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Building research competence of students of technical majors in the context of distance education

Fortalecer la competencia investigadora de estudiantes de carreras técnicas en el contexto de la educación a distancia

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Abstract

The aim of the study was to establish ways of developing research competence in students of technical majors in the context of distance learning, and to evaluate their effectiveness. The research methods were: comparison, Forester's method, Cohen's coefficient, Pearson's correlation coefficient. It was established that the use of the research method of teaching in the context of distance education had a high effect on the level research competence of students of technical majors. A slightly lower effect was also achieved when introducing a course on research work. The maximum effect is achieved when combining both methods of building research competence. An increase in the research competence level was found. At the same time, students' confidence in discussing research ideas with colleagues, conducting literature search, editing and shortening the text, and presenting research results also increased. Prospects for further research consist in the diagnostics of innovative methods of building research competence that can be applied in technical majors and increase the success rate of students in the context of distance education.

Key Words: Project method, augmented reality, gamification, self-regulated learning, innovative technologies, research method, active learning.

Resumen

El objetivo del estudio fue establecer formas de desarrollar la competencia investigativa en estudiantes de carreras técnicas en el contexto de la educación a distancia, y evaluar su efectividad. Los métodos de

investigación fueron: comparación, método de Forester, coeficiente de Cohen, coeficiente de correlación de Pearson. Se estableció que el uso del método investigativo de enseñanza en el contexto de la educación a distancia tuvo un alto efecto en el nivel de competencia investigativa de los estudiantes de carreras técnicas. También se logró un efecto ligeramente menor cuando se introdujo un curso sobre trabajo de investigación. El efecto máximo se logra cuando se combinan ambos métodos para desarrollar la competencia investigadora. Se encontró un aumento en el nivel de competencia investigativa. Al mismo tiempo, también aumentó la confianza de los estudiantes para discutir ideas de investigación con colegas, realizar búsquedas bibliográficas, editar y acortar el texto y presentar los resultados de la investigación. Las perspectivas para futuras investigaciones consisten en el diagnóstico de métodos innovadores para desarrollar competencias de investigación que puedan aplicarse en carreras técnicas y aumentar la tasa de éxito de los estudiantes en el contexto de la educación a distancia.

Palabras clave: Método de proyecto, realidad aumentada, gamificación, aprendizaje autorregulado, tecnologías innovadoras, método de investigación, aprendizaje activo.

1. Introduction

The rapid development of innovative technologies causes changes in the environment. This places demands on society: training future specialists for the effective performance of professional duties in the rapidly changing environment. In other words, students must acquire the necessary competencies that will enable them to engage in lifelong learning (Leshchenko et al., 2021). It was also proved (Wishkoski et al., 2022) that people are engaged in research activities for a significant part of their life, even without always realizing it. Therefore, teachers are tasked to create conditions for the development of research competence in students during their studies at an educational institution (Astafieva et al., 2020). Specialists in any field should familiarize themselves with the current results of research in their professional field, plan their activity, and forecast its results. Research competence contributes to the creation, accumulation and dissemination of professional knowledge based on research results and previous experience.

The events of 2020, when the whole world switched to distance learning because of the pandemic (Suriagiri et al., 2022), and 2022, when Ukrainian pupils and students were forced to return to distance learning again because of hostilities in the country (Marienko & Sukhikh, 2022), posed new challenges for teachers and scientists. These include preserving and increasing the effectiveness of the educational process under new extreme conditions. Interest in the organization of distance learning arose a long time ago (Petrenko et al., 2020). The researchers have investigated its advantages and disadvantages (Ward & Lindshieil, 2020), established effective approaches, strategies and teaching methods (Rincon-Flores & Santos-Guevara, 2021). A number of learning resources have been developed and tested. But there are still difficulties in ensuring a continuous learning process due to the forced transition of students of technical majors, whose education involves a significant proportion of practical and laboratory work that involves the use of various technical real equipment, to online learning.

The aim of this research was to identify ways of building the research competence of students of technical majors, and to study their effectiveness in the context of distance education. The aim involved the following research objectives:

- 1) find out the attitude of students and teachers to distance education;
- 2) propose and implement ways of developing research competence in students of technical majors in the context of distance education;
- 3) study the effectiveness of the proposed recommendations for the organization of the educational process in building research competence of students of technical majors in the context of distance education.

2. Literature review

Education of students of technical majors and research activities are closely related. For example, mathematical competence is better developed in a science-oriented environment (Astafieva et al., 2020). At the same time, the educational process should be built in such a way that the student is not only an object, but also a subject of educational activity (Makhmudova et al., 2020). The student should be able not only to use the information provided by the teacher, but also to supplement it. So, learning is not aimed at memorizing information by students, but at involving them in activities during which they acquire new knowledge (Rincon-Flores & Santos-Guevara, 2021).

The research competence can be built during curricular and extracurricular (Diaz-Iso et al., 2020) research activities (Abbott, 2019). For example, many educational programmes contain subjects, the purpose of which is to build students' research competences. They should make students understand the basics of research, teach not to accept facts as truth, but to question and analyse. For this purpose, it is necessary to involve students in research activities as early as possible.

The dependence of students' success on the teaching methods used by teachers was proved. The positive impact of the research method, which develops students' skills in generating, applying and adapting new knowledge, on their learning outcomes was established (Turner et al., 2018). The effectiveness of business, educational, serious games in the development of research competence was found (Rincon-Flores & Santos-Guevara, 2021). They allow students to show their curiosity, persistence, ability to take risks, pay attention to details, solve problems and interpret the results obtained. Abbott (2019) studied the effectiveness of the business game *How to Fail Your Research Degree*, which is intended for building research competence in graduate and doctoral students.

Astafieva et al. (2020) identified the difficulties that students and teachers face when creating a research-based learning environment for learning, for example, mathematics in the context of distance learning. Makhmudova et al. (2020) also studied the effectiveness of an open system of teaching physics and mathematics in higher educational institutions (HEIs) equipped with information and communication technologies.

Innovative communication technologies play an important role not only in the development of research competence (Skantz-Åberg et al, 2022). but also in the organization of distance learning (Suriagiri et al., 2022). They enable the choice of the topics of students' research, implementing experimental and theoretical research, carrying out remote field and computational experiments, using virtual laboratories, etc. (Udeozor et al., 2021). In particular, virtual reality allows replacing risky environments, for example, in chemical engineering. Multifunctional mobile devices can help students acquire the necessary skills, including research skills (Reddy et al., 2022). They can be further successfully used in professional activities. Open network resources facilitate the organization of students' educational activities. They can be used as a means of communication between participants of the educational process to provide educational information to students. Online resources can be sources of information used by students during in-class lessons and during independent work (Kiv et al., 2019). A number of learning networks have also been established that can be used in distance education, and that contribute to improved practical outcomes (Boyd, 2019). Various online platforms for hosting interactive educational resources have also gained popularity (Ward & Lindshieil, 2020).

Improving digital competence contributes to increasing the level of research competence (Leshchenko et al., 2021). Therefore, when training researchers and scientists, it is appropriate to include a course on studying, for example, cloud technologies, platforms and services, in the curricula (Kiv et al., 2019). Additional opportunities provided by cloud technologies enable for research that is difficult to implement in real conditions, when special equipment is not available (during distance learning), unrealistic (model for

demonstrating the states of relativistic mechanics), or dangerous to use (radioactive decay). Virtual laboratories and simulators, software that enables simulating various processes can also be used. The use of such resources interlinks research competences with subject and digital ones. However, it is necessary to conduct extra-curricular online activities to improve the digital level of students (Foley & Marr, 2019).

The teacher's ability to properly design and manage a virtual classroom is important (Ghateolbahra & Samimi, 2021). It is also necessary (Huszi et al., 2022) to take into account three important components of distance learning: course structure, student autonomy and educational dialogue. The teacher must provide students with pedagogical support during their independent cognitive activities, provide a differentiated and individually creative approach, and be able to evaluate their work. One of the options for presenting the results of students' research is a poster (Arcila Hernández et al., 2022). The poster makes it possible to assess the nature, the depth of the student's understanding of the conducted research, and to carry out a critical assessment of the level of research competence.

3. Methods

Design

The research was conducted in three stages. The first stage involved studying the attitude of students and teachers to distance learning, their successful experiences and failures. The second stage provided for the development of recommendations on the organization of distance education for the students of technical majors of HEIs aimed at building research competence, as well as their implementation in the experimental groups. At the third stage, the effectiveness of the introduced recommendations was determined by comparing the level of research competence of students in the control and experimental groups. The study was conducted over two years, from September 2020 to May 2022.

Sample

The sample included 927 students and 17 teachers from three HEIs of Ukraine, who also acted as experts: Prydniprovsk State Academy of Civil Engineering and Architecture, Ukrainian Engineering Pedagogics Academy, State University of Telecommunications. The criterion for the selection of students was their technical major, and the teachers —teaching of technical and research-related subjects (for example, Scientific Research in Energy, Planning and Management of Energy Research & Development Projects). According to the Distance Education Perception Questionnaire, the average values of points scored by students in all experimental and control groups should have been approximately the same. A total of 271 students were included in the control group, 215 — in Experimental Group I, where the research method was introduced during the study of technical subjects, 213 — in Experimental Group II, where research competence was developed during the study of a special course on the research methodology in a particular field, and 228 — in Experimental Group III, where the research method was introduced during the study of technical subjects and a special research-related course.

Tool

The authors of this study used the Perception Questionnaire (Astafieva et al., 2020) to find out the students' attitude to the distance form of education in the formation of their research competence. It contained 20 questions, which were divided into 4 groups. A survey of teachers was also conducted using semi-structured interviews, and experts determined the level of students' research competence according to criteria (Leshchenko et al., 2021). Besides, the students' self-efficacy during the research was assessed according to the measures of research self-efficacy (Forester, 2004).

Data collection

A four-point Likert scale was used to assess students' perception of distance education. Research competence was determined according to the Leshchenko's criteria:

- A high level was characterized by in-depth knowledge of the research topic, mastery of the methodology of conducting research and processing the obtained results, a high level of motivation to deepen knowledge and carry out further research (3 points on the Likert scale).
- A sufficient level was achieved by students who had knowledge of the basic concepts of the research topic, mastered the methodology of conducting research, were able to carry out research planning, information search, information processing, its analysis and interpretation. They were willing to work on improving their level of research competence (2 points on the Likert scale).
- The low level characterized students who did not have deep knowledge of the research topic. They did not master the methodology of carrying out research. They had no or weak motivation to conduct research. They did not know how to work with scientific literature. They had no desire to increase the level of research competence (1 point on the Likert scale).

The students' self-efficacy when conducting the research according to the measures of research self-efficacy (Forester, 2004) was assessed on a one-point scale, where 0 is the absence of such a skill, and 100 is perfect mastery of it.

Data analysis

Mathematical data processing methods and Statistica software were used during data analysis. The Pearson correlation coefficient was determined, which ranged from 2.7 to 3.4 for the control group, and about 1.55 for the experimental group. When determining the self-efficacy of students during the research, the values of the Pearson correlation coefficient ranged from 30 to 103. Cohen's kappa coefficient was also established, which helped to identify the effect from using the proposed ways of building research competence.

Ethical criteria

Participation in the study was voluntary. All participants provided their written consent to participate in the study. The survey was anonymous, free of charge. The duration of the surveys did not exceed 40 minutes.

4. Results

In order to reduce the impact of different perceptions of distance learning in different groups on the research results, the sample was formed with approximately the same average value in the control and experimental groups. However, the introduction of recommendations on the level of research competence of students of technical majors changed the students' attitude to distance education (Table 1).

Table 1.
Results of determining students' perception of distance education

		Pre-test	Post-test (score difference)			
		All groups	CG	EG I.	EG II.	EG III.
I	Utility					
1.1.	Does the distance learning contribute to the acquisition of knowledge, skills and abilities?	2.8	+0.1	+0.3	+0.2	+0.3
1.2.	Does distance learning make the learning process more effective?	2.3	+0.2	+0.3	+0.2	+0.3
1.3.	Does distance learning contribute to the increased performance?	3.1	+0.2	+0.4	+0.2	+0.4
1.4.	Does distance learning enable understanding the educational material?	2.0	-0.1	+0.2	+0.1	+0.2
1.5.	Does the distance learning facilitate the perception of educational material?	1.8	-0.3	+0.1	0	+0.1
II	Computer self-efficacy					
2.1.	Do you have access to learning materials and resources during distance learning?	3.2	+0.4	+0.4	+0.4	+0.5
2.2.	Can you use all materials and resources without further explanation?	2.7	+0.6	+0.5	+0.5	+0.5
2.3.	Can you independently solve problems that arise in the course of distance learning?	2.9	+0.2	+0.3	+0.1	+0.4
2.4.	Do you have enough skills to use ICT in the educational process?	3.4	+0.3	+0.4	+0.3	+0.4
2.5.	Are there technical difficulties that prevent distance learning?	3.5	-0.4	-0.7	-0.3	-0.7
III	Simplicity					
3.1.	Is the interface of the resources used in distance learning convenient for you?	3.1	+0.2	+0.3	+0.2	+0.3
3.2.	Is communication with the teacher sufficiently established?	2.7	+0.3	+0.6	+0.2	+0.5
3.3.	Is communication with groupmates well established?	3.0	+0.7	+0.7	+0.8	+0.7
3.4.	Are the tools you use for reporting to the teacher convenient?	2.9	+0.2	+0.3	+0.2	+0.3
3.5.	Do you have the opportunity to ask the teacher questions, if they arise?	2.6	+0.1	+0.4	+0.2	+0.4
IV	General attitude					
4.1.	Are you interested in distance learning?	2.9	+0.2	+0.4	+0.3	+0.4
4.2.	Does distance learning evoke your positive emotions?	2.9	+0.1	+0.4	+0.2	+0.4
4.3.	Does distance learning evoke your negative emotions?	2.7	-0.1	-0.5	-0.2	-0.5
4.4.	Do you think that distance education supports your interest in learning?	2.8	+0.1	+0.3	+0.2	+0.3
4.5.	Do you think distance learning is boring and uninteresting?	2.4	-0.1	-0.6	-0.4	-0.6

As Table 1 shows, the students' attitude to the distance learning changed in the course of this study. The positive influence of research methods of learning on the attitude of students of technical majors to this form of education was found. It was also established that the introduction of subjects for studying the peculiarities of research work did not have such a strong impact on the improvement of students' perception of distance learning.

Besides, the answers to the open-ended questions of the questionnaire revealed the difficulties that the students of technical majors face during distance learning. These include the following:

- 1) lack or low-quality feedback;
- 2) lack of previous experience for independent acquisition of new knowledge, therefore low interest in learning;
- 3) lack of practice, working with real devices in laboratories leads to lack of practical skills;
- 4) presentation of educational material in the form of texts does not motivate learning.

The survey of teachers of the sample made it possible to reveal their attitude to distance learning (Figure 1) and the difficulties they faced in preparing and conducting distance learning. As Figure 1 shows, more than a third of all teachers do not consider distance education to be effective.

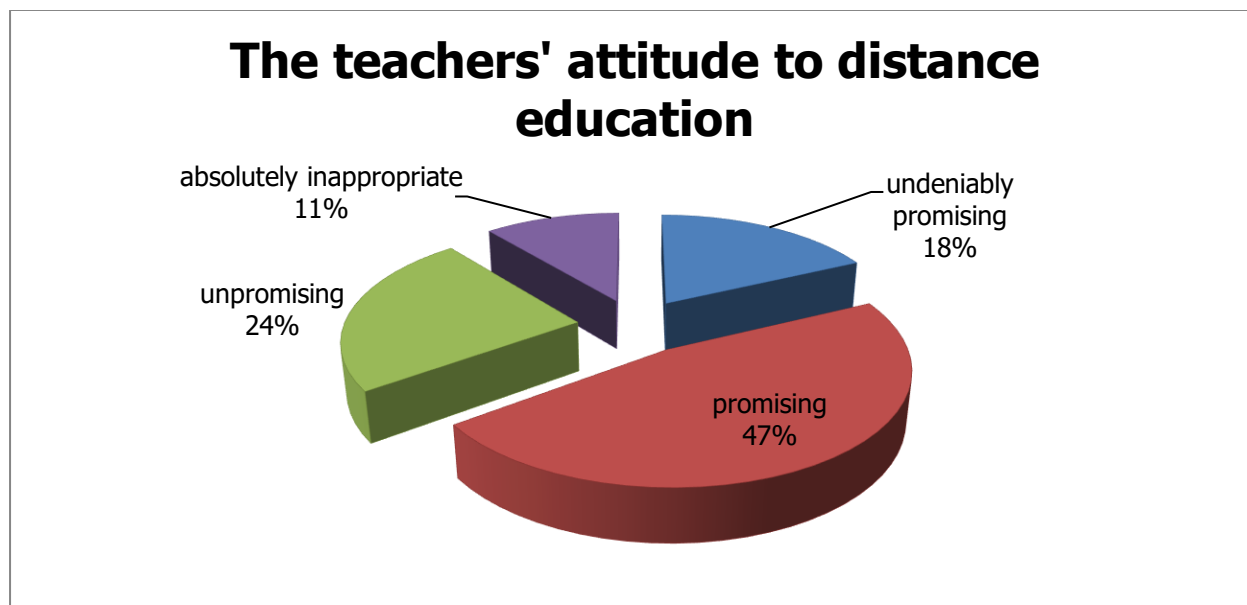


Figure 1. The teachers' attitude to distance education

The underlying reasons include the following:

- 1) lack of the opportunity to see all students as in offline learning. This leads to a misunderstanding of the students' perception of new material and timely correction of its presentation in accordance with the situation;
- 2) students' lack of communication skills in the virtual space creates certain obstacles during conversations, reports, discussions, performances, etc.;
- 3) inability to track the degree of independence in the performance of homework and test assignments;
- 4) difficulties associated with the creation of educational content. A lot of time spent on shooting training videos, especially with technical equipment, on creating digital diagrams, formulas, etc., the need for special technical support, lack of proper digital skills.

Recommendations were developed for the organization of distance learning, which would contribute to the development of research competence of students of technical majors. They include:

- 1) Introducing students to research activities as early as possible, even in the first years of study at a HEI.
- 2) Implementing a special course that introduces students to the basics of conducting the research and promotes the development of their research competence. As a result of learning the course, students should learn to formulate research objectives, advance hypotheses, select research methods, and conduct research. At the same time, it is necessary to teach students to use basic digital resources that

allow to speed up the process of searching and processing large amounts of information, for example, web systems for monitoring scientific publications, use and dissemination of research results. The students should acquire the skills of searching in bibliographic databases, information and analytical services of open digital archives, use scientometric platforms, etc. It is important for students to learn to analyse and interpret the obtained research results, to be able to present and disseminate them.

- 3) Develop the research competence during the study of other subjects by using the research method of learning.
- 4) Texts of lectures should not be presented as a monolith, but should be divided into small parts. Each part shall be followed by students' knowledge check with the use of several questions. The student would be able to proceed to the next part of the lecture only by giving the correct answer to the questions. The material should be presented in the form of a dialogue with an imaginary interlocutor (asking questions and giving answers to them). The truth should not be communicated to the students immediately, they must come to it through research or experiment.
- 5) Applying active learning methods (problematic, project, case study, flipped classroom). The time allocated for an online meeting with students should not be spent on the teacher voicing the lecture, which the students can read independently even before the meeting based on the materials provided by the teacher, or watch the video lectures recorded by the teacher or selected from the Internet. It should be spent on discussing the questions that students had while viewing or reading educational material. It is also appropriate to spend the meeting time on completing practical assignments and training skills. It is better to use extracurricular time to complete problematic and creative assignments.
- 6) The resolution of the problematic issue formulated by the teacher should be the result of research conducted by students. At the same time, it is worth dividing complex problems into component parts and distributing them among small groups of students.
- 7) The assignments should be formulated in such a way that their completion requires research, they should not be obvious or predictable. Giving freedom to students when choosing assignments.
- 8) The research objectives and projects can be jointly fulfilled and implemented with the help of Wiki. Research results can also be presented in the form of posters. This helps students to develop brevity in expressing their thoughts, to learn to distinguish the main thing without being distracted by the secondary information.

During the research, the students of the experimental group took an active part in research and development in the research centers operating at their HEIs. Students also participated in competitions of students' studies. The necessary technical equipment was used for building research competence, which can be used in the fulfilment of the research objectives set by the teacher for offline learning. In the distance learning setting, the teachers used the equipment to formulate research objectives that students had to fulfil independently, applying all their previous knowledge and available resources.

Determining the level of research competence of students of technical majors during distance learning showed positive results in all three experimental groups (Figure 2). However, the highest effect was achieved in EG III.

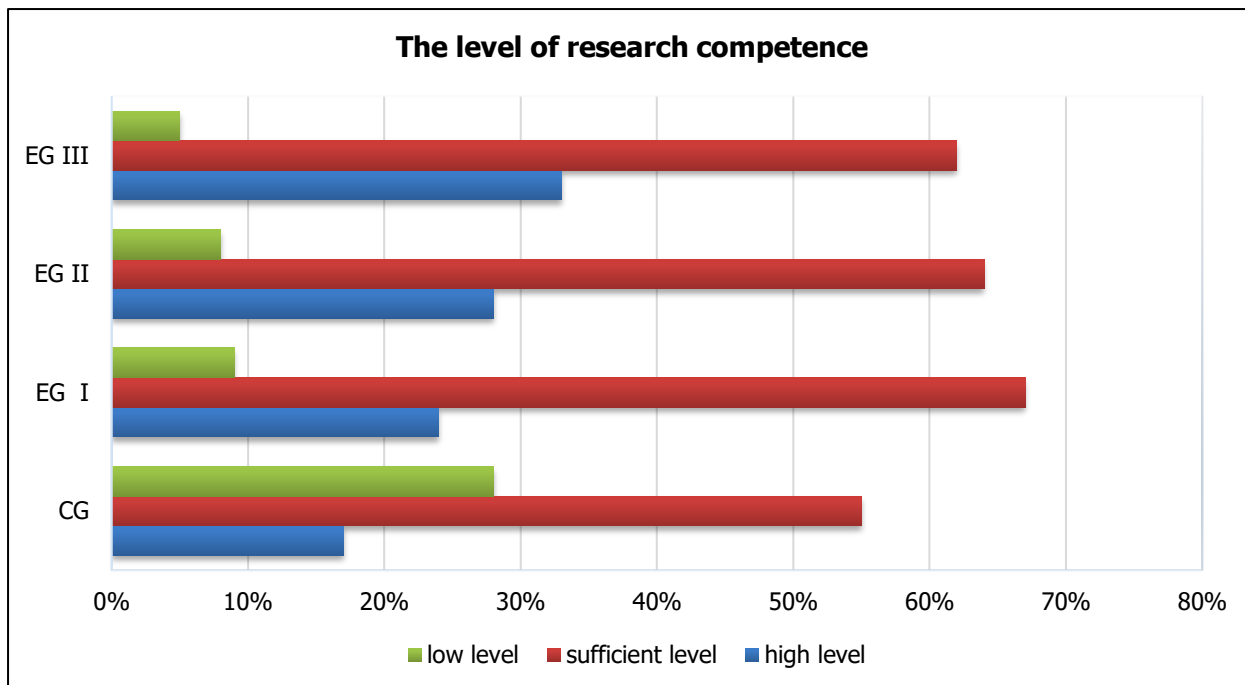


Figure 2. The effectiveness of the use of digital technologies according to the answers of future PhDs and teachers

Table 2 provides the results of the evaluation of students' self-efficacy in research activities.

Table 2.

Results of the evaluation of students' research self-efficacy

	Pre-test	Post-test (score difference)			
	All groups	CG	EG I.	EG II.	EG III.
Confidence in one's ability to complete work on the project.	57	+3	+5	+7	+9
Compliance with ethical standards of research.	45	+2	+7	+9	+10
Generating research ideas.	36	+4	+10	+11	+12
Interaction in the research community	59	+7	+12	+8	+13
Discussing research ideas with colleagues	61	+9	+12	+10	+14
Asking senior colleagues for help with ideas	78	-2	-4	+3	+5
Self-limitation in the search for information	44	+3	+7	+6	+8
Conducting a literature search	67	+5	+11	+9	+14
Self-limitation in the generation of ideas	52	+3	+4	+6	+7
Generalization of the literature	60	+6	+13	+8	+15
Outlining further research directions based on literature review	49	+3	+5	+4	+8
Justification of research ideas	56	+4	+7	+7	+8
Determining research objectives	51	+3	+6	+7	+9
Ability to present research ideas in writing	48	+4	+5	+6	+8
Editing and shortening the text	62	+7	+14	+15	+19

Presentation of the research idea	69	+6	+13	+6	+16
Using criticism of a research idea in order to improve it	57	+3	+8	+9	+12
Choice of research design	36	+2	+6	+8	+10
Demonstrating flexibility in the development of alternative ways of research	38	+2	+5	+6	+12
Selection of the necessary methods of analysis of the obtained results	53	+3	+7	+9	+13
Obtaining special permits for research	54	+7	+10	+12	+16
Selection of necessary equipment for research	49	+4	+12	+13	+15
Data collection	63	+5	+14	+14	+17
Performance of experimental measurements	68	+6	+11	+12	+14
Verification of the reliability of the obtained data	56	+3	+5	+6	+7
Careful assessment of every detail of data collection	51	+2	+5	+6	+7
Arranging the obtained data for analysis	64	+3	+7	+9	+11
Using ICT for analysis of obtained data	72	+6	+12	+13	+17
Interpretation of the obtained data	58	+3	+14	+12	+16
Generalization of the results of the conducted research	51	+4	+9	+8	+15
Identifying research limitations	63	+3	+8	+7	+9
Determining the place and role of research findings for further research	57	+3	+9	+7	+10

On average, the pre-test showed approximately the same results in all three experimental and control groups. Table 2 presents the difference in students' self-assessment of research competence at the beginning and at the end of the research.

It was established that the weighted sum of squared deviations from the mean is caused by the heterogeneity of the sample, associated with conducting research in different educational institutions and different groups. The null hypothesis turned out to be invalid, because the root mean square deviations for the same questionnaire question in different HEIs of the sample were different, and the intergroup variance, which describes the fluctuations of these groups, and the intragroup variance, which describes the fluctuations caused by random factors not taken into account, were also equal. At the same time, it was found using the Pearson correlation coefficient that χ_1^2 values obtained for the experimental groups are greater than χ_2^2 values calculated for the control group. Using the Cohen's kappa coefficient, it was established that the greatest effect was in the Experimental Group III. That is, the development of research competence among students of technical majors is best facilitated by distance learning, the combination of the research method in the study of technical subjects and the introduction of a special course on the basics of conducting research.

5. Discussion

The experience gained during the 2020 pandemic irrevocably changed the education system (Suriagiri et al., 2022). Teachers have developed additional video materials, manuals, test assignments, quizzes, with the aim of encouraging students to engage in active learning activities, stimulating students' independent learning and developing various skills (Wakes & Dunn, 2023). This experience resulted in the emergence of a culture of distance collaboration, cooperation and coordination (Stracke et al., 2022). Although there are still differences in the attitude of teachers to distance education. For example, primary school teachers have the most positive attitude towards distance learning, compared to university teachers (Dashtestani, 2020). However, most teachers, having learnt new teaching methods, will never return to traditional

education (Stracke et al., 2022). Blended learning has become the most optimal form of education, which includes offline and online learning, as well as synchronous and asynchronous. Therefore, it remains important to improve distance education, especially for practice-oriented and research-oriented courses and areas of education. For example, the authors (Li & Wang, 2021) identified a number of shortcomings in the quality of distance teaching in the field of science and engineering, in particular, the need for laboratory practice, which is difficult to provide at a distance. The effectiveness of adaptation to distance education is influenced not only by the support of teachers and classmates, but also by the student's family (Rockinson-Szapkiw & Watson (2020). The ability to support a family member in studying at a university depends directly on the availability of higher education in the student's parents and relatives.

Surveys of about 5,000 educators showed that almost 29% of respondents consider the use of distance learning to be undeniably promising, the same number have certain doubts about the possibilities of using distance learning for technical majors. About 8% of teachers are convinced of the inappropriateness of using distance learning in technical education (Petrenko et al., 2020). At the same time, almost 16% of teachers have a negative experience of using distance learning. However, research results showed a reduction in the number of students with low academic performance by more than 11% due to the transition to distance learning (El Refae et al., 2021). This study found that more than a third of teachers have a negative attitude to distance education, considering it unpromising (24%) and absolutely inappropriate (11%) for teaching students of technical majors.

The students themselves consider distance learning to be inappropriately organized, complained about unsatisfactory emotional and academic support from the administration and teachers (Maré & Mutezo, 2021). The study of the level of development of information and research competences among graduate and doctoral students, conducted according to the author's technique (Leshchenko et al., 2021), showed that the majority of respondents had a low (almost 33%) and sufficient (almost 49%) levels of these competences, with a high level of only about 19%. This study found that the introduction of the research method in learning technical subjects and a special course on the research methodology made it possible to achieve a high level of research competence of 16% of students, and reduce the number of students with the low level of this competence by 23%.

The study conducted in the USA (Wishkoski et al., 2022) showed that research activity causes students to feel anxious, for example, when working in a library, lack of interest in this type of activity, inability to find relevant content, negative attitudes, and misconceptions about the research procedure, lack of motivation. However, the introduction of courses on research methods into educational programs contributes to the development of skills necessary in research practice and promotes the development of the self-efficacy of young researchers. Students' confidence in applying research methods in new fields of research increases. Students plan and organize their own research more effectively, have experience in presenting research results, developing recommendations for their use and further research. This study confirmed the increased research self-efficacy of students of technical majors during distance learning. Moreover, a high effect is observed when applying the research method in classes in technical subjects, but it is the highest when combined with a special course of preparation for research and development.

Although there are other results (Scogin et al., 2023), which showed low motivation of students to engage in research activities, despite the implementation of a wide variety of activities provided by the research experience course. Therefore, it is recommended to introduce not only separate courses on the research methodology, but also to integrate the research method when studying other educational subjects in order to build the research competence more effectively.

Preparing students to conduct research, teaching them research methods, as identified in (Abbott, 2019), encourages and inspires them to conduct their own research. A total of 63% of students became more confident in conducting research, 85% learned to plan their work efficiently, 54% became better aware of

risks. This study showed that the proposed ways of developing research competence contributed to the growth of students' confidence in discussing research ideas with colleagues, conducting a literature search, editing and shortening the text, and presenting research.

6. Conclusions

Technical education turned out to be the most vulnerable to extreme learning conditions because of the difficulty of developing practical skills and abilities at a distance from laboratories and equipment. The importance developing students' competencies necessary for future professional activity, including research competence, makes educational institutions to find ways of building those competencies. Three ways of building the research competence of students of technical majors during distance learning were verified. It was found that among the three proposed ways, the most effective is the combination of the use of the research method during the study of technical subjects and the introduction of a course on the basics of research. The results of the study can be used in the planning and implementation of distance learning in HEIs in order to build competencies necessary for lifelong learning. Further research should be focused on finding new methods of building research competence and improving students' performance.

This study does not cover the impact of the recommendations on building the research competence on the level of student's performance, it was reduced to measuring the level of research competence and research self-efficacy.

The results of this study are recommended for researchers and teachers who are engaged in the search and implementation of new effective methods of distance learning.

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