professional tasks for PhD students
Search for information on various resources	Create a source base on the issue under research using AI (300 sources)
Creation of annotated catalogues of works on the issue under research	Create an annotated catalogue of works related to the issue under research (150 studies) using AI
Construction of virtual models of academic research	Generate a model of academic research using AI. Build a model of academic research independently. Compare the results, draw conclusions
Formation of scientific research algorithms	Generate an algorithm for conducting academic research on a selected topic with full details of its stages using AI
Development of personalized training courses	Develop a model of a special course on the issue under research for 20 hours using AI, adjust the generated course content

Exchange of research ideas	Prepare a letter to the publishing house with a request to publish an academic article prepared on the issue under research with a full justification of the achieved results. Translate the text of the letter into a foreign language, generate an annotation to the prepared article in a foreign language with the help of AI.
Carrying out correlation analysis of empirical data	Use AI to calculate Spearman correlation coefficients based on empirical research data, independently provide an interpretation of correlation relationships based on the obtained calculations data
Automatic verification and correction of authored academic texts	Check the text of an academic article prepared on the issue under research using AI

Source: created by the author based on the results of empirical research

This research also involved monitoring the achieved level of research competence of PhD students. It was conducted after the introduction of our proposed method of using AI in building the research competence of PhD students. Monitoring data on the achieved level of research competence of PhD candidates is presented in Table 4.

Table 4.
Monitoring of the achieved level of research competence of PhD students, %

Criterion	CG	EG
Substantive	42.1	50
Design	52.6	62.5
Procedural	31.6	45
Optional	21.1	32.5
Communicative	26.3	35
Mean	34.7	45

Source: created by the author based on survey data of respondents

Table 4 shows qualitative changes that after the implementation of our proposed method of using AI in building the research competence of PhD students of the EG. In particular, the achieved level of research competence is best formed by procedural, design, and substantive components. This indicates that PhD students have developed the ability to analytically evaluate their research activities. They also developed the ability to determine the appropriateness of methods, techniques and means of planning and conducting individual research; search for various information from different sources. PhD students are also characterized by an understanding of the possibility of using the information they have developed within the scope of individual academic research. The research competence of PhD students is less developed for optional and communicative components. This indicates a less developed ability to manage the research process towards a satisfactory final result. The data also indicate that they are insufficiently motivated to conduct further research; to establish new and expanding existing professional contacts. PhD students need to develop the skills to analyse the relevance of scientific research and predict its scale. At the same time, it was recorded that the achieved level of research competence of the PhD students of the CG was the highest for design and substantive components, and the worse – for procedural, optional, and communicative components.

Figure 1 shows that positive changes were recorded in the PhD students of the EG after applying the method of using AI in building the research competence. There is an increase in the achieved level of research competence compared to the current one for substantive (by 7.5%), design (by 10%), procedural (by 8.4%), optional (by 11.4%), and communicative (by 8.5 %) components. In the CG of PhD students, an increase in research competence was recorded for substantive (by 2.6%), procedural (by 2.6%), and communicative (by 2.6%) components. Much higher growth rates of research competence of PhD students testify to the effectiveness of the proposed method of using AI in building the research competence of future scientists/scholars/academicians. This proves the appropriateness of using AI in building the research

competence of PhD students. AI promotes the development of their ability to analytically evaluate their research activities, determine the appropriateness of methods, techniques and means of planning and conducting individual research. Thanks to AI, the ability of PhD students to search for various information from various sources and to understand the possibility of their use within the framework of individual academic research increases. AI contributes to the development of the ability to manage the research process with an orientation towards a satisfactory end result. AI also enhances the motivation to conduct further research, to establish new and expand existing professional contacts. AI deepens the skills to analyse the relevance of one's academic research and predict its scale.

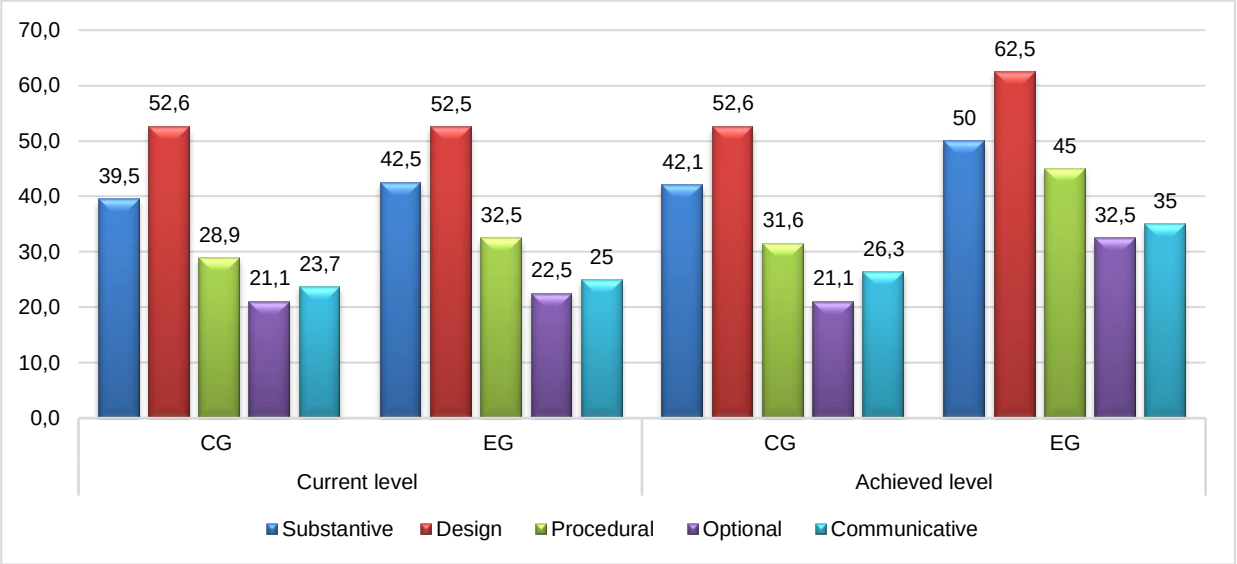

Figure 1. Comparative analysis of the levels of research competence of PhD students, %
Note: CG, EG are control and experimental groups, respectively.
Source: created by the author based on survey data of respondents

Discussion

The studies related to our research emphasize the importance of using AI in higher education. Attention is also focused on taking into account all the possible advantages and ethical challenges of introducing AI into educational and research practice (Jafari & Keykha, 2024). The authors of empirical studies state the positive impact of AI integration in the content of education of students, graduate students, improve the performance of students in many subjects, increase the efficiency of the learning process (Zhou, 2023). Similar studies emphasize the importance of using AI in personalizing the academic research of graduate students. The leading role of AI in conducting automatic assessment, selecting special training courses, systematizing the work of graduate students and generating a summary of the content of the analysed studies is noted (Riabets, 2023).

In the context of our research, the approach to creating an educational environment that optimally combines positive practices in the AI use is also worth noting (Spivakovsky et al., 2023). An empirically proven approach to the positive impact of AI tools on the development of students' programming skills, self-efficacy, and motivation for learning is interesting (Yilmaz & Yilmaz, 2023).

We also share the opinions of other researchers on the appropriateness of using AI to increase the innovation capacity of graduate students (Han et al., 2024).

In our research, we also received empirical confirmation of other researchers' opinion regarding the correlations between research and digital skills of PhD students (Ochoa-Tataje et al., 2024).

Our research is distinguished by a comprehensive approach to assessing the impact of AI on the development of all components of research competence of PhD students.

Summing up the results of our study, we can fully agree with the advantages and challenges of using AI in the training of graduate students mentioned by other researchers. The AI ability to optimize the work of future scientists/scholars/academicians on the topics of their research can be considered the main advantage, and the challenge is the violation of ethics and academic integrity by graduate students.

In contrast to our research, other study consider the examples of using AI as a personalized learning platform that can facilitate the learning of various subjects (Zhou, 2023). The research that differs from ours covers the use of chatbots as smart assistants (Chen et al., 2023), the use of AI as a programming training base (Yilmaz & Yilmaz, 2023).

Our study is important because of the possibility of solving the different points of view available in the academic and teachers' communities of HEIs regarding the appropriateness of using AI in the training of PhD students. The study is also a thorough insight for the development of a clear institutional policy of HEIs regarding the use of AI tools in the research work of PhD students. The research is the basis for the development of clear ethical criteria for the AI use by future scientists/scholars/academicians.

So, the aim of this research was achieved, which is to determine the AI role in the development of research competence of PhD students. The study confirms the importance of the AI role in building the research competence of PhD students. A positive difference between the achieved and current levels of research competence of PhD students was established through the fulfilment of the research objectives. Our proposed method of using AI in building the research competence of PhD students can be used in other universities of Ukraine.

Limitations

The main limitations of the study are the involvement of PhD students from two HEIs in Ukraine — Bohdan Khmelnytsky National University of Cherkasy and Alfred Nobel University. Although there is an opportunity to conduct similar empirical studies in other HEIs, which train PhD students.

Recommendations

The main recommendations are to expand the sample of the study by covering PhD students of various fields in HEis of different specializations in a similar study. It is also recommended to test the proposed method of using AI for building the research skills of PhD students in different majors.

Conclusions

The study raised the relevant problem of using AI in building research competence of PhD students. The study is focused on the impact of AI on the development of the research competence components of PhD students (substantive, design, procedural, optional, and communicative). The current and achieved levels of research competence of PhD students was monitored for each of the components during the study. The authors of this research proposed and tested the method of using AI in building the research competence of PhD students. It involves the search for information on various resources, the formation of annotated catalogues of works on the issue under research. The proposed method employs the construction of virtual models of the research, the creation of algorithms of scientific research is used as part of. The method also provides for the development of personalized training courses, exchange of academic ideas, correlation analysis of empirical data, automatic verification and correction of authored academic texts. The study established that the majority of PhD students have higher levels of research competence in terms of substantive, design, and lower – in terms of procedural, optional, and communicative components. The

results of the study indicate that the AI use is appropriate to increase the level research competence of future scientists/scholars/academicians.

The study confirmed the hypothesis that the AI use contributes to increasing the level of research competence of PhD students. The obtained research results can be used in the professional training of PhD students, in the development of recommendations regarding the AI use in the development of research skills of future scientists/scholars/academicians. Further research may focus on the AI use for the development or adjustment of the content of the education of PhD students at HEIs of Ukraine.

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