SAINT-PETERSBURG STATE UNIVERSITY

Printed as manuscript

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PEDAGOGICAL CONDITIONS FOR THE DEVELOPMENT OF STUDENTS' TEAMWORK COMPETENCE IN THE UNIVERSITY'S ELECTRONIC INFORMATION AND EDUCATIONAL ENVIRONMENT

Scientific specialty:
5.8.1. General Pedagogy, History of Pedagogy and Education

Thesis Research
for the Degree of Candidate of Pedagogical Sciences

Translation from Russian

Research Supervisor:
Doctor of Pedagogical Sciences, Professor
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Saint-Petersburg
2025

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INTRODUCTION

Relevance of the study. In the modern era, one of the key aspects of the modernization of Russian higher education is its digital transformation. This process is driven by the necessity of forming a digital society and establishing a digital economy, as evidenced by the objective demands of the contemporary world, the challenges of globalization, scientific and technological progress, and the digitalization of various spheres of life. These trends are reflected in regulatory and legal documents [74; 84; 71].

In this regard, over the past decade, significant scientific and practical interest among educators and education specialists has been focused on the development of electronic information and educational environments in universities. These environments represent a complex of information and communication technologies that facilitate students' acquisition of educational programs regardless of their location [23; 38].

An analysis of regulatory and legal documents outlining the requirements for organizing the learning process within university-based electronic information and educational environments [74; 76] has revealed that educational institutions are mandated to ensure that students achieve learning outcomes in a remote format that are comparable to those attained through traditional forms of education [75].

Consequently, numerous Russian pedagogical studies (conducted by L. A. Darinskaya, M. E. Vaindorf-Sysoeva, Yu. V. Vainshtein, T. G. Galaktionova, L. S. Ilyushin, E. I. Kazakova, A. N. Oskina, and O. A. Solovyeva) have been dedicated to exploring new educational technologies and didactic tools. These studies aim to optimize the organization of the educational process within contemporary electronic information and educational environments in universities, ensuring that learners achieve the expected academic outcomes prescribed by educational programs.

At the same time, one of the most significant challenges in the transition to digital education is the development of students' universal (key) competencies. This process requires both the clarification of their component structure and the study of the psychological and pedagogical characteristics of their development in the context of computer-mediated communication [90]. An analysis of studies dedicated to the development of universal competencies in students [5; 53; 99] suggests that the issue of

identifying and formulating theoretical foundations for transferring effective practices in the development of universal competencies — such as critical thinking, teamwork, project-based learning, intercultural interaction, and communication skills — from offline to online environments remains insufficiently addressed in Russian pedagogy.

Among these universal competencies, teamwork is one of the most relevant [99; 83]. In the context of digitalization and the increasing prevalence of hybrid work formats, employers are increasingly seeking specialists capable of effective collaboration both in face-to-face interactions and in virtual (online) teams [88].

Given that university-based electronic information and educational environments serve as the initial "laboratories" where students acquire experience in remote teamwork [147, p. 7], a current **scientific issue** is the study of the principles and approaches to fostering students' teamwork competence in online settings.

State of research on the problem. The scientific and methodological foundations for addressing this research problem include scholarly works dedicated to the development of digital didactic resources (A. A. Andreev, P. P. Dyachuk, V. I. Soldatkin, G. Dudeney, R. Mayer, and others). A significant body of pedagogical research focuses on the implementation of the project-based learning method in the development of students' teamwork competence in the context of distance and blended learning (Yu. V. Amelina, N. V. Buzhinskaya, I. A. Valdman, and others). Furthermore, numerous studies by foreign educators and psychologists examine the peculiarities of teamwork competence in online environments (J. Goñi, E. A. Gomez, H. Y. Ku, and others).

However, some of the theoretical provisions developed by these researchers are now outdated or have proven to be of limited effectiveness. Consequently, the search for and justification of pedagogical conditions for developing students' teamwork competence within a university's electronic information and educational environment remains a topical issue in both pedagogical science and educational practice. This relevance is further confirmed by the following identified **contradictions**:

- Between the societal demand for young professionals to demonstrate teamwork competence in online teams and the insufficient attention given to fostering this competence in the university training process for future professional activities.

- Between the need to supplement students' teamwork competence with knowledge, skills, and abilities related to remote team collaboration in the context of digitalized education and the lack of research on the specifics of online teams and students' remote teamwork interaction.
- Between the didactic potential of modern information and communication technologies and the insufficient realization of this potential in educational practice when developing students' teamwork competence within a university's electronic information and educational environment.
- Between university instructors' recognition of the necessity of organizing student teamwork in an electronic information and educational environment and their insufficient ability to effectively integrate the "digital" teamwork component into the learning process.

Thus, the **relevance of the study** is determined by the search for ways to resolve these contradictions, thereby strengthening the role of students' teamwork competence in the development of universal competencies within the university's electronic information and educational environment.

Based on this, the **scientific problem** of the study lies in identifying the pedagogical conditions for developing students' teamwork competence in the university's electronic information and educational environment.

The **practical problem** involves the development of methods, tools, and organizational forms for fostering students' teamwork competence in the university's electronic information and educational environment.

Considering the identified relevance and research problems, the topic, object, subject, aim, and hypothesis of the study were determined.

Research topic: "Pedagogical conditions for the development of students' teamwork competence in the university's electronic information and educational environment".

Research aim: To design and experimentally validate a structural-functional model for developing students' teamwork competence in the university's electronic information and educational environment.

Object of the study: The process of developing students' teamwork competence in the context of online education.

Subject of the study: The pedagogical conditions for developing students' teamwork competence in the university's electronic information and educational environment.

Research hypothesis:

1. The development of students' teamwork competence in the university's electronic information and educational environment is ensured by the implementation of a structural-functional model that includes target, content-conceptual, organizational-technological, and outcome-evaluation blocks.

2. The stages of developing students' teamwork competence in the university's electronic information and educational environment are designed based on the concept of the systemogenesis of the activity psychological structure, which ensures the coordinated development of all competence components (motivational, axiological, cognitive, operational, and reflective).

3. The formulation of pedagogical conditions for developing students' teamwork competence in the university's electronic information and educational environment considers the influence of the computer-mediated communication specific features on traditional methods of teamwork organization.

In accordance with the research aim, object, subject, and hypothesis, the following **research objectives** were formulated:

1. Analyze the key concepts of the study: "team", "virtual team", "teamwork", and "remote team interaction".

2. Clarify the component structure of students' teamwork competence in the context of digitalized education.

3. Identify the main stages of the development of students' teamwork competence in the university's electronic information and educational environment, based on the psychological structure of activity.

4. Systematize the psychological and pedagogical characteristics of the development of students' teamwork competence in the university’s electronic information and educational environment.

5. Substantiate the pedagogical conditions for the development of students' teamwork competence in the university’s electronic information and educational environment and conduct an expert evaluation of these conditions.

6. Design a structural-functional model for developing students' teamwork competence in the university’s electronic information and educational environment.

7. Conduct a pedagogical experiment to assess the effectiveness of the developed pedagogical conditions; formulate key conclusions and provide methodological recommendations for educators.

The **methodological framework** of the study is based on the principles of the competency-based approach (V. I. Baidenko, I. A. Zimnyaya, A. V. Khutorskoy), the learner-centered approach (V. V. Serikov, I. S. Yakimanskaya), the information-environmental approach (A. Ya. Danilyuk, Yu. S. Manuylov), and the axiological approach to education (I. B. Bicheva, V. A. Slastenin).

The *competency-based approach* serves as the foundation of the study, as it focuses on developing students' skills and abilities necessary for solving practical problems in their professional activities [105]. Within the developed structural-functional model, the competency-based approach defines the criteria and methods for assessing the level of development of the teamwork competence operational component.

The *learner-centered approach* in education emphasizes the importance of considering students' individual characteristics and their role as active participants in the educational process. This is achieved by creating conditions that promote personal motivation and responsibility in teamwork, fostering an educational environment that facilitates each student’s potential, and structuring the learning process around students’ needs and interests, thereby enhancing engagement in teamwork [91].

The *information-environmental approach* in education draws researchers’ attention to the influence of the electronic information and educational environment on students’ communication and coordination skills in online teams. It also focuses on the

creation of technological conditions that enhance effective learning and teamwork interaction [32; 64].

The *axiological approach* in education is centered on developing students' conscious attitude toward teamwork and their responsibility for collective outcomes. This is achieved through fostering professional and universal human values such as mutual respect, cooperation, and mutual assistance [67; 93].

The **theoretical framework** of the study is based on works in the field of higher education didactics (N. V. Bordovskaya, L. A. Darinskaya), the psychological concept of activity systemogenesis (V. D. Shadrikov, A. V. Karpov), research on the didactic potential of information and communication technologies in organizing students' team interaction (Yu. V. Amelina, N. V. Buzhinskaya, O. A. Solovyeva), and studies on the specifics of remote teamwork (J. Goñi, E. A. Gomez, M. Ismailov, H. Y. Ku).

The **research methods** employed in the study included: *theoretical methods* – content analysis, comparative analysis, pedagogical modeling and design, systematization, and data generalization; *empirical methods* – surveys, expert evaluation, testing, and pedagogical experiment; *statistical methods* – ranking and statistical data processing techniques.

The **scientific novelty** of the research lies in the development of pedagogical conditions for fostering students' teamwork competence in a university's electronic information and educational environment. This was achieved through a systematic study of remote team interaction and its connection with the stages of psychological activity development. The key contributions include:

- Clarification of the component structure of teamwork competence in the context of digitalized education.
- Description of the teamwork competence development stages in an electronic information and educational environment, aligned with the concept of activity systemogenesis.
- Systematization of psychological and pedagogical characteristics affecting teamwork competence development in an electronic information and educational environment.

- Identification and justification of pedagogical conditions for fostering teamwork competence in an electronic information and educational environment.
- Design of a structural-functional model for teamwork competence development in an electronic information and educational environment.

The **theoretical significance** of the study lies in enriching the theoretical and methodological foundations of general pedagogy and digital didactics through:

1. Expanding scientific understanding of student preparation for remote teamwork in the context of education digitalization.
2. Identifying structural components of teamwork competence, considering its implementation in a digital environment.
3. Developing assessment criteria and defining levels of teamwork competence formation under digital education conditions.
4. Providing a theoretical and methodological rationale for the process of teamwork competence development in a university’s electronic information and educational environment.

The **practical significance** of the study is reflected in the following:

1. Pedagogical conditions for developing students' teamwork competence in a university’s electronic information and educational environment were identified, ranked through expert evaluation, and validated through experimental training.
2. A structural-functional model for teamwork competence development was designed, tested in practice, and proven applicable to both social sciences and natural sciences disciplines.
3. Course content for "Pedagogy" and "Pedagogy and Psychology" was developed and adapted based on digital didactics for students in social sciences and natural sciences programs.
4. Methodological guidelines were created for instructors on organizing student teamwork in a university’s electronic information and educational environment.

The experimental base of the study was Saint Petersburg State University (SPbU), Saint Petersburg, Russian Federation.

Organization and stages of the study. The study was conducted between 2021 and 2024 and included three stages: diagnostic, formative, and summarizing. A total of 306 participants were involved at different stages.

During the pilot phase, the sample included 68 first- and fourth-year psychology students and 33 third-year journalism students from SPbU. The expert evaluation of pedagogical conditions for teamwork competence development involved 10 faculty members with over 10 years of experience and academic publications in digital education technologies. These experts specialized in psychology, pedagogy, mechanical engineering, philosophy, and linguistics.

In the diagnostic experiment, the sample included 155 third- and fourth-year students from social science programs (international journalism, occupational psychology, geography, and geology) and 40 faculty members specializing in psychological and pedagogical sciences.

The formative experiment involved 39 students, divided into control and experimental groups. The control group included 20 fourth-year psychology students (Program 37.05.02 "Occupational Psychology"). The experimental group included 19 fourth-year geography students (Program 05.03.02 "Geography").

At the *diagnostic stage* (2021–2022), literature and policy on education in Russia were analyzed, key research concepts refined, and the structural and conceptual characteristics of teamwork competence defined. The study established the link between activity systemogenesis theory and teamwork competence development stages, systematized psychological and pedagogical characteristics of teamwork competence formation in an electronic information and educational environment, and conducted a pilot study to test the relevance of these characteristics on a Russian student sample.

At the *formative stage* (2022–2023), pedagogical conditions for teamwork competence development were identified and evaluated by experts, and a structural-functional model for teamwork competence development in an electronic information and educational environment was designed and implemented in practice.

At the *summarizing stage* (2024), the study analyzed and interpreted experimental results, applied mathematical statistics for data processing, formulated key conclusions, and outlined research prospects.

Presentation of research results. The main findings of the study were presented at international and statewide conferences: "Pashkusov Readings 2024" (Saint Petersburg, 2024), "II Statewide Scientific and Practical Conference 'Translation and Foreign Languages in the Global Dialogue of Cultures'" (Saint Petersburg, 2024), International Scientific and Practical Conference "Pedagogy of Success: Dialogue of Generations" (Saint Petersburg, 2024), International Scientific and Practical Conference "Trends in the Development of Language Education in the Modern World – 2023" (Minsk, Republic of Belarus, 2023), V Statewide Conference for Young Linguists "Traditional and New: Mobile Technologies in Teaching Intercultural Communication" (Saint Petersburg, 2023), "Youth of Siberia – for Russian Science" (Krasnoyarsk, 2022), "Ananyev Readings – 2022. 60 Years of Social Psychology at SPbU: Towards New Achievements and Innovations" (Saint Petersburg, 2022), Statewide Scientific and Practical Conference "Current Problems and Directions of Digital Transformation in Education" (Pskov, 2021), and "Trends in the Development of Language Education in the Modern World – 2021" (Minsk, 2021). The study results were also discussed at meetings of the Department of Pedagogy and Psychology of Education at the Faculty of Psychology of SPbU and at methodological seminars for PhD students at the Institute of Pedagogy.

The primary findings were shared through the following activities:

1. A teaching-methodological seminar for educators within the supplementary education program "Pedagogy and Psychology of Higher Education and Continuing Professional Education" (Program Registration Number: 071856).

2. A workshop for philology students at SPbU during the statewide conference "Traditional and New: Mobile Technologies in Teaching Intercultural Communication," titled "Organizing Distance Teamwork for Students Using Digital Services."

3. An open plenary session of the Center for Teaching Excellence at the Graduate School of Management, SPbU.

The research outcomes have been published in 12 works, including 1 article in an international scientific journal indexed in Scopus and listed in the "whitelist" of scientific journals, 3 articles in peer-reviewed scientific journals recommended by the Higher Attestation Commission of the Ministry of Science and Higher Education of the Russian Federation, 1 chapter in a collective monograph, 1 article in an international publication indexed by international scientometric systems such as ProQuest and OpenAIRE.

The reliability and validity of the obtained results are ensured through a comprehensive analysis of normative documents, a comparative analysis of psychological and pedagogical studies, a systematic approach to designing a structural-functional model for developing students' teamwork competence in the university's electronic information and educational environment, experimental work on testing pedagogical conditions for developing students' teamwork competence in the university's electronic information and educational environment, and the application of a set of mathematical statistics methods in analyzing and summarizing the results of the pedagogical experiment.

The study aligns with the passport of scientific specialty 5.8.1 – "General Pedagogy, History of Pedagogy and Education," as it addresses:

- Conditions for effective pedagogical interaction in the university's electronic information and educational environment for developing students' teamwork competence (corresponding to research topic 1.14.9 – "Pedagogical conditions for organizing effective interaction with students in the information and educational environment").
- Methods, tools, and organizational forms of teaching students to work in online teams (corresponding to research topic 1.14.4 – "Directions of transformation the interaction between subjects of the information and educational, hybrid environment").
- The specifics of forming students' personal significance of online teamwork (corresponding to research topic 1.14.11 – "Theoretical, methodological, and methodological foundations for forming students' value orientations in the context of digitalization of education").

Volume and structure of the thesis. The study consists of an introduction, two chapters, a conclusion, list of abbreviations and conventions, references, and appendices. The total volume of the work is 195 pages. The number of literature sources used is 167,

of which 53 are in foreign languages. The number of appendices is 16. The number of tables is 31. The number of figures is 47.

Key scientific findings:

1. Through a systematic review of the scientific literature and a pilot study, the primary psychological and pedagogical characteristics of developing students' teamwork competence in a university's electronic information and educational environment were identified. These findings are detailed in Chapter 1 and published in works [15; 16].

2. By analyzing literature and conducting surveys among students and faculty, the theoretical and methodological foundations for developing students' teamwork competence in a university's electronic information and educational environment were described. The results are presented in Chapter 1 and published in works [13; 37; 118].

3. Based on content analysis of psychological and pedagogical periodicals and expert evaluations conducted during the study, a set of pedagogical conditions ensuring effective development of students' teamwork competence in a university's electronic information and educational environment was proposed. These conditions are thoroughly described in Chapter 1 and presented in works [36; 118] (70% personal contribution).

4. A structural-functional model for developing students' teamwork competence in a university's electronic information and educational environment was developed. This model includes methodological foundations, stages, pedagogical conditions, tools for developing the specified competence, as well as methods and criteria for diagnosing the formation of each component. The model is presented in Chapter 1 and published in work [36], with a personal contribution of at least 70%.

5. A pedagogical experiment confirmed a positive dynamic in the development of teamwork competence components among students in the experimental group compared to those in the control group. The results of the statistical analysis of the experimental data are provided in Chapter 2. The didactic methods and tools used in the experiment are partially described in works [12; 14; 119].

Key provisions for defense:

1. Students’ teamwork competence in the context of education digitalization comprises five components: motivational, axiological, cognitive, operational, and

reflective. Each component is enriched with knowledge, skills, abilities, value orientations, and experiences that enable students to effectively implement this competence in distributed (remote, virtual) teams (understanding online team structures, proficiency with online trackers, the ability to facilitate online brainstorming, etc.).

2. Effective development of students' teamwork competence in the university's electronic information and educational environment is achievable by considering the psychological and pedagogical characteristics of each component's development within computer-mediated communication (the correlation between motivation for online teamwork and the level of digital skills, the preference for conflict avoidance strategies during goal setting, the necessity for timely feedback from instructors, and reliance on the "digital footprint" during team reflection, etc.).

3. Pedagogical conditions for developing students' teamwork competence in the university's electronic information and educational environment include:

- For developing the motivational component – ensuring regular pedagogical interaction aimed at forming a unified level of digital skills among students, implementing techniques for recursive team building and methods for the even distribution of the academic load.
- For developing the axiological component – stimulating team reflection and supporting interactive self-assessment.
- For developing the cognitive component – applying forms of proactive learning with elements of preliminary self-assessment.
- For developing the operational component – creating a training environment for improving students' digital skills, organizing synchronizing online meetings.
- For developing the reflective component – using reflection techniques based on teams' "digital footprints" aimed at developing skills in providing formative feedback.

4. The effectiveness of developing students' teamwork competence in the university's electronic information and educational environment is ensured by implementing a structural-functional model in the educational process. The model comprises target, content-conceptual, organizational-technological, and outcome-evaluation blocks.

CHAPTER 1. Theoretical and Methodological Foundations for Developing Students' Teamwork Competence in the University's Electronic Information and Educational Environment

The first chapter of the thesis is dedicated to the theoretical justification of the process of developing students' teamwork competence (hereinafter referred to as TW competence) in the university's electronic information and educational environment (hereinafter referred to as EIEE). It explores aspects of forming this competence and analyzes scientific literature on the phenomenon of teamwork, including in the context of education digitalization.

Particular attention is given to analyzing the concepts of "team," "teamwork," "virtual team," and "remote team interaction" and their interrelations in the modern world. The chapter examines methodological approaches to defining the component structure of students' TW competence in the conditions of digital education transformation. Additionally, it analyzes existing psychological and pedagogical characteristics of the development of this competence in EIEE, considering factors of computer-mediated communication (hereinafter referred to as CMC).

As a result, pedagogical conditions that contribute to the effective development of students' TW competence in the university's EIEE are identified.

1.1 The Development of Students' Teamwork Competence in the University's Electronic Information and Educational Environment as a Pedagogical Problem

The 21st century is characterized by the increasing pace of informatization and digitalization of various aspects of human activity [165]. The implementation of changes in various geopolitical, industrial, and social processes increasingly requires the merging of competencies of a whole range of specialists, who have to analyze vast amounts of data in close cooperation with each other to make decisions [70].

True collaboration, in turn, arises when each individual realizes the necessity of combining resources, competencies, and personal experience with other people to achieve new socially significant goals both within individual states and on the global stage [68]. Therefore, in the modern world, the importance of interdisciplinary competencies and

personal qualities is increasing, allowing professionals with various competencies to unite to solve new complex and creative tasks in the process of continuous self-learning and self-development [81].

Sociologists distinguish various types of social interaction — union, association, cooperation, etc. [13]; however, the phenomenon of the team and teamwork is of particular scientific and public interest, as the *team* is the main organizational unit of modern enterprises, scientific-innovative collectives, and business startups [50, p. 3]. This is because teamwork ensures the necessary flexibility in adapting people to organizational changes caused by a rapidly changing environment. The interchangeability of team members, their readiness for mutual learning, as well as the presence of well-developed operational strategies allow such social formations to achieve goals even within short-term planning frameworks [18].

Teamwork is the primary form of interaction in high-tech industries [39]. This is because for the creation of innovative and high-tech products, developers need to integrate competencies and knowledge, thereby ensuring a synergistic effect in achieving a common goal [156, p. 44]. Thus, the well-known Agile project methodology is entirely based on the concept of cross-functional teams, bringing together experts from various fields who work intensively together to create a unique product to solve a business problem or a social issue [160].

According to V. A. Mikheev, the term "team" is widely used in the political sphere, although the practice of team-based political management is not yet a widespread topic of scientific research [68, p. 101]. The experience of the first quarter of the 21st century shows that many politicians and state leaders have resorted to team-building tactics for implementing national and strategic projects (National Projects “Culture”, “Demographics”, “Labor Productivity”, etc.) [ibid., p. 103]. In addition, major scientific research centers in Russia (Scientific Engineering Center "SNIIP", Russian Academy of Education Scientific and Educational Center, etc.) are increasingly forming cross-functional leadership teams consisting of scientists, business representatives, and government officials [ibid.].

The necessity of developing TW competence in the training of specialists in any field is confirmed by the results of numerous domestic and international sociological surveys and labor market studies.

For example, the company Gallup, in collaboration with Microsoft Partners in Learning and Pearson Foundation, developed the 21st-century skills index, which includes collaboration, self-learning, professional communication, global awareness, self-regulation, problem-solving in real-world situations, and the use of technology in education [115, p. 4]. According to the authors of the study, these seven skills prepare young people for the challenges and specifics of work in the modern knowledge- and technology-based globalized environment [ibid.].

The necessity of developing TW competence was also confirmed in a survey conducted in 2020 by the non-profit organization "Russia – State of Opportunities". More than one hundred Russian companies participated in the survey, and over 60% of respondents named teamwork and information skills as the key qualities of future graduates [88].

An analysis of the register of professional standards of the Russian Federation established that the requirements for young specialists' implementation of TW competence are specified in groups of necessary labor actions and skills related to project work, organizing research team interaction, and coordinating team activities within a collective [72].

A study of Russian and international rankings of "soft skills" conducted by M. M. Malova showed that self-organization and teamwork skills have held leading positions in Russia since 2015 [63].

As part of the "Atlas of New Professions" project in 2022, eleven key cross-professional skills of future workers were identified, at least three of which relate to social collaboration and teamwork: project management, cross-industry communication, and working with people [27, p. 28]. Researchers notably observed that most progressive companies are transitioning from hierarchical management structures to decentralized ones. For example, at the company Valve, all employees have equal rights and form teams at their discretion, depending on the nature of the professional task [ibid., p. 400]. This

decentralized business process model, which is gaining popularity in various organizations worldwide, undoubtedly requires modern specialists to have teamwork skills, the ability to set common goals, decompose them according to the team's composition, and engage in mutual monitoring and learning.

Thus, today, higher education teachers face a challenging task: to effectively organize the educational process to develop students' TW competence, considering the diversity of their personal qualities, differences in levels of digital literacy, and motivation to prepare future specialists for team interaction in the modern digital society.

However, educators should also consider that modern students and young professionals must work in teams not only in offline environments but also remotely, which requires clarifying the structure of TW competence and finding optimal ways to develop it in the context of education digitalization [37]. This became particularly evident after the Covid-19 pandemic when there was a mass transition of educational process participants to remote interaction formats [38].

This transition was also noted in the professional environment. As T. A. Lachinina, a researcher of the team-based approach to change management, observes, in the modern era, "digital connectivity" between team members is strengthening just as the connection between an employee and an organization is. Simultaneously, inversely proportional to this trend, is the weakening of professionals' ties to a specific workplace in a defined space and time. The effectiveness of teams engaged in social-virtual relations is increasing, which defines the demand for developing TW competence in university students so that young specialists demonstrate readiness and ability to work both in traditional and virtual teams [55].

The authors of the digital project "Atlas of New Professions," when describing the future of one of Russia's most crucial industries — mineral extraction and processing — identified a trend where specialists are increasingly reluctant to relocate to production sites. According to scientists, by 2030, employees will more frequently work in distributed virtual teams using appropriate telemetry systems [27, pp. 355–356]. For example, in describing the profession of a coordinator of distributed tunneling teams (oil and gas industry), the primary function of such a specialist is ensuring coordinated

interaction between people at the site and those working remotely. At the same time, the functions of a team manager remain standard: setting work tasks, organizing communication within the team, and resolving contradictions and conflicts [ibid., p. 358]. This indicates that TW competence today requires the addition of a set of digital skills and abilities that must be developed during university education.

This position is also reflected in international research. For example, an analysis of Gallup's study on identifying key 21st-century skills found that many collaboration-based competencies must be implemented online [115]. Independent researchers of professional trends confirm that this requirement is entirely justified, as the majority of professional activities, starting as early as 2030, will take place online or involve collaboration with colleagues in different locations [116, p. 282].

Thus, the social demand for students' TW competence is clearly evident both in Russia and internationally. At the same time, the area of competence implementation in the current stage of digitalization is shifting from traditional offline environments to situations of remote team interaction.

The pedagogical problem requiring resolution in higher education today can be formulated as follows: how to effectively develop students’ TW competence in the context of ongoing education digitalization, taking into account the specifics of virtual interaction, the peculiarities of role distribution in virtual teams, and the necessity of maintaining motivation for teamwork in a digital environment?

Since the education sector, as G. Moore rightly notes, is a dynamic and constantly evolving "landscape" that changes depending on social demand, global and local trends in societal development, the level of informatization, and the latest technological innovations [147], modern university EIEEs must implement appropriate methods and tools for developing students’ TW competence for both offline and online interactions. If, as G. Moore suggests, classrooms in educational institutions should become the "first laboratories" for acquiring systematic experience in teamwork within the framework of solving professionally oriented tasks [ibid., p. 7], then university EIEEs must provide students with the necessary and sufficient experience of remote team interaction.

Thus, *the pedagogical problem of developing students' TW competence* in the current stage of education digitalization and the development of a digital society *is complex and multi-level*.

First, higher education teachers today need to organize the process of developing students' TW competence so that the learners acquire both general knowledge about teamwork, team values, and collaboration technologies, as well as experience in remote team interaction. This includes familiarizing students with digital tools for online teamwork and studying the characteristics of online teams. To achieve this, teachers must understand the specifics of teamwork in general, the psychological and pedagogical characteristics and technological aspects of remote team interaction and possess the necessary digital tools for organizing students' team activities within a university's EIEE.

Second, the necessity of developing students' TW competence for its subsequent implementation in distributed professional teams imposes additional requirements on the structure and content of universities' EIEEs. It requires the introduction of digital tools for team goal-setting, workload distribution, and monitoring the progress of achieving common goals in a digital environment. Additionally, it is essential to create a virtual space for team and personal reflection and integrate digital tools for brainstorming, interactive voting, and presenting the results of remote teamwork.

Third, according to several researchers [3; 137; 158], the stages of developing students' TW competence in an online format should follow a different sequence from those in traditional face-to-face learning.

In support of this latter challenge, J. Staggers et al. note that the biggest issue faced by educators today when developing TW competence is helping a group of students (often randomly assigned) to become a team in conditions where courses are implemented fully or partially in a remote format. A large body of research, the authors note, has been gathered on various team-building exercises aimed at helping each group go through the necessary phases for developing into a team [158]. However, the online environment adds another level of complexity to teaching teamwork. A theoretical foundation is needed to determine how exactly to transfer successful strategies for developing students' TW competence from in-person education to university EIEEs and what conditions ensure the

effectiveness of this process [ibid.]. The researchers emphasize that despite extensive studies on collaboration, most theories about how teams function are based on research on non-virtual social formations. Given the widespread use of information technologies, additional studies are required on the formation and development of student teams in an online environment [ibid.].

M. Ismailov and J. Laurier share a similar viewpoint, noting that while a significant number of psychological and pedagogical studies focus on the initial factors influencing the effectiveness of virtual teamwork (participants' digital skills, motivation, value-based attitudes toward teamwork) and the outcomes of this form of social collaboration (participant satisfaction, labor productivity, learning effectiveness), to date, only a limited number of studies provide a comprehensive theoretical and methodological foundation for the processes, stages, and sequence of developing students' TW competence in university EIEEs [137].

As a general conclusion, classifying TW competence as a cross-context skill (or interdisciplinary competence, key competence, universal competence — according to different researchers' definitions) implies that this competence can be applied in various spheres of social, professional, and academic activities [97]. In other words, on the one hand, knowledge about the value, methods, and strategies of teamwork should be structured around fundamental elements that remain unchanged regardless of the interaction format (e.g., motivation for teamwork, a stable commitment to adopting a shared team goal, skills in goal-setting and delegation, mutual respect, etc.). On the other hand, the specifics of modern social and technological development require young professionals to acquire an additional "layer" of skills — namely, proficiency in various digital tools and an understanding of the nuances of remote interaction in the implementation of TW competence [166].

Thus, methodologically, the process and outcomes of developing students' TW competence during their higher education can be represented along two trajectories: preparing students for work in traditional offline teams and providing them with experience in working in virtual teams (see Figure 1.1).

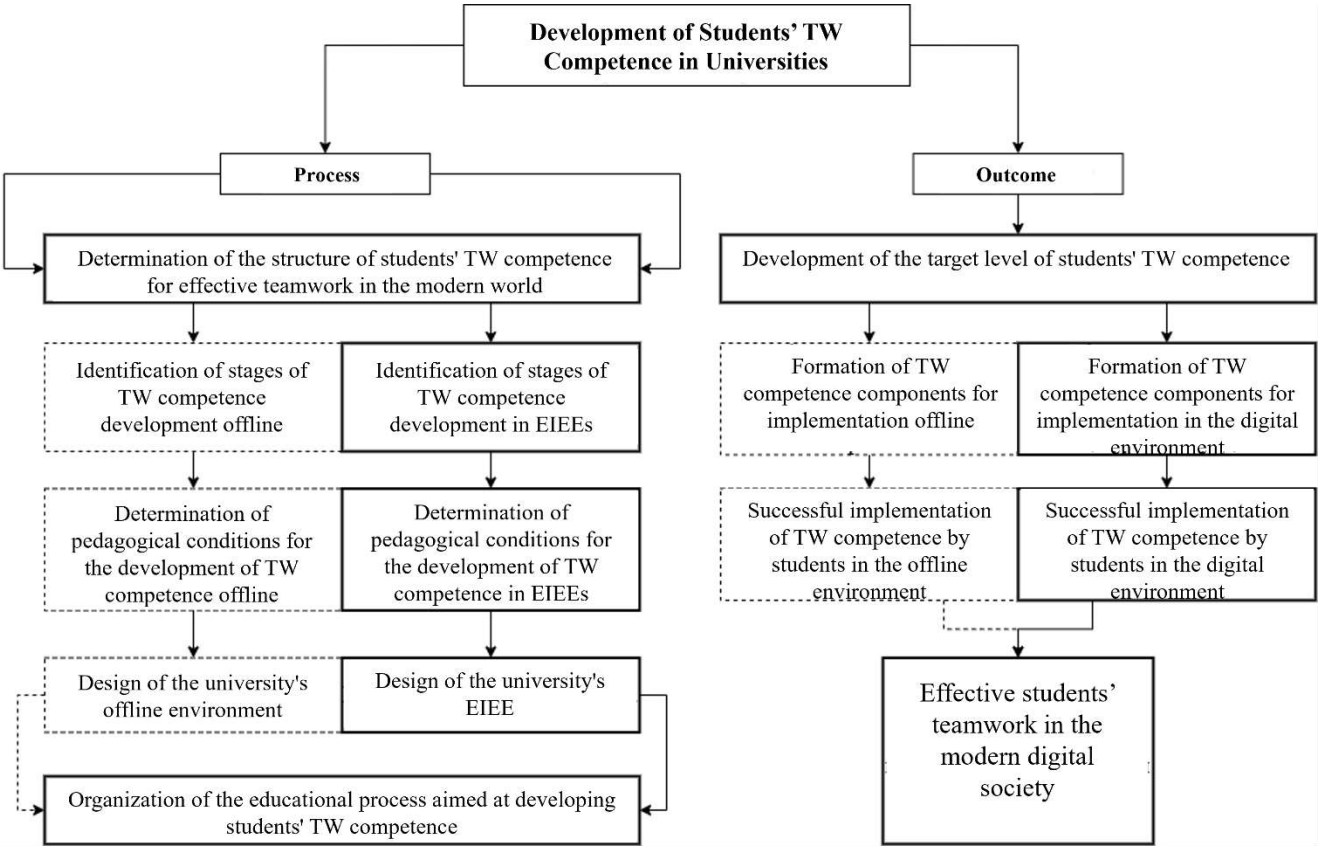

Figure 1.1. – The process and outcomes of developing university students' TW competence in the context of education digitalization

As shown in Figure 1.1, preparing a modern specialist in any field for successful teamwork requires: **a)** clarifying the structure of TW competence, **b)** identifying the stages and pedagogical conditions for developing this competence, and **c)** formulating theoretical and methodological foundations and practical recommendations for designing both traditional learning environments and EIEEs in universities. However, solving all these tasks comprehensively goes beyond the scope of this study.

In our research: **a)** the component structure of students' TW competence is clarified for its subsequent implementation in digital academic and professional environments; **b)** the process of developing this competence in the university's EIEE is examined, with an identification of the accompanying pedagogical conditions; **c)** an assessment is conducted on the level of TW competence development in students within the university's EIEE, based on the implementation of the proposed pedagogical conditions. The specified research directions are **highlighted with bold outlines** in Figure 1.1.

Thus, an analysis of scientific literature and independent labor market research has led to the conclusion that the necessity of developing students' TW competence in universities' EIEEs is driven by the current economic situation, social agenda, industrial changes, digitalization and technologization of various aspects of life, as well as the ongoing digital transformation of Russian education.

The pedagogical problem lies in the need to develop and implement teaching methods and conditions that contribute to the effective development of students' TW competence in a university's EIEE. This problem involves not only the transmission of domain knowledge but also the formation of skills for effective interaction, collaboration, and adaptation in virtual teams, which is particularly important for preparing students for the realities of their professional activities.

To address this pedagogical problem, it is necessary to:

- Systematically refine the definition and component structure of TW competence in the current stage of education digitalization.
- Systematize the psychological and pedagogical characteristics of the process of developing students' TW competence in universities' EIEEs.
- Propose and justify pedagogical conditions for developing students' TW competence in the university's EIEE.
- Develop a pedagogical model for the development of students' TW competence in the university's EIEE.
- Determine the didactic and technological requirements for the university's EIEE to implement academic disciplines that will contribute to the development of students' TW competence.
- Formulate methodological recommendations for teachers on organizing teamwork in universities' EIEEs.

To explore scientific research on this issue, a content analysis of psychological and pedagogical literature was conducted.

1.2 Content Analysis of Literature on the Research Problem

The purpose of the content analysis is to define the key concepts – "team", "teamwork", "virtual team", "remote team interaction", "students' TW competence", as well as to systematize studies on the structural composition of students' TW competence. The analysis was conducted using articles from journals "Pedagogics", "Higher Education in Russia", "Psychological Science and Education", "International Journal of Educational Research", "American Educational Research Journal" and others.

The search for studies was primarily carried out in scientometric databases Google Scholar, Education Resources Information Center (hereinafter – ERIC), Russian Science Citation Index (hereinafter – RSCI) using various search algorithms, for example, "teamwork", "team interaction", "learning teams", "team learning", "team collaboration".

A total of 57 scientific texts published over the past 10 years were analyzed during the content analysis. Among them: 21 scientific articles (RSCI, Higher Attestation Committee (hereinafter – HAC) indexed), 4 thesis research abstracts, 17 foreign scientific articles (Web of Science, SCOPUS indexed); 12 monographs by Russian educators and psychologists, as well as 3 English-language dissertations.

In accordance with the stated objective, the analysis was conducted in two stages:

1. *Definition of key concepts*. At the first stage, we conducted a review of scientific literature to identify different researchers' approaches to defining the concepts "teamwork", "virtual team" and "remote team interaction" in academic publications and monographs. The semantic units (categories) of analysis were specific terms (for example, team interaction) and the topics of separate sections of scientific works that addressed the research problem (for example, features of team operation in a virtual environment). The counting units were the key characteristics of teams and team interaction as a form of social collaboration, as well as justifications for distinguishing these characteristics. The results of this analysis step are presented in § 1.2.1.

2. *Systematization of approaches to defining the component structure of students' TW competence*. At this stage, the component structure of TW competence was used as the content analysis category. The objective was to determine how many components researchers identify in the structure of TW competence. Through a

comparative analysis of the key characteristics of teamwork identified in the first step and the competence components proposed by various researchers, the component structure of TW competence was refined. The results of this step are presented in § 1.2.2.

1.2.1 Analysis of Key Research Concepts: "Team", "Teamwork", "Virtual Team", and "Remote Team Interaction"

The analysis of data from scientometric systems (Google Scholar, RSCI, ERIC, etc.) based on the keywords "teamwork," "team interaction," "team" has shown that approaches to their definition are widely covered in pedagogy, sociology, management, and economics.

For example, E. V. Krasavina et al. assert that the concept of "team" is more often used as a managerial term that describes the characteristics of interaction among a small number of people united by a common goal and complementary competencies [52, p. 356].

In one of the most cited works on team interaction, we find the following definition: "A team is two or more people with specific roles who interact to achieve a common goal" [152, p. 562]. G. Parker and R. Kropp consider a team to be a group of people who, possessing a high level of independence, jointly determine a specific activity goal and the tactics for achieving it [82].

Other similar definitions are presented in Table 1.1, which also lists some definitions of teamwork.

Table 1.1 – Examples of definitions of "team" and "teamwork"

Definition	**Source**
A team is a group of people working toward a common goal who are accountable to each other for the final outcome of their activities.	[57, p. 59]
Teamwork is an adaptive, dynamic, and episodic process that encompasses the thoughts, feelings, and behaviors of team members as they interact to achieve a shared goal.	[152, p. 562]
Teamwork consists of interdependent actions of individuals who achieve common results through cognitive, verbal, and behavioral activities.	[144, c. 358]
A team is a group of individuals who are interdependent and exchange information, resources, and skills to achieve common goals through the synergy of individual capabilities.	[161, p. 18]
A team is a dynamic and adaptive structure with a high level of delegation of authority among its members, as well as the ability and skills for self-assessment of collective performance outcomes.	[48, p. 20]

The field of educational sciences has revealed a significant number of studies dedicated to clarifying the concept of teams and student teamwork.

For instance, K. E. Shakhmaeva considers student teamwork as a collective, goal-oriented educational and professional activity of students aimed at solving a common task with a high degree of responsibility and coordination of actions, self-monitoring of role behavior, and carried out based on discussing and implementing ideas from various professional fields according to rules established by the team members [110, p. 28].

L. I. Savva et al. believe that a student team is a group of students who recognize the necessity of interaction to achieve a common goal, take responsibility for the result, and have a creative attitude toward joint work [89].

Foreign researchers propose shorter but similar definitions. For example, R. Bravo et al. define a team as a group of students who apply shared knowledge, judgment, and experience to collectively solve an assigned educational task [120]. E. Pfaff & P. Huddlestone define student teamwork as the ability of students to co-create projects aimed at achieving a collective goal [150].

As can be seen from the definitions given, when describing the phenomenon of teams and teamwork in a pedagogical or broader social sense, researchers operate with several *key characteristics*:

- a common goal and motives for activity,
- shared team values,
- established knowledge about teams and teamwork,
- developed strategies and tactics of interaction,
- self- and mutual control.

Let us consider each characteristic in more detail based on analyzed research perspectives.

According to L. V. Fatkin and K. A. Morozova, team members' motivation is primarily associated with the presence of a *shared goal* and its recognition by each participant in the interaction [102]. The awareness of responsibility for achieving this goal is one of the key components of team formation, as it ensures that participants perceive each other not just as equal members of interaction but as bearers of unique experience that can complement others' competencies, thereby ensuring more productive progress toward a common result [49, p. 64].

Such a synergetic effect, as noted by A. V. Brushlinsky, is also provided by *similar value orientations* among team members, which allow individuals to form group unity and holistic behavior towards other social groups and phenomena, acting as a collective subject of activity [21]. Among these values, researchers highlight the recognition of the uniqueness of participants, the aspiration to make collective rather than individualistic decisions, the desire to contribute equally to the common endeavor, the recognized value of self-development through mutual learning, non-confrontational behavior, and others [139]. As E. A. Alexandrova notes, a set of common values is often formulated in the form of a *team mission*, which ensures participant cohesion and regulates certain aspects of team interaction [2, p. 33].

For effective teamwork, *knowledge of behavioral norms and interaction regulations* is crucial, as it ensures the stable reproducibility of team actions [18]. Team members should be knowledgeable about team structure, goal-setting and delegation

processes, planning and executing team activities, control and assessment mechanisms at different stages of teamwork, as well as knowing the methods of team and personal reflection [17; 101; 80].

A team assumes that its members have *experience in team interaction*, as well as *developed teamwork skills and abilities* [1]. The specifics of team activity processes have been examined in many Russian and foreign studies, allowing for a high degree of elaboration on the specific actions and operations inherent both to the team as a whole and to each individual. These actions include goal setting, decomposition of team goals, role distribution and delegation of authority, analysis and selection of alternative activity strategies, control and assessment, adjustment of actions and operations, and team reflection [125; 155]. An additional feature of team activities, according to W. van Ginkel et al., is actions related to requesting and providing formative feedback, as well as reflective skills [131]. The first includes actions taken by team members aimed at consistently requesting and providing assessments of each other's individual performance. Furthermore, participants should be trained in the process of delivering formative feedback. When team values are well-developed, and members have strong self-reflection skills, feedback becomes a central component of both team and individual development [ibid.].

The reflective component itself — *the monitoring of work progress and the comprehension of activity methods and results* — lies in teams' pronounced orientation toward self-evaluation of joint activity results, peer evaluation of individual contributions, and each member's awareness of the value of giving and receiving feedback on their specific tasks [1]. According to T. Dickson & R. McIntyre, the conditions for developing a high level of reflection are particularly ensured by a "supportive environment" within teams. This environment includes participants' orientation toward two main types of supportive relationships: the willingness to assist any team member in completing part of the tasks (which implies knowledge of the detailed decomposition of the team's goal and an understanding of roles) and the ability to seek help if a task proves to be too difficult for a particular individual [125]. It is worth noting that a supportive environment largely ensures the *social-psychological characteristics* of a team identified by A. L. Zhuravlev:

interconnectedness and complementarity of team members, mutual assistance, psychological readiness for shared work, etc. [40].

As a result of literature analysis, we will define a **team** as a *small community of students (from 4 to 12 people) united by a common goal, interdependent in terms of accomplishing assigned academic tasks, possessing a drive for mutual learning and team reflection skills, and having established interaction strategies*.

We will define **teamwork** as the *joint activity of students in both face-to-face and remote interaction formats, in which a collective goal is achieved through the integration of resources and competencies of all participants, shared collective responsibility for results, self-monitoring, and self-assessment at various stages of activity*.

At the same time, the results of the content analysis showed that modern studies on teamwork do not always reflect the evolving nature of teams and individual team activities in the context of education digitalization. It has been noted that the digital environment imposes specific interaction features that must be considered when organizing the development of students' TW competence in the university's EIEE [158]. It was established that the specifics of this process are primarily described in scholarly works dedicated to *virtual teams* and *remote team interaction* [148; 129; 121].

S. Morrison-Smith & J. Ruiz define a virtual team as a geographically distributed group of people using information and communication technologies (hereinafter – ICTs) in synchronous and asynchronous interactions to achieve common goals [148, p. 1].

N. A. Ebrahim et al. also define a *virtual team* as a group of people interacting from different locations and possibly different time zones, working toward a common goal, and heavily relying on ICTs for communication and organizing joint activities [117].

Remote team interaction is defined as the process of conducting teamwork in a digital environment, in which participants apply ICT skills and abilities for planning, execution, and assessment of team tasks [140; 165].

As L. Pei & H. Wu write, online and offline teamwork formats should not be perceived as separate types of activities, as this limits the development of skills necessary for real-world team collaboration, where physical environments and virtual platforms constantly intersect [149].

A study by M. Saghafian et al., conducted among MBA students, found that learners in both teamwork formats exhibit the same expectations for teamwork and implement similar interaction strategies, with their specifics varying depending on the technical and communication features of the environment [151]. The researchers conclude that despite possible structural-functional differences between virtual and non-virtual teams, the foundation of teamwork remains identical in both interaction formats.

Jucevičienė & Vizgirdaitė write that the nature of collaboration is built on intersubjective perception and cooperation, which is not confined to either digital or physical formats [138]. According to their research, the process of interaction and experience exchange itself forms the value of teamwork, regardless of the environment [ibid.]. This highlights the relevance of integrating both traditional and online interaction features into teamwork.

Thus, it can be concluded that teamwork in the modern world is a type of multi-faceted social interaction that can take place either offline with or without ICTs or entirely in a digital environment. Students' readiness to work in a team should be evident regardless of the interaction format. These aspects will be considered in further identifying the structural composition of students' TW competence.

1.2.2 Specification of the Component Structure of Students' Teamwork Competence in the Context of Education Digitalization

The content analysis of scientific literature has shown that researchers propose defining the level of students' teamwork development in different ways: as skills and abilities [57], as competence [73; 69], and as team values [61].

At the same time, from the perspective of the competency-based approach in education, the final outcome of students' mastering a system of knowledge about teams, acquiring teamwork experience, and developing team-relevant personal qualities is formulated as *students' teamwork competence* [74; 75; 78; 73].

The development of students' TW competence does not involve merely learning separate knowledge and skills but rather acquiring practical experience, in which

knowledge, skills, experience, and values form a unified complex aimed at solving personal, social, everyday, and professional tasks [105; 106].

N. M. Semchuk and A. S. Moskalenko define students' TW competence as the ability to engage in role-based interaction, determine the appropriate composition of a team considering the characteristics and interests of all participants, effectively recognize team interaction situations, and take personal responsibility for team results [70, p. 155].

E. V. Grib, E. N. Kolomoets, and V. V. Latysheva, through the description of indicators of TW competence formation, define it as students' readiness to work in a team, identify and fulfill a team role, analyze the effectiveness of its implementation, and use interpersonal and team communication tactics [32, p. 128].

N. I. Lygina et al. define TW competence as an individual's readiness to set and achieve common goals, establish trusting subject-to-subject relationships, take responsibility for collective results, contribute to the common endeavor, argue their position, and recognize others' right to make independent decisions regarding their share of teamwork [60, p. 110].

These definitions clearly reflect connections with the characteristics of teams and teamwork established in the first stage of the content analysis. It was also noted that researchers rely on key definitions of competence as an educational outcome: readiness for activity implementation, knowledge, skills, and abilities, value-based attitudes, and practical experience [41; 42; 105].

Thus, **teamwork competence** is understood as a *psychological formation of personality, developed in the learning process and including a set of knowledge about teamwork processes, skills, and abilities for team interaction, methods and strategies of team activities, as well as value-semantic attitudes necessary for productive subject-to-subject interaction*.

The interpretation of competence as a psychological formation, an integrative characteristic of personality, requires clarification of the component structure of students' TW competence, i.e., a list of what exactly needs to be developed in students during their education. In other words, further decomposition of the educational outcome for TW competence development into specific components is required [107].

O. R. Kudakov et al. identify six components in the structure of TW competence: *operational, communicative, motivational, value-semantic, cognitive, and behavioral* [54].

E. S. Vaseva and N. V. Buzhinskaya distinguish three components in students' TW competence: *motivational-target, operational, and control-reflective* [28, p. 21–22].

S. D. Lipatova and E. A. Khokholeva include the following in the structural components of students' TW competence: common goals, a system of knowledge about teams and teamwork, developed teamwork skills and abilities, motivation for team interaction, knowledge of team management, and a sense of community [57, p. 60].

The most comprehensive structure of students' TW competence, in our opinion, is presented in the work of A. D. Nikolaeva and A. D. Malysheva. The authors identify the *motivational component, personal component, cognitive component, communicative component, and operational component* [73, p. 104].

Based on the analysis of scientific literature, we identify **five components in the structure of students' TW competence**:

- *motivational* (including personal motivation for teamwork, recognition of a shared goal, goal-setting skills, anticipation of future results, etc.).
- *axiological* (defining value-semantic attitudes toward each team member as an equal participant in subject-to-subject interaction).
- *cognitive* (including competency-based knowledge and cognitive processes underlying mutual learning and collective knowledge storage and dissemination necessary for task execution).
- *operational* (experience in team activities, ability and readiness to implement TW competence, tactics and strategies of team interaction, etc.).
- *reflective* (skills of self-control and mutual control, mastery of team reflection techniques, ability to analyze activity stages and results, striving for self-improvement and contributing to team development, etc.).

At the same time, during the clarification of students' TW competence structure, it became evident that most researchers do not consider its implementation in virtual (or distributed) professional teams, which are becoming increasingly common. Additionally,

they do not include skills and abilities for using ICTs to support students' team interactions in the university's EIEE.

We believe that just as the concepts of teams and team interaction required supplementation with the characteristics of virtual teams and remote team interaction to better reflect their pedagogical essence in the context of education digitalization, the structure of students' TW competence must also be refined in each of the identified components to account for its development and implementation in the university's EIEE, beyond it, and later in professional interaction environments.

Studies by S. Krumm, G. Hertel, and J. Shulze focus on analyzing TW competence components for their development and implementation in the digital environment.

The researchers found that TW competence undergoes the most significant changes in the cognitive and operational components [154, p. 7]. Additional knowledge required by online team participants includes knowledge about enriching team communication channels using multimedia tools, differences in single, sequential, and simultaneous use of multimedia expression tools in the process of CMC, and knowledge about the specifics of teamwork in the digital environment [ibid., p. 7–12]. Additions to the operational component include skills for expressing emotions via digital communication tools, CMC coordination strategies, self-organization skills, and communication skills for conflict resolution in the digital environment [ibid.].

The researchers believe that while the axiological component serves as a starting point for any team interaction in both offline and online environments, the motivational component requires several additions. Individuals must have positive prior experience using digital tools and recognize additional advantages that ICT offers in academic and professional activities [ibid., p. 13].

G. Hertel et al. add that the axiological and motivational components of students' TW competence for its subsequent implementation in the digital environment should include subcomponents such as persistence in online interaction and motivation for mastering ICT [136]. Persistence, in the authors' interpretation, is the conscious necessity for distributed team members to resume and continue interaction after a CMC

interruption, whether planned or unplanned (e.g., due to technical failures during a video conference) [ibid., p. 481].

In a joint study, S. Krumm & G. Hertel developed a model of skills, knowledge, abilities, and other characteristics (KSAOs) for virtual team participants [141]. The authors highlight the following necessary knowledge: the functional capabilities of the digital environment for team interaction, strategies for adapting to CMC channel limitations, and intercultural communication peculiarities (if participants are from different countries) [ibid.]. Essential skills for remote team interaction include mutual learning in the digital environment, skills for structuring and decoding information in CMC conditions, the ability to establish and maintain trust in an online team, skills for online project management, and the ability to resolve conflicts in the digital environment [ibid.].

Thus, after analyzing researchers' approaches to clarifying the structure of students' TW competence in the context of education digitalization, we supplemented the five previously identified competence components (motivational, axiological, cognitive, operational, and reflective) with several characteristics necessary for the comprehensive development of TW competence in the university's EIEE.

For the *motivational component*, such additions include a stable motivation to use digital services for participation in remote teamwork, which is formed based on successful experiences of applying these services at various stages of interaction (e.g., using an online calendar for planning team meetings and individual work, using digital templates on interactive whiteboards (such as Miro) for brainstorming during the team goal-setting stage, etc.). Additionally, it includes a willingness to resume remote teamwork after a break or in case of technical issues.

For the *axiological component*, it is necessary to add the individual's awareness of the value of using ICT in the online teamwork process (e.g., relying on the digital footprint of online team participants when justifying one's position and providing feedback).

Within the *cognitive component*, students need to acquire an additional system of knowledge about strategies and tactics for conflict resolution in the digital environment,

the functional capabilities of online calendars and teamwork trackers in relation to planning team interactions, the functional limitations of synchronous and asynchronous CMC channels, and ways to enrich messages in the digital environment using appropriate multimedia tools, among other aspects.

For the *operational component* of students' TW competence to be fully developed, it is necessary to form skills in using virtual interactive whiteboards for teamwork (MS Whiteboard, Google Jamboard, Miro, etc.), online voting tools (Miro Planning Poker, reactions to posts in Microsoft Teams, Slack, etc.), and documenting work results in virtual spaces with multimedia tools. A modern specialist should also develop skills in monitoring team activities using online teamwork trackers (such as Asana), choosing appropriate expressive means when composing verbal statements, conducting and participating in team reflection, and more.

Finally, in developing the *reflective component* of students' TW competence, it is also important to foster skills in searching for and analyzing the “digital footprints” of online team participants, as well as the ability to forecast future work based on reflection in the digital environment.

The research results related to refining the structure of students' TW competence in the context of education digitalization are presented in Appendix A.

Thus, in the second stage of content analysis, we successfully clarified the concept and structure of students' teamwork competence.

We define **teamwork competence** as a *psychological formation of personality, integrating motivational, axiological, cognitive, operational, and reflective components. It is developed during the educational process and encompasses a set of knowledge about the teamwork process, skills, and abilities for team interaction, methods and strategies for teamwork, as well as value-based and meaning-oriented attitudes necessary for productive collaboration in both traditional and online teams*.

The refined structure ensures that students can implement TW competence both in traditional offline environments and in virtual teams, reflecting the growing integration of digital tools in professional collaboration.

The analyzed experience on the research problem indicates the feasibility of synergizing the characteristics of traditional and virtual teams, as well as the need to model the process of developing students' teamwork competence in the university's EIEE.

The next step in the study is to analyze existing methodological approaches to developing students' teamwork competence in the university's EIEE, as well as to synthesize scientific and pedagogical experience in organizing and supporting remote team interactions among students (within the research boundaries outlined in § 1.1) using various ICT tools.

1.3 Analysis of Methodological Approaches to the Development of Students' Teamwork Competence in the Electronic Information and Educational Environment of a University

The analysis of psychological and pedagogical periodicals on the research problem has revealed that methodological approaches to the development of students' TW competence in the EIEE of a university are concentrated around three main directions:

1. Identification and description of the didactic potential of individual ICT tools when transferring the process of student teamwork from an offline environment to the university's EIEE (O. A. Repp, G. A. Fedorova, N. V. Buzhinskaya, E. S. Vaseva, et al.).

2. Adaptation of the project method to the conditions of education digitalization as the main means of developing students' TW competence in the university's EIEE (T. P. Pushkareva, V. V. Kalitina, I. A. Valdman).

3. Development of recommendations for teachers on fostering students' TW competence in the university's EIEE based on psychological research on remote teams, summarizing the differences in student actions when working in offline and online teams (Y. V. Amelina, B. Maiden, H. Y. Ku).

Within the *first direction*, researchers focus on finding optimal ICT tools that help teachers organize specific aspects of student teamwork online. For example, O. A. Repp and G. A. Fedorova presented a project for organizing teamwork among future teachers using the online whiteboard Padlet [86]. The researchers focused on the activity

component of competence, proposing that discussions on goals and tasks should be organized in text format or through voice messages on Padlet, along with interactive reflective surveys at the end of the interaction [ibid., p. 407].

Similarly, G. M. Fedchenko explores the possibility of developing students' TW competence through specially organized online tools, which the author classifies based on their role in supporting remote teamwork: communication tools, tools for recording teamwork results, information exchange (file sharing), and tools for planning and managing team activities [7].

In G. M. Fedchenko's study, the didactic potential of individual digital tools was analyzed within these categories. In particular, the functionality of Miro was examined in detail, highlighting its potential for students to create mind maps of learning tasks or activity plans, which enhance cognitive processing, structuring, and retrieval of information in remote teamwork settings [ibid., p. 121].

N. V. Buzhinskaya and E. S. Vaseva analyzed the capabilities of individual online resources for organizing various stages of student teamwork [22]. For example, the researchers described Padlet's functionality in relation to the brainstorming technique. They emphasized that this resource effectively facilitates open discussions where each participant can see and evaluate others' ideas, fostering an atmosphere of openness and trust—an essential aspect of developing the axiological component of students' TW competence [ibid., p. 5].

To support students in task delegation, role distribution, responsibility assignment, and activity planning in a remote learning environment, the authors recommend using Trello. One of its didactic advantages is the ability for students and teachers to attach digital documents to specific tasks, ensuring structured storage and retrieval of relevant information within the framework of mutual learning [ibid., p. 7].

The analysis of studies within the first research direction on developing students' TW competence in the university's EIEE shows that this approach can essentially be called *technology-centric*. It remains unclear how student motivation for participating in online teams is ensured, as well as how value-semantic relationships within teams are formed and developed.

In the *second research direction*, scholars focus on adapting project-based learning to the specifics of online education.

For example, T. P. Pushkareva and V. V. Kalitina explore the integration of project-based learning and cloud technologies into the training of future specialists [85].

The initial phase of the teamwork cycle begins with students planning learning activities in Google Calendar. The goal-setting stage is linked to formulating project tasks on the Miro online whiteboard. Mutual learning and knowledge sharing within teams are supported through Wiki sites, allowing participants to comment on each other's ideas asynchronously [ibid., p. 3]. After synchronous online interaction in Zoom or Skype, students must present their projects using Prezi or Google Slides. Reflection is facilitated through interactive feedback forms on platforms such as Google Forms, Polly, or Typeform [22; 85]. However, the mechanisms for developing the reflective component of TW competence in an online interaction format are not explicitly discussed.

I. A. Valdman and O. V. Meretskov, describing the process of organizing online teamwork for participants in the professional development program "Design and Development of Electronic Educational Courses", rely on methodical principles that have proven effective in distance education [26]:

1. The presence of a clear role model within the team.
2. Initiating work on a project which results will be used in students' future professional activities.
3. Interlinking intermediate assignments with the final project through cumulative assessment.
4. Ensuring intra-team communication among participants in the remote educational process.
5. Highlighting the individual contribution of each participant to the overall result and the ability to track this at intermediate stages of online teamwork.

Relying on the project method for developing students' TW competence in the university's EIEE leaves several questions unresolved: when and how should students acquire knowledge about team activities? How can continuous feedback from the teacher

be ensured? What is the relationship between the concepts of "project group" and "team", given that they refer to different forms of social interaction? [78].

The *third research direction* primarily examines problems that arise in the process of developing individual components of students' TW competence in an online setting, which are conditioned by the specifics of CMC.

For example, Y. V. Amelina identifies key psychological and pedagogical challenges in organizing students' remote teamwork, including motivation issues among team members, assessment of individual contributions, selection of appropriate tools and methods for remote teamwork [3, p. 43].

The motivation problem, according to the researcher, lies in the difficulty of engaging students in sustained online interaction due to external distractions. At the same time, when students work individually on separate tasks, there is a high risk of the "free-rider effect" where students with low motivation to participate in teamwork take advantage of the team's achievements without making an equivalent contribution to the team goal [143].

This issue is closely tied to the problem of assessing individual contributions in teamwork. As noted by L. M. Tukhbatullina and L. A. Saffina, when assessing individual contributions, teachers should analyze students' strengths and weaknesses as team players and identify areas for improvement [100]. According to Y. V. Amelina, assigning the same grade to all team members reduces academic motivation and undermines trust in the objectivity of assessment systems [3, p. 43].

The selection of methods and tools overlaps with the first research direction and focuses on choosing adequate didactic resources for developing students' TW competence in the university's EIEE. It is suggested, for example, to use project management systems such as Jira, Trello, and Zoho to fairly distribute team workloads [ibid.]. However, unlike the purely technological approach in the first research direction, this area of research also considers the psychological and pedagogical characteristics of remote teamwork, and not just reliance on actions and operations within the operational component of competence.

A significant body of international research within the third direction focuses on studying dependencies between specific factors of remote team interaction. For instance,

studies have found a positive correlation between the degree of prior acquaintance between team members, the level of online teacher support, and students' satisfaction with online teamwork [142].

Factors negatively impacting students' readiness for online teamwork include the lack of real-world relevance in team activities, the absence of timely teacher feedback, low awareness of the significance of teamwork, the free-rider effect [140].

Overall, the third research direction appears to be the most methodologically aligned with a comprehensive exploration of the phenomenon of remote teamwork and the identification of pedagogical conditions for developing students' TW competence in the university’s EIEE.

However, as noted by T. Yu. Bazarov and A. R. Dikusarova, modern pedagogical research lacks a unified psychological theory of activity that would allow for systematization of the accumulated knowledge on remote teamwork and the determination of the most effective pedagogical conditions for developing each component of TW competence in the university’s EIEE [10].

Thus, the analysis of literature and scientific sources (dissertations, conference materials, etc.) has revealed that, despite a wide range of studies dedicated to the organization of students' remote teamwork, the issue of the methodological foundation, stages, and specifics of developing students' TW competence in the EIEE of a university requires further investigation.

Relying on the third methodological approach to the development of students' TW competence in the university's EIEE, as well as continuing the idea of T. Yu. Bazarov, we believe that further theoretical justification of the pedagogical conditions for the development of TW competence requires clarification of the stages and psychological-pedagogical characteristics of the team interaction processes among educational participants in the university's EIEE through the lens of the psychological structure of activity.

1.4 Systemogenesis of Activity as a Methodological Basis for the Development of Students' Teamwork Competence in the Electronic Information and Educational Environment of a University

Systemogenesis describes the stages of formation of complex systems (in this case, competencies) in a specific sequence [56; 59]: from the cognitive mastery of teamwork rules and regulations to the practical implementation of skills and abilities in team interaction.

§ 1.4.1 outlines the process of developing students' TW competence as the systemogenesis of the psychological structure of activity, identifies its stages, and systematizes the psychological and pedagogical characteristics of team interaction in the EIEE found in scientific literature.

§ 1.4.2 presents the results of a pilot study assessing the relevance of the psychological and pedagogical characteristics of TW competence development in the university's EIEE based on a sample of Russian students.

All of the above has made it possible, at the theoretical level, to describe the process of developing students' TW competence in the university's EIEE and to establish the methodological foundation for further determining the pedagogical conditions for the effectiveness of this process.

1.4.1. Stages of Students' Teamwork Competence Development in the Electronic Information and Educational Environment of a University

Consideration of students' TW competence as an integrative personal characteristic [41; 42; 104; 106] implies accepting as a key methodological principle the position that personality traits not only manifest but also form through activity [56; 109].

Therefore, the development of TW competence in the set of five structural components (motivational, axiological, cognitive, operational, reflective) is a systematic and sequential process, governed by the general patterns of development of the psychological structure of activity (in this case, team activity).

In psychology, there are several theories and approaches to explaining the process of forming, developing, and implementing competencies: the theory of systemogenesis

of activity [108; 47]; structural-functional approach [51]; theory of subjectogenesis of activity [77]; hermeneutic approach [153].

In our research, we will rely on the theory of *systemogenesis of the psychological structure of activity* as the methodological basis for the development of students' TW competence in the EIEE of the university. First, this theory has been repeatedly used for analyzing academic activity in the works of N. P. Ansimova [6], I. Yu. Tarkhanova [98], R. M. Asadullin [8], and others. Second, in accordance with A. V. Karpov's position, we see the applicability of this concept in that the structure of competence becomes virtually isomorphic to the psychological structure of activity [46, p. 128–129].

Following V. D. Shadrikov, we will consider the **systemogenesis of activity** as the *unfolding of the psychological structure of activity as a result of the individual decoding the conditions and goals of the activity, interiorizing the parameters of the normative result, and mastering the normatively approved method of individual and collective activity* [109, p. 136].

The psychological structure of activity includes **five blocks**: *motives, goals, the informational basis of activity, the process of developing and implementing the activity program, and reflection* [ibid., p. 140]. Consequently, the components of this structure align with the components of TW competence (motivational, axiological, cognitive, operational, and reflective). It is important to note that the systemic nature of activity implies close functional interconnections between these components [46]. Therefore, the process of systemogenesis of activity cannot be strictly sequential: the formation and development of one component directly influence similar processes in another [109].

The diagram showing the relationship between the stages of systemogenesis of activity and the process of developing students’ TW competence in relation to each structural component is presented in Figure 1.2.

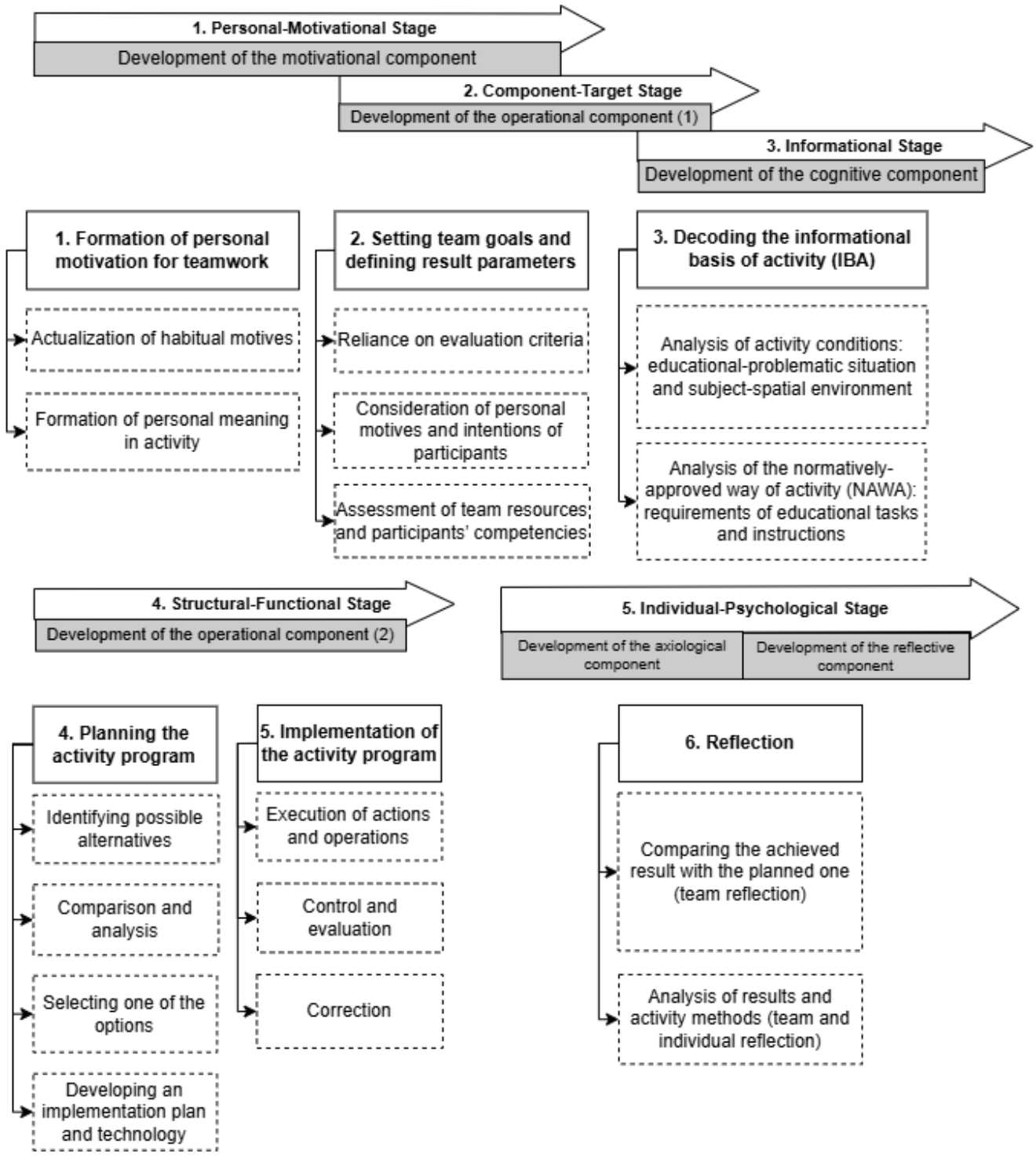

Figure 1.2. – Development of students' TW competence in the process of team activity systemogenesis

It is important to note that the arrows indicating the stages at the top of Figure 1.2 encompass the development of several components of students' TW competence, as the psychological processes involved in the development of the structure of activity have both progressive and, at times, regressive influences on other stages [109]. Thus, each stage

impacts the subsequent ones, emphasizing the continuous, cyclical nature of the development of students' TW competence.

Let’s consider in more detail the stages of systemogenesis of activity and the TW competence development process, as reflected in Figure 1.2.

1. **Personal-Motivational Stage.** At this stage, the predominant development occurs in the motivational component of students' TW competence, achieved by actualizing familiar motives for academic activity and by students determining the personal significance of participating in team work to realize these motives. As a result, the personal meaning of team activity in the EIEE is formed.

Motives can include the needs, interests, and impulses of the students. The formation of motivation as the first and primary block of systemogenesis of activity involves, in the broadest sense, providing students with opportunities for active transformation of the educational environment to satisfy their cognitive and social needs, as well as the needs for self-improvement and self-development [65, 16].

According to P. A. Korchemnoy, the formation of motives for acquiring a new competence occurs when the existing set of competencies or their development level is insufficient for achieving a goal significant to the individual [51]. In this situation, the mobilization of the individual's mental resources takes place to master new activity experience [ibid.].

Based on this, we believe that a student's intention to engage in team activity in the EIEE will depend, firstly, on the successful actualization of existing motives related to their educational-professional field (e.g., how the topic and goals of the lesson align with the student's professional training); secondly, on the presence of a problem situation at the beginning of the educational event, the resolution of which requires collective efforts and the pooling of each student's resources; and thirdly, on the richness of the EIEE, which should include tools and resources for team interaction (digital templates of virtual whiteboards for brainstorming, digital boards to track progress, online teamwork trackers, etc. [14]). To develop stable motivation for team activity in the EIEE, the instructor must provide positive reinforcement for the results of teamwork and continuously update and complicate the educational-professional situations.

As established in § 1.2.2, the motivational component of students' TW competence must also include sustained motivation for using digital services for participating in team activity within the EIEE, as well as the willingness to resume remote teamwork after a break or in case of technical issues. For this purpose, the EIEE should include training exercises to improve digital skills, as well as digital instructions for solving the most common technical problems (as will be discussed below in § 1.5).

2. **Component-Target Stage.** At this stage, the development of the motivational component continues, and the partial development of the cognitive and operational components of students' TW competence begins. Students learn to use clear criteria for assessing team success when setting goals for teamwork and forming a model-image of the future result, taking into account the interests and abilities of each participant. Students also assess the resources they have to achieve the set goals, including the competencies of each participant for subsequent distribution of team tasks.

The need to establish a unified collective goal is a characteristic of team goal-setting (see § 1.2.1). At the same time, the instructor's task is to maintain the personal meaning of the activity for each student, as, according to A. V. Khutorskoy and L. N. Khutorskaya, only when there is personal meaning in the activity (including team activity) can the student most effectively assess the socially significant and personal results of the activity, determine the most rational ways of acting, and demonstrate readiness to apply activity experience in new life situations [106].

Considering this, it seems reasonable not to restrict students in designing the final result only according to assessment criteria. A stage of team discussion of the practical benefits of the planned result for academic-professional activities should be provided. During the discussion, students’ opinions can become the basis for supplementing the characteristics of the planned result.

Thus, during the component-target stage, the partial development of the operational component of TW competence takes place, specifically, the development of students' abilities to set goals, plan team activity, and anticipate the future team result.

At the same time, the motivational component of TW competence continues to develop, as the discussion and setting of increasingly ambitious goals further shapes

students' positive motivation for teamwork in the EIEE as a means of achieving more significant results in their academic activities.

For effective team goal-setting, students must also acquire knowledge about the specifics of brainstorming in the EIEE, the necessity of considering each participant's opinion, and the possibilities of ICTs for visualizing the characteristics of the planned team result. Therefore, during the component-target stage, the primary development of the cognitive component of students' TW competence also occurs.

3. **Informational Stage.** Further development of the cognitive component of students' TW competence occurs at this stage. First and foremost, students analyze the informational basis of activity (IBA) [108, p. 63]: the educational-problem situation and the subject-spatial environment of the EIEE.

For students to master the required knowledge system during the analysis of IBA, theoretical materials about teams and teamwork (roles in a team, conflict resolution, task distribution, and coordination methods) must be included in the subject-spatial environment of the EIEE. These materials may include video materials and lectures with examples of successful team projects, interviews with team leaders, and analyses of successes and failures in teamwork; interactive quizzes (tests, assignments with feedback) to allow students to check their understanding of the material.

When modeling the educational problem situation, the instructor needs to create a demand for a team approach to solve it. For example, it might be a project to develop a product concept or a social issue resolution, where each student has a specific role. This helps students understand that teamwork is necessary for solving complex problems and raises their awareness of the importance of mastering a knowledge system about teams and team interaction.

We also consider digital templates for formulating team goals, interactive virtual whiteboards for brainstorming and team planning, online timers, digital Kanban boards (or their templates) for each student team, digital templates for team reflection, and so on as part of the IBA. The fulfillment of the EIEE with ICT tools for teamwork will promote the development of students’ orientation towards team interaction during learning and ensure the integration of theory and practice.

Moreover, at this stage, students analyze the normatively-approved way of activity (NAWA), expressed in the set of requirements of the educational task and instructional materials [108]. The instructional materials should also include references to educational resources that allow students to master the required knowledge system about teams and team interaction, and the educational task requirements should orient students towards practical application of the knowledge they acquire through team interaction in the EIEE.

4. **Structural-Functional Stage.** The goal of this stage is the further development of the operational component of students' TW competence through the planning and implementation of their team activity program.

The activity program refers to the individual's knowledge of the components of the activity, the methods of performing actions and operations, and the norms of interaction [108, p. 67], making the structural-functional and informational stages inseparably connected in the psychological structure of activity.

According to the provisions discussed in § 1.2.2, the team activity program includes the following invariant components: team goal-setting, decomposition of the academic goal into sub-tasks, team planning, role and function distribution, implementation of team work, interaction correction, results control, and team activity reflection [92]. These components are formed during the subsequent stages of student teamwork in the EIEE [118].

Identification of possible alternatives for activity. Students work on creating different solutions to the tasks set using available information resources in the EIEE. These may include joint brainstorming sessions using online communication tools (forums, video conferences, chats), working in project management systems (Asana, Trello), or creating collaborative documents in cloud services (Google Docs). In this process, students develop skills in using various online tools for discussing and presenting solution options and form the ability to interact effectively online.

Comparison and analysis of alternatives. Students use digital tools to analyze proposed alternatives. These can include online tables or boards to visualize information and make comparisons. The comparison can be made collectively in real-time using video conference platforms or asynchronously through online forums. As a result, students

develop analytical skills in working with information gathered from various sources, including digital materials placed in the EIEE, and enhance their critical thinking and evaluative skills.

Choosing one alternative. In the process of selecting the optimal solution, students may use group voting mechanisms or online evaluation methods. This can take place through discussions on video conference platforms (Zoom, Microsoft Teams) or asynchronously through chats, forums, or online surveys (e.g., Polly). Students learn to reach consensus in conditions of limited physical communication, which requires skills in resolving conflicts within CMC. During the discussion, students develop the skill of appropriately fulfilling CMC channels, accurately and properly presenting their thoughts and proposals online.

Developing a plan and technology for its implementation. Developing an action plan includes distributing tasks among team members, which can be done through project management software (e.g., Trello, Asana, or Jira). It is important that all participants have access to digital tools to track progress and adjust tasks. The EIEE should include online calendars for scheduling synchronous meetings and video conferencing services for conducting them.

The implementation of the activity program represents the process of executing the planned actions to achieve the team's goals. At this stage, students transition from planning and discussing to practically completing tasks using digital tools for team interaction, progress monitoring, and task adjustment. The development of the activity-related component continues at this stage, but now this process is more oriented towards practical implementation in three main stages.

Execution of actions and operations. This stage involves carrying out the actions and operations planned by students during the previous stage while completing academic assignments. All actions can take place asynchronously (each student works at their convenience) or synchronously (e.g., via video conferences).

Monitoring and evaluation. During the implementation of the activity program, an important stage is monitoring the current progress. In the EIEE, this is implemented through various mechanisms, such as checking task statuses on online platforms,

intermediate reports, automated systems for evaluating academic assignment completion, and digital boards for tracking tasks. Given the need to develop the required level of autonomy in learning teams (developing skills in mutual control and evaluation), the instructor's role in monitoring the learning process should be facilitative and consultative [126]. For correcting the actions of individual students, it is recommended to involve the collective through discussions on the effectiveness of the team's actions as a whole and of its individual participants in synchronizing meetings, which should be established at regular intervals.

Correction. If problems or deviations are detected during the execution of actions and operations, the team activity program may need correction. In the EIEE, correction can include redistributing roles, adjusting the instructor's time frames for the assignment, or adjusting the set educational tasks based on feedback from students. It is important that all changes are reflected in the task conditions, instructions, and evaluation criteria (IOD) and are available for review in the shared virtual space.

5. **Individual-Psychological Stage.** At this stage, the formation of the axiological and reflective components of students' TW competence is an inseparable part of one process [108; 111].

G. P. Shchedrovitsky writes that reflection as a psychological phenomenon involves the individual stepping out of the position of an actor into the position of an external observer, where they contemplate various aspects of the performed activity using reflective skills [111, p. 222]. The scholar notes that the results of reflection – reflective knowledge – should form the basis for designing future activities [111, p. 223]. For effective teamwork, it is important to reflect not only on the individual actions of the student (self-reflection) but also to offer the evaluation of the results of social cooperation (socio-reflection).

According to V. D. Shadrikov, during reflective activity, students not only reflect on the obtained experience but also form competence-related personal qualities. These qualities are an extension of psychological functions that are actualized and reach the necessary level for specific activities through training. Competence-related personal qualities are embedded in the specific activity process and influence its efficiency [108,

pp. 96–98]. Important personal qualities that determine success in teamwork (axiological component) include collectivism, empathy, responsibility, self-control, tolerance, initiative, critical judgment, and – a specific quality for implementing TW competence in the EIEE – persistence in mastering and using ICTs (see § 1.2.2).

Thus, the stages of developing students' TW competence in the EIEE include personal-motivational, component-target, informational, structural-functional, and individual-psychological stages.

We believe that the described process of systemogenesis of team activity provides the methodological foundation for the development of students' TW competence in the university's EIEE.

1.4.2 Organization and Results of the Pilot Study on the Systematization of Psycho-Pedagogical Characteristics of the Students' Teamwork Competence Development in the Electronic Information and Educational Environment of a University

In many studies, it is noted that various factors of ICT influence each of the stages of the students' TW competence development in the universities' EIEEs: changes in the nature of perception and processing of digital information at the informational stage, lack of physical interaction at the structural-functional stage, limitations of non-verbal communication at the individual-psychological stage, and so on [135; 157; 122]. These CMC factors, in turn, determine the psychological and pedagogical characteristics of the development of students' TW competence in the EIEE, which need to be considered in the educational process [15].

Since we did not find comprehensive studies that summarize the psychological and pedagogical characteristics of the development of students' TW competence in the EIEE of a university at each stage, we decided to conduct a pilot study.

The goal of the pilot study was to systematize the psychological and pedagogical characteristics of the students' TW competence development in the EIEE of a university and to test their relevance on a sample of Russian students.

The study was conducted in two stages.

In the first stage, scientific publications on the research problem were analyzed. The criteria for selecting scientific publications included: indexing in Scopus, Web of Science, and HAC; publication date no earlier than 2015; and citation count of at least 30 for Scopus and Web of Science, and at least 10 for HAC index. A total of 34 scientific sources were analyzed, including 31 journal articles and 3 monographs.

In the second stage, a survey was conducted, during which students analyzed their experience of teamwork in the EIEE of the university.

First Stage. Based on the comparison of the identified components of students' TW competence and the stages of their development (see § 1.4.1), the following keywords were selected for systematizing the psychological and pedagogical characteristics of the development of students' TW competence in the EIEE in science databases such as Scopus, RSCI, Google Scholar, and others:

- *For the motivational component*: motivation in online teams, formation of motives for team activity in the digital environment, student motivation in online learning, and others.
- *For the axiological component*: team building in the online environment, cohesion in online teams, trust in distributed teams, conflict regulation in online teams, and others.
- *For the cognitive component*: cognitive load in multimedia learning, knowledge dissemination in online teams, peer learning in distributed teams, and others.
- *For the operational component*: development of skills and abilities for online teamwork, features of remote team interaction, control and evaluation in online teams, and others.
- *For the reflective component*: reflection of virtual team participants, specifics of distance evaluative-reflective actions of online team members, stages of personal reflection in online settings, and others.

Based on the aforementioned selection criteria, the list of relevant sources comprised 34 units. From each publication, all the psychological and pedagogical characteristics mentioned were extracted (one or more). If the identified features appeared

in several publications, only one mention was kept with a reference to the source with the earlier publication date.

As a result of the systematic review, 18 characteristics of the development of students' TW competence in the EIEE were identified, which we then classified according to the components of TW competence (see Appendix B).

Second Stage. To test the relevance of the systematized psychological and pedagogical characteristics of the development of students' TW competence in the EIEE on a sample of Russian students, a survey was conducted.

The sample consisted of 68 students from the first and fourth years of the Faculty of Psychology at St. Petersburg State University (SPbU), as well as 33 third-year students from the Institute of Journalism at SPbU (N = 101).

The questionnaires, consisting of 18 questions, were presented to students remotely via the Google Forms platform.

Respondents were asked to evaluate 18 statements (Q) on a 10-point Likert scale according to their level of agreement. Each statement corresponded to one of the characteristics of the development of TW competence in the EIEE (see Table C.1 in Appendix C). For example, the statement "If I encounter technical difficulties in distance learning, my motivation to work in an online team decreases" (QM1) corresponded to the relationship between student motivation for team work online and the level of digital skills (motivational component of competence, personal-motivational stage of development). Students were asked to choose a value from 1 to 10, where 1 = "Strongly disagree" and 10 = "Strongly agree."

The threshold for the characteristic’s relevance to the development of students' TW competence in the EIEE was set at a level of 5 points, both for the mean value (μ) and for the median (Me).

The final results of the survey are reflected in Table C.1 (see Appendix C), which shows that four characteristics of online team interaction were removed from the pilot study: two from the axiological component of TW competence (μ (QA3) = 3.79, Me (QA3) = 3; μ (QA4) = 4.09, Me (QA4) = 3), one from the cognitive component (μ (QC1)

= 3.45, Me (QC1) = 1), and one from the operational component (μ (QD2) = 2.85, Me (QD2) = 1).

Let us now consider the findings from the survey in more detail for each component of TW competence.

In the assessment of students' agreement with the characteristics of the motivational component development in the EIEE, the minimum agreement (μ = 5.64) was recorded for the characteristic QM1, while the maximum agreement (μ = 8.48) was recorded for QM4 (see Figure 1.3).

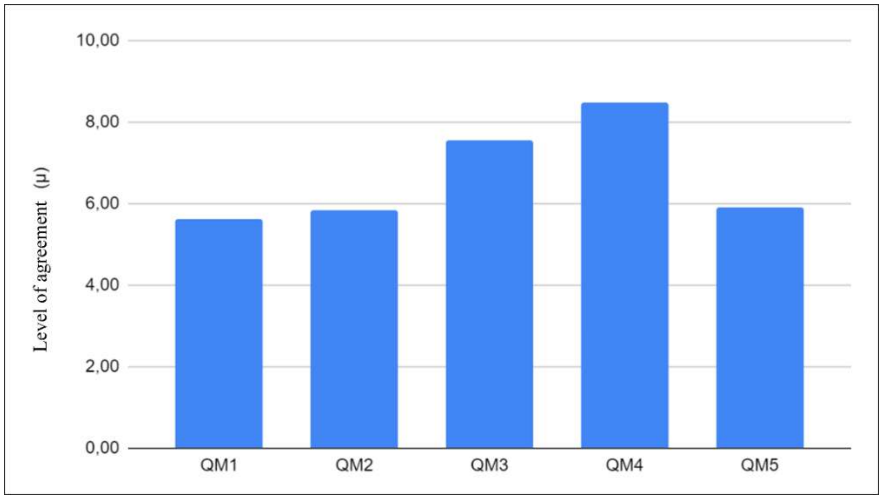

Figure 1.3. – The distribution of the average agreement levels of students regarding the characteristics of motivation when working in a team within the university's EIEE

Therefore, students emphasize the paramount importance of having regular and supportive feedback from the instructor during remote teamwork.

Students also expressed an equally high level of agreement with two relevant characteristics of the development of the TW competence's axiological component in the university's EIEE (see Figure 1.4).

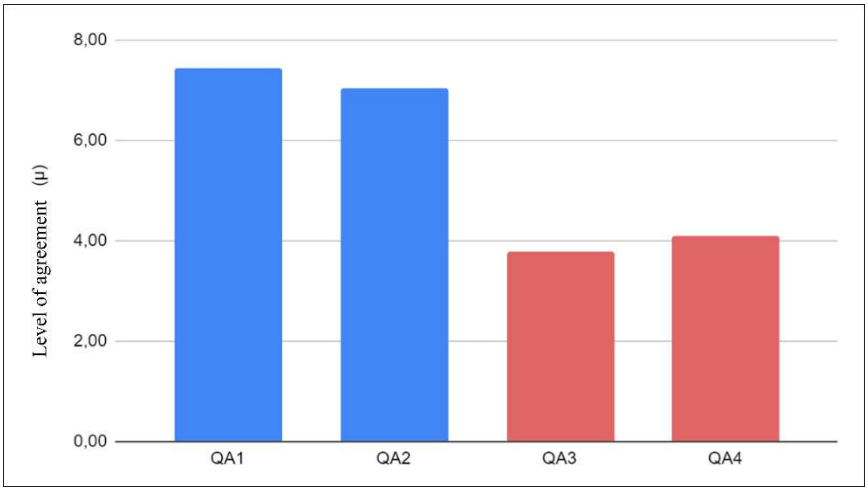

Figure 1.4. – The distribution of the average agreement levels of students regarding the characteristics of value-based relationships in online teams

From Figure 1.4, it can be concluded that for students, it is important to know their partners in remote team interaction well to feel secure and confident, as well as to receive an assessment of their personal contribution to teamwork in order to form a positive attitude towards the process of developing TW competence in the EIEE. At the same time, "social loafing" in online teams, as well as the reduced ability to interpret the actions of online team partners, were not noted by students as features of their experience in remote teams.

For the development of the cognitive component of students' TW competence in the EIEE, two characteristics were relevant: the predominantly inductive nature of mastering the knowledge system (QC2) and the need for prior diagnosis of students' knowledge level on a specific topic (QC3) (see Figure 1.5).

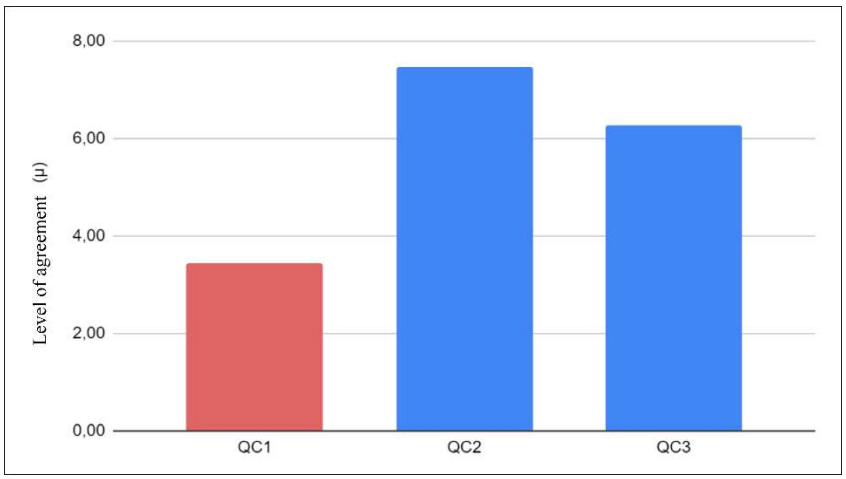

Figure 1.5. – The distribution of the average agreement levels of students regarding the characteristics of acquiring knowledge in the EIEE

At the same time, as shown in Figure 1.5, students do not consider the multimodality of presenting digital learning material (QC1) to be an issue.

The evaluation of the relevance of the psychological and pedagogical characteristics of the operational component development in the university's EIEE revealed that students, when working in online teams, are indeed more focused on the task rather than on interaction (QD1). This can have a negative impact on the process of developing students' team skills and abilities in the EIEE. It was also confirmed that the speed of development of such skills and abilities depends on the experience of working in the EIEE (QD3) (see Figure 1.6).

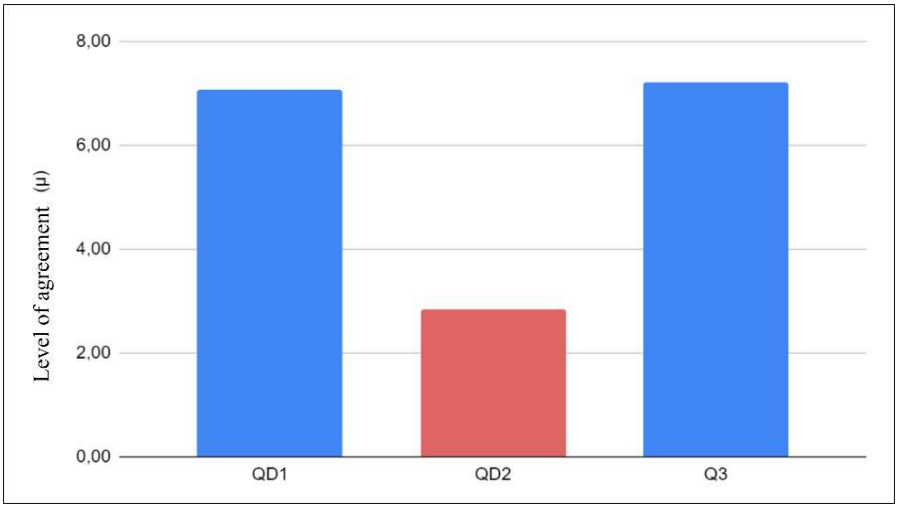

Figure 1.6. – The distribution of the average agreement levels of students regarding the characteristics of performing actions and operations when working in a team in EIEEs

At the same time, the data in Figure 1.6 also indicate that the level of students' confidence in their actions does not differ depending on the interaction format (QD2).

Finally, all the psychological and pedagogical characteristics of developing the reflective component of students' TW competence in the EIEE were found to be relevant, as shown in Figure 1.7.

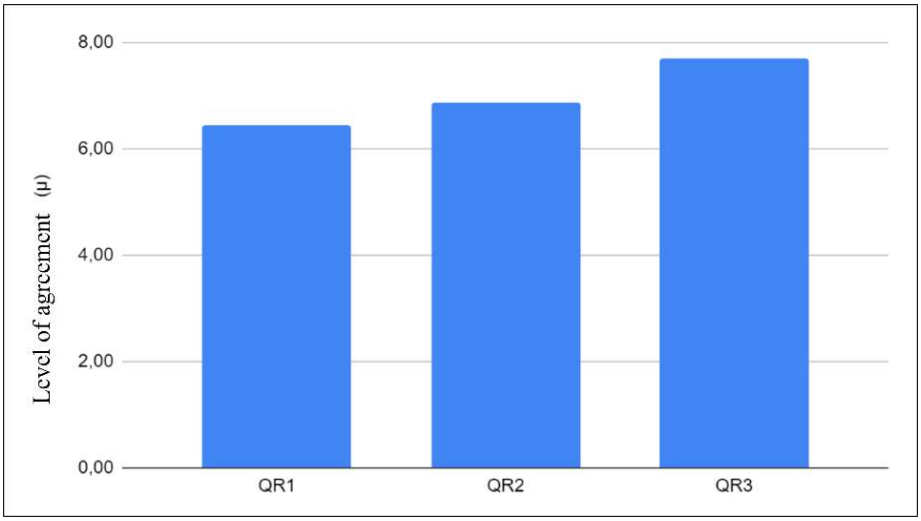

Figure 1.7. – The distribution of the average agreement levels of students regarding the characteristics of reflection in online teams

This means that when organizing and conducting team and personal reflection in the university's EIEE, the instructor should consider the necessity of preserving the students' digital footprint (QR1), ensure team discussions of results before or during the assessment of individual parts of the work (QR2), and offer forms of reflection aimed at improving team interaction in future work cycles (QR3).

Thus, the pilot study confirmed the relevance of most of the characteristics of the students' TW competence development in a university’s EIEE. This allowed for the formulation of pedagogical conditions that promote the effectiveness of this process.

1.5 Justification of the Pedagogical Conditions for the Development of Students' Teamwork Competence in the Electronic Information and Educational Environment of the University

In this paragraph, the pedagogical conditions for the development of students' TW competence in the university's EIEE are proposed and theoretically justified, and the results of expert evaluation of these conditions by instructors are presented. § 1.5.1 reflects the relationship between the previously established characteristics of the development of each component of TW competence and the pedagogical conditions. The information in § 1.5.2 presents the results of the expert evaluation, based on which the proposed pedagogical conditions were ranked by their variability for inclusion in the educational process.

1.5.1 The Relationship Between the Psycho-Pedagogical Characteristics and the Pedagogical Conditions for the Development of Students' Teamwork Competence in the Electronic Information and Educational Environment of the University

The analysis of literature and results from the pilot study have shown that organizing teamwork in the university's EIEE differs from organizing teamwork in offline learning, requiring additional preparation from both instructors and students. It was also found that the development of each of the five components of TW competence in the university's EIEE has specific characteristics that must be considered in relation to the corresponding pedagogical conditions.

A *pedagogical condition* can be defined as a set of objective opportunities specially organized for the successful implementation of the educational process and the development of students' personalities. Conditions include methods, means, forms of teaching and education, and the educational environment, which are directed at achieving pedagogical goals [62].

The number of pedagogical conditions presented further corresponds to the number of established psychological and pedagogical characteristics of the development of students' TW competence in the university's EIEE, as reflected in Appendix D.

The pedagogical conditions presented in Table D.1 in Appendix D were proposed based on the generalization of pedagogical experience from both Russian and foreign scholars in the field of education. Much of the work was based on sources analyzed during the pilot study (see § 1.4.2). Additionally, modern approaches to implementing pedagogical interaction in the EIEEs of educational institutions were studied (see § 1.3). Below is the theoretical justification of the suggested pedagogical conditions for developing students' TW competence in the university's EIEE for each of its five components, considering the psychological and pedagogical characteristics identified during the pilot study.

1. Pedagogical conditions for developing the motivational component of students' TW competence in the university's EIEE.

- *"Digital Skills"*. Since differences in students' digital competency levels may pose a significant barrier to productive interaction in an online team, it is important to provide opportunities within the EIEE for technical sessions and the posting of instructions to ensure equal technical preparation for students [122]. Additionally, diagnostic testing can help identify students with insufficient digital skills, allowing efforts to be directed toward their training. This reduces the likelihood of intra-team tension related to differences in digital skills and creates conditions for more productive student interactions.

- *"Recursive Team Building"*. Motivation in online teams requires continuous support through time-distributed engaging activities. The inclusion of recursive (repeating, time-distributed) approaches allows team members to strengthen social bonds in the EIEE and helps avoid the sharp drop in motivation typical of linear approaches, which are often focused only on the initial stages of interaction [162]. Repeating team-building activities, such as online quizzes, help foster trust and psychological safety, which are crucial for effective teamwork. This is especially important in an EIEE, where physical interaction is absent and achieving team cohesion becomes more challenging. Such methods also enhance trust among students, positively influencing their motivation for teamwork [ibid.].

- *"Virtual Space"*. Organizing movement between teams within a unified virtual space enables students to develop intergroup interaction skills, which is an important component for increasing motivation to work in teams. "Scouts" (special learner roles), moving between rooms and bringing information back to their teams, facilitate knowledge exchange and encourage other students to creatively solve tasks. Some studies have noted that students perform better when participants can move freely between teams [121; 162].
- *"Connection with Instructor"*. Constant access to the instructor reduces student stress and increases their confidence when solving team tasks [159]. The availability of the instructor in synchronous formats, such as via online chats or by periodically joining team virtual rooms, helps coordinate student actions, especially during key stages of completing team assignments [ibid.]. Feedback is especially important for maintaining student motivation and improving their results, as it enables timely adjustment of work direction and adaptation of approaches to team interaction. Access to the instructor through synchronous and asynchronous CMC channels helps each student feel part of a unified learning process, which is especially important for team interaction in the university's EIEE.
- *"Distributed Workload"*. Equal distribution of tasks allows each participant to realize their significance in the team, fostering a sense of responsibility. Studies show that when the workload is clearly distributed, students exhibit higher engagement in the learning process and participate more actively in solving team tasks [143]. Online trackers provide transparency in teamwork and allow students to see which tasks are being completed, deadlines, and the responsible individuals. This helps maintain discipline and responsibility throughout the team project [3]. Equal distribution of tasks helps avoid overloading individual members and potential conflicts that may arise from unequal task distribution.

2. Pedagogical conditions for developing the axiological component of students' TW competence in the university’s EIEE.

- *"Team Reflection"*. Reflective practices help create a climate of trust within the team, as participants are given the opportunity to openly discuss difficulties and

successes. This approach strengthens team spirit and helps participants feel that their contributions are valued. This is especially important for work in an EIEE, where personal interaction is limited. Discussing team strengths and weaknesses helps identify areas of interaction that need further development and assists both the instructor and students in setting new goals. This improves teamwork outcomes and maintains academic motivation, as students recognize their growth and development as an essential part of the team's overall success [158]. The use of structured reflection techniques, such as the "Sailboat" or "Start/Stop/Continue" retrospectives, helps develop self-reflection skills and makes the analysis of team work more purposeful.

- *"Interactive Peer Assessment"*. Regular peer evaluation improves team interaction as participants begin to understand each other better and can approach tasks more consciously [130]. Synchronous discussions allow team members to discuss their strengths and weaknesses in a respectful and supportive environment, and digital tools for peer evaluation help capture feedback and improve the objectivity of responses [22]. Peer evaluation helps the team become more cohesive as each participant realizes that their work is being assessed and recognized by others.

3. Pedagogical conditions for developing the cognitive component of students' TW competence in the university's EIEE.

- *"Advance Knowledge"*. Students who acquire preliminary knowledge about teamwork demonstrate a higher level of engagement and productivity in the EIEE [129]. The use of video lectures, hyperlinks, and digital documents to familiarize students with the basics of team interaction allows them to study the material at their own pace, while self-assessment tasks help evaluate their understanding of the subject. This approach to learning fosters student autonomy and readiness for independent teamwork [95]. Preemptive knowledge formation also reduces the likelihood of conflicts and improves team dynamics. Students familiar with effective team interaction basics are better able to understand different communication styles and conflict resolution methods, making them more prepared for teamwork [123].

- *"Preliminary Self-Assessment"*. Students who assess their knowledge beforehand are more motivated to engage in active learning and achieve better results

[ibid.]. The ability to objectively evaluate their own knowledge allows students to integrate more successfully into the team process, as they are more aware of their strengths and weaknesses. Moreover, self-assessment fosters self-reflection, which strengthens students' ability to learn independently and take responsibility for their contributions to the team [155].

4. Pedagogical conditions for developing the operational component of students' TW competence in the university's EIEE:

- *"Synchronizing Meetings"*. Regular synchronizing meetings allow students to stay informed about the progress of the work and see the progress of the entire team, which is important for focusing attention on the teamwork process rather than just its outcome [162]. Conducting such meetings enhances teamwork efficiency and enables the instructor to provide feedback to all teams.
- *"Virtual Sandbox"*. This pedagogical condition is based on the need to create a training environment where students can improve their skills with the digital tools used in teamwork. Such an approach creates a psychologically safe atmosphere and allows students to master digital tools for teamwork in the EIEE within a special training environment [132].

5. Pedagogical conditions for developing the reflective component of students' TW competence in the university's EIEE:

- *"Digital Footprint"*. The ability to access digital records (digital footprints), such as virtual boards with planning and discussion results, allows students to see how their contributions impact the team's overall results. Visualizing progress and having access to historical data increases students' motivation as they can see the significance of their participation and its impact on the final outcome [159]. This approach ensures students more consciously perceive the progress and results of the learning process, strengthening their personal involvement in teamwork in the EIEE.
- *"Prospective Reflection"*. The introduction of this pedagogical condition aims to help students see the contributions of other participants to the overall team result, better understand them, and develop closer social ties. Research on teamwork indicates that focusing on the positive contributions of each participant enhances team cohesion

and reduces conflict levels within the team [162; 164]. This helps students perceive teamwork as a collective achievement rather than a collection of individual actions. Using special techniques, such as "4L", "Sailboat", or "Start/Stop/Continue", helps students not only realize their individual strengths but also assess collective dynamics. These digital templates help develop socio-reflection and awareness of each participant's role in the process, improving team interaction and strengthening trust within the team.

- *"Evaluate & Discuss"*. This condition assumes that after evaluating teamwork results and mutual evaluations by participants, a synchronous online meeting takes place. During this meeting, the instructor and students discuss each participant's contribution and the results of individual evaluations. The instructor acts as a moderator, helping students develop skills in constructive communication and positive feedback perception. Students are given the opportunity not only to analyze their own work but also to critically assess the contributions of others, which develops their reflective skills [3; 26]. Open discussions help improve understanding of roles and responsibilities within the team, creating conditions for more productive interaction among students in the university's EIEE.

The proposed pedagogical conditions are intended to ensure the effective development of students' TW competence in the university's EIEE.

The effectiveness of these conditions will be evaluated based on the students' TW competence development dynamics (i.e., positive changes in motivation for distance teamwork, the formation of team values, mastery of knowledge about distance teamwork, the development of skills and abilities in online teamwork, and the ability for reflective-evaluative activity in the digital environment). Diagnostic techniques are described in § 1.6, and the effectiveness was tested within the framework of experimental training in Chapter 2.

1.5.2 Expert Assessment of Pedagogical Conditions for the Development of Students' Teamwork competence in the University's Electronic Information and Educational Environment

To conduct an initial testing of the formulated pedagogical conditions and to rank them based on the necessity of their inclusion in the educational process, the expert assessment method was applied. The expert panel consisted of 10 university faculty members with over 10 years of teaching experience and publications in the field of digital educational technologies.

The experts represented various academic disciplines, including psychology (3 experts), pedagogy (4 experts), mechanical engineering (1 expert), philosophy (1 expert), and linguistics (1 expert). The assessment was conducted using an interactive questionnaire (see Appendix E) hosted on the Google Forms online platform.

Experts were asked to evaluate each pedagogical condition according to five criteria, using a five-point Likert scale:

1. Correspondence to the established characteristics of the development of TW competence components in the university's EIEE (where 1 – does not correspond at all, and 5 – fully corresponds) – Criterion 1 (*CRT1*).
2. Importance of the pedagogical condition for the development of the given competence component (where 1 – not important at all, and 5 – very important) – Criterion 2 (*CRT2*).
3. Variability/invariance of the pedagogical condition's implementation (where 1 – variable (optional), and 5 – invariant (mandatory)) – Criterion 3 (*CRT3*).
4. Feasibility of implementing the pedagogical condition in practice (where 1 – almost impossible to implement, and 5 – fully implementable) – Criterion 4 (*CRT4*).
5. Degree of dependence of the pedagogical condition on the digital competence of the instructor (where 1 – requires an advanced level, and 5 – does not require special skills) – Criterion 5 (*CRT5*).

Prior to each of the five blocks of pedagogical conditions (grouped according to TW competence components), the questionnaire provided descriptions of the characteristics of TW competence development in the university's EIEE. This ensured

that experts had the necessary background information from the study to assess pedagogical conditions based on the first criterion (*CRT1* – Correspondence).

As a result, each pedagogical condition was assigned a score from 1 to 5 across the five criteria (*CRT1–CRT5*) for each competence component.

These scores were then averaged, forming the basis for the final ranking of the pedagogical conditions. This ranking helped determine which conditions must be integrated into the educational process for the development of students' TW competence in the EIEE and which can remain optional.

The results of the expert assessment of pedagogical conditions for the development of the motivational component are presented in Table 1.2.

Table 1.2. – Ranking of pedagogical conditions by necessity of inclusion in the educational process (motivational component)

Pedagogical conditions	*CRT1*	*CRT2*	*CRT3*	*CRT4*	*CRT5*	**μ**
Connection with Instructor	4.5	4.7	4.6	4.8	3.2	4.36
Recursive Team Building	4.4	4.5	4	3.5	2.6	3.8
Digital Skills	4.3	4.5	3.8	3.6	2.6	3.76
Distributed Workload	4.1	4	3.5	3.9	2.9	3.68
Virtual Space	3.9	3.9	3.5	3.3	2.2	3.36

As shown in Table 1.2, the pedagogical condition "Connection with Instructor" received the highest rating across all criteria, emphasizing its significance and high feasibility of implementation.

The high rating of the pedagogical condition "Recursive Team Building" in terms of importance (*CRT2*) and correspondence (*CRT1*) confirms its necessity for maintaining student motivation in the process of teamwork within the university’s EIEE.

Although the pedagogical condition "Digital Skills" received a high rating for importance (*CRT2*), its implementation may depend on the current level of student preparedness and the capabilities of the educational institution. It is recommended to conduct preliminary technical sessions, provide instructional materials and screencasts,

and implement diagnostic testing. These measures will help ensure a uniform level of digital competence among students; however, they can be implemented as needed, particularly if students already possess basic digital skills.

The pedagogical condition "Distributed Workload" received high ratings from experts in terms of correspondence (*CRT1*) and importance (*CRT2*). Additionally, experts considered this condition relatively easy to implement in practice (*CRT4*). Therefore, the use of online teamwork tracking tools such as Asana or Microsoft Tasks is recommended for task assignment, deadline management, and monitoring the even distribution of workload. This approach will help students clearly understand their responsibilities, but the implementation of this pedagogical condition is not mandatory.

The pedagogical condition "Virtual Space" was rated as the least important and the most dependent on the instructor's digital competence. The introduction of virtual rooms, the creation of interactive whiteboards, and the assignment of students to roles such as "scouts" can contribute to team dynamics development, but these measures are not essential and depend on the level of digital infrastructure available at the university.

Thus, for the effective development of the motivational component of TW competence in the university's EIEE, the conditions "Connection with Instructor" and "Recursive Team Building" must be implemented. The pedagogical conditions "Digital Skills," "Distributed Workload," and "Virtual Space" can be incorporated as needed, taking into account student needs, instructor capabilities, and available educational resources.

The results of the ranking of pedagogical conditions for the development of the axiological component of TW competence in the university's EIEE are presented in Table 1.3.

Table 1.3. – Ranking of pedagogical conditions by necessity of inclusion in the educational process (axiological component)

Pedagogical Conditions	*CRT1*	*CRT 2*	*CRT 3*	*CRT 4*	*CRT 5*	**μ**
Team Reflection	4.5	4.4	4.1	3.6	3.5	4.02
Interactive Peer Assessment	4.1	4	3.7	3.9	3.3	3.8

As shown in Table 1.3, the pedagogical condition "Team Reflection" received high scores across all key criteria and is essential for shaping value-based attitudes and students' awareness of their role and contribution to the team. Its feasibility (*CRT4* = 3.6) and dependence on the instructor's level of digital competence (*CRT5* = 3.5) indicate that this condition is quite achievable, although it requires a certain level of digital competency from the instructor.

The pedagogical condition "Interactive Peer Assessment" is also important, as it enables an open and structured evaluation of each team member's contribution, fostering students' ability for mutual control and critical reflection on their teamwork. However, the implementation of this condition requires some technical preparation on the part of the instructor (*CRT5*). Overall, this condition can be implemented optionally, depending on the readiness of instructors and the availability of digital tools for facilitating peer assessment.

Next, an expert assessment of pedagogical conditions for the development of the cognitive component of TW competence in the university's EIEE was conducted (see Table 1.4).

Table 1.4. – Ranking of pedagogical conditions by the degree of necessity for inclusion in the educational process (cognitive component)

Pedagogical Conditions	*CRT1*	*CRT2*	*CRT3*	*CRT4*	*CRT5*	**μ**
Advance Knowledge	4.5	4.5	4.2	4.4	3.6	4.24
Preliminary Self-Assessment	3.5	3.3	2.7	4	3.6	3.42

The data in Table 1.4 indicate that the average rating (μ = 4.24) of the pedagogical condition "Advance Knowledge" confirms its high significance for the development of the cognitive component of TW competence. It received high scores for correspondence (*CRT1* = 4.5) and importance (*CRT2* = 4.5), highlighting its necessity for preparing students for teamwork in the university's EIEE. Its feasibility (*CRT4* = 4.4) was also rated highly, demonstrating its practical applicability. The instructor's level of digital

competence (*CRT5* = 3.6) suggests that this condition can be implemented without requiring advanced technical training.

The average rating of the pedagogical condition "Preliminary Self-Assessment" (μ = 3.42) indicates lower significance compared to "Advance Knowledge." The relatively low scores for correspondence (*CRT1* = 3.5) and importance (*CRT2* = 3.3) suggest that while this condition may be beneficial, it is not essential. Experts noted that implementation is feasible (*CRT4* = 4), but the rating for variability (*CRT3* = 2.7) highlights its optional nature, depending on the educational context. Overall, implementing "Preliminary Self-Assessment" could provide additional benefits for students who wish to evaluate their knowledge of teamwork before starting their coursework.

Next, the ranking of pedagogical conditions for the development of the operational component of TW competence in the university's EIEE was conducted (see Table 1.5).

Table 1.5. – Ranking of pedagogical conditions by necessity of inclusion in the educational process (operational component)

Pedagogical Conditions	*CRT1*	*CRT2*	*CRT3*	*CRT4*	*CRT5*	**μ**
Synchronizing Meetings	4.3	4.3	4.2	4	4.1	4.02
Virtual Sandbox	4.3	4.2	3.7	3.6	3.2	3.8

As shown in Table 1.5, the pedagogical condition "Synchronizing Meetings" has high feasibility and moderate requirements for the instructor's digital skills, making it accessible for most educational programs. High ratings across the first three criteria also indicate the necessity of mandatory implementation of synchronized video conferences in the student teamwork process within the university's EIEE.

Experts noted that the pedagogical condition "Virtual Sandbox" aligns with the established psychological and pedagogical characteristics of developing the operational component of TW competence in the university's EIEE and holds significance in the educational process. However, creating a safe training space for students with low levels

of digital skills in working with ICT may present practical challenges. This pedagogical condition can be implemented as resources become available and based on student needs.

Finally, an expert assessment of pedagogical conditions for the development of the reflective component of TW competence in the university's EIEE was conducted. The results are presented in Table 1.6.

Table 1.6. – Ranking of pedagogical conditions by necessity of inclusion in the educational process (reflective component)

Pedagogical Conditions	*CRT1*	*CRT2*	*CRT 3*	*CRT4*	*CRT5*	**μ**
Digital Footprint	4.4	4.4	3.9	4.2	3.1	4
Prospective Reflection	4.5	4.4	4	3.5	3.1	3.9
Evaluate & Discuss	4.2	4.2	3.9	3.6	3	3.78

Based on the data in Table 1.6, the following conclusions were drawn.

The average rating (μ = 4) of the pedagogical condition "Digital Footprint" indicates its importance for developing the reflective component of TW competence. High scores for correspondence (*CRT1* = 4.4) and importance (*CRT2* = 4.4) confirm its significance for recording key results of team interactions, helping students analyze completed work stages more comprehensively. Its feasibility (*CRT4* = 4.2) was also rated highly, indicating practical applicability. However, the digital competence requirements for instructors (*CRT5* = 3.1) suggest that its implementation requires a certain level of technical knowledge. This condition is recommended for mandatory inclusion, as it enables students to reflect on teamwork processes and outcomes by analyzing recorded interactions and "digital traces".

The average rating (μ = 3.9) of the pedagogical condition "Prospective Reflection" highlights the importance of using reflective techniques aimed at analyzing and emphasizing the positive contributions of team members. High ratings for correspondence (*CRT1* = 4.5) and importance (*CRT2* = 4.4) emphasize its role in fostering discussions and analyses of teamwork processes and results. Its feasibility (*CRT4* = 3.5)

and moderate digital competence requirements for instructors (*CRT5* = 3.1) indicate that this condition can be implemented depending on the instructors' level of preparation.

Experts acknowledged the correspondence (*CRT1* = 4.2) of the pedagogical condition "Evaluate & Discuss" with the established characteristics of remote team interactions and noted its importance (*CRT2* = 4) for deepening team reflection. Its feasibility was rated moderate (*CRT4* = 3.6), while the digital competence requirements for instructors (*CRT5* = 3) were considered significant. This condition can be implemented when needed to optimize teamwork and enhance students' reflection on their collaboration.

Statistical reliability of the results. To verify the statistical reliability of the expert assessment results, the inter-rater agreement level was calculated using Fleiss' kappa coefficient in SPSS Statistics 20. The agreement level was 0.69, which corresponds to a high level of reliability [146], as 0.59 (moderate) < 0.69 (strong) < 0.80 (maximum).

As a result of the expert assessment, the pedagogical conditions necessary for developing TW competence in the university's EIEE were identified. At the same time, some pedagogical conditions were deemed more optional by the experts surveyed. These findings are summarized in Table 1.7.

Table 1.7. – Mandatory and optional pedagogical conditions for the development of tw competence components in the university's EIEE

Competence Component	**Mandatory Pedagogical Conditions**	**Optional Pedagogical Conditions**
Motivational	Connection with Instructor, Recursive Team Building	Digital Skills, Distributed Workload, Virtual Space
Axiological	Team Reflection	Interactive Peer Assessment
Cognitive	Advance Knowledge	Preliminary Self-Assessment
Operational	Synchronizing Meetings	Virtual Sandbox
Reflective	Digital Footprint, Prospective Reflection	Evaluate & Discuss

Thus, at this stage of the study, pedagogical conditions that need to be included in the structural-functional model for the development of students' TW competence in the university's EIEE were proposed, theoretically substantiated, and presented for expert evaluation.

1.6 Structural-Functional Model for the Development of Students' Teamwork Competence in the University's Electronic Information and Educational Environment

To reflect the interrelation between goals, stages, methods, and pedagogical conditions for the development of students' TW competence in the university's EIEE, the method of *pedagogical modeling* was applied. Following N. V. Bordovskaya, we understand pedagogical modeling as a method of scientific and pedagogical research used to reflect the coherence of multiple elements of the research object [20, p. 198].

The pedagogical interaction model presented below integrates structural and functional aspects, focusing on the interaction between participants within the educational environment to achieve specific learning objectives (in this case, the development of students' TW competence). Based on this and following the classification of pedagogical models by E. A. Lodatko, we define the developed model as *structural-functional* [58].

The model does not reflect the logic and scope of educational content presentation but emphasizes the organization and effectiveness of interactions among all components of the educational process to achieve pedagogical objectives. This is particularly relevant because students' TW competence is classified as universal competence, meaning its development can be integrated across various academic disciplines. The model incorporates both structural aspects (stages of the educational process) and functional elements (methods, tools, conditions), aligning with the characteristics of a structural-functional pedagogical model [58].

The structural-functional model for the development of students' TW competence in the university's EIEE is presented in Figure 1.8. It integrates the results of theoretical analysis and pilot research, providing a comprehensive representation of the process of TW competence development in the university's EIEE.

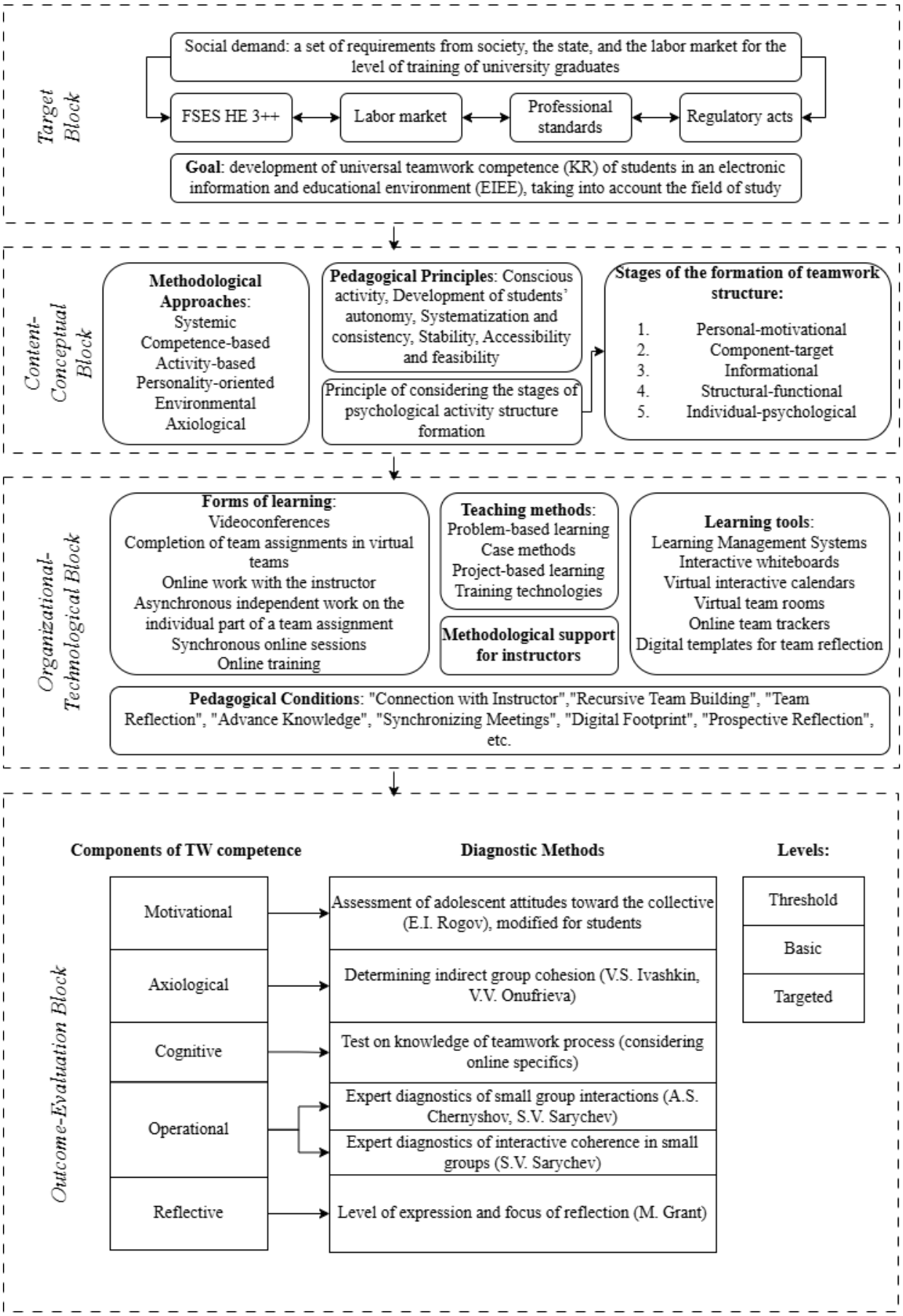

Figure 1.8. – Structural-functional pedagogical model for the development of students' TW competence in the university's EIEE

The *target block* of the model reflects the interconnection between the societal demand and the goal of implementing the presented pedagogical model. A detailed description of the societal demand and the justification for the relevance of the pedagogical problem being addressed is provided in § 1.1.

The *content-conceptual block* reflects the methodological approaches and pedagogical principles of the model's implementation. Based on the conducted theoretical research, the leading methodological approaches identified include the systemic, competence-based, learner-centered, environmental, and axiological approaches.

The *systemic approach* ensures the development of students' TW competence in the EIEE as an integral and interconnected pedagogical process, integrating psychological and pedagogical characteristics at each stage [25]. Additionally, teamwork requires the synchronization of efforts among all participants, an understanding of each member's role, and coordination of actions. The systemic approach allows teamwork to be viewed as a unified process consisting of interrelated components.

The *competence-based approach* serves as the foundation for defining the components of TW competence, learning outcomes, and the means and goals of educational activities. Selecting this approach as the primary one ensures a focus on acquiring conscious experience in teamwork rather than merely accumulating theoretical knowledge about this phenomenon [105]. TW competence includes not only theoretical understanding but also practical interaction skills. The competence-based approach enables the integration of this principle into the presented model.

The *learner-centered approach* takes into account students' personal and individual characteristics when designing the educational process and organizing pedagogical interaction aimed at developing TW competence. Identifying the strengths and areas for growth of each team member, both by instructors and peers, contributes to the formation of a psychologically safe and comfortable educational environment [113]. This approach allows for flexible adaptation of tasks within the EIEE to meet the individual needs and capabilities of students. It fosters a comfortable working atmosphere within the team,

improves communication, and increases personal engagement, which is crucial for successful teamwork.

The *environmental approach* is implemented in the model through the creation of digital spaces (virtual whiteboards, chats, video conferencing systems) that facilitate effective student interaction. This approach helps students develop remote teamwork skills, which are increasingly necessary in the modern world. The effectiveness of teamwork in EIEEs largely depends on the richness of the educational environment, where students can efficiently collaborate.

The *axiological approach* focuses on shaping students' value-based and meaningful attitudes toward teamwork and its outcomes. Developing collective values and ensuring that students internalize them fosters an understanding of teamwork as a socially and personally significant means of self-development, team growth, and societal contribution [67]. The axiological approach helps students recognize the importance of ethical behavior and strengthens team spirit, contributing to a positive group atmosphere.

The model also incorporates a set of *pedagogical principles*, including conscious activity, the development of learning autonomy, systematization and consistency, accessibility and feasibility, and stability [36].

The *principle of conscious activity* emphasizes the importance of students' active participation in the educational process. In teamwork, initiative and deliberate engagement are essential since, without the active involvement of each student, the team task cannot be successfully completed. This principle encourages students to be active contributors rather than passive observers, motivating them to make meaningful contributions to the collective effort.

The *principle of developing learning autonomy* focuses on equipping students with independent work skills, as teamwork requires not only collaboration but also the ability to take responsibility for individual tasks. Enhancing learning autonomy enables students to plan and execute their respective contributions within the team while recognizing their responsibility for the overall outcome.

The *principle of systematization and consistency* ensures a logical and structured approach to mastering educational content, helping students better understand

information and recognize connections between various aspects of teamwork knowledge. Team-based projects often consist of multiple stages that require clear coordination and sequential execution. This principle helps students grasp the structure of teamwork and follow the necessary steps.

The *principle of stability* is implemented in the model through sequential tasks that refine and strengthen skills acquired by students during previous teamwork cycles. Additionally, durability is reinforced by relying on the digital footprint of teams within the EIEE, allowing students to reference and build upon past experiences when planning future collaboration cycles.

The *principle of accessibility and feasibility* is applied by adapting tasks to students' skill levels, ensuring balanced workload distribution and opportunities for each participant to contribute. This prevents excessive workload for some students while others remain under-engaged, ultimately fostering a supportive environment for teamwork.

Alongside these pedagogical principles, the model also incorporates the *principle of considering the stages of psychological activity formation*. According to this principle, the development of TW competence in EIEEs should not simply rely on commonly recognized stages of teamwork or project-based work (such as goal-setting, planning, individual task execution, and result presentation). Instead, it should consider the stages of systemic psychological activity formation, including personal-motivational, component-target, informational, structural-functional, and individual-psychological stages [108]. A detailed description of these stages is provided in § 1.4.1.

The *organizational-technological block* includes methods, organizational forms, and didactic tools for the development of students' TW competence in the university’s EIEE, as well as the conditions ensuring the effectiveness of this process.

As a result of analyzing methodological approaches to the development of TW competence in the EIEE (see § 1.3), the most appropriate organizational forms of learning were identified, including video conferences, student task completion in virtual team rooms during practical online sessions, intermediate synchronizing online sessions, synchronous teamwork in the EIEE under instructor’s supervision, and asynchronous work on individual parts of team assignments. The latter includes familiarizing students

with teamwork rules and technologies, using online calendars for planning activity stages, and completing interactive reflection sheets.

Synchronizing online sessions serve, on the one hand, as a means of updating activity plans for students' individual work in team projects. On the other hand, these online meetings allow students to present interim results to the instructor and receive necessary feedback to continue their work. This form of remote interaction was identified based on theoretical findings indicating that students in an online environment tend to focus excessively on task completion rather than interaction [132; 133].

The inclusion of practical online sessions in virtual team rooms in this model aims to ensure a sufficient degree of practice-oriented learning within the framework of the competence-based approach.

An analysis of regulatory requirements for the development of TW competence in EIEEs necessitated the inclusion of professional training for instructors in the organizational-technological block. This training may take the form of methodological recommendations, guidelines, or training seminars on organizing remote teamwork for students.

Based on the analyzed scientific and pedagogical research on the problem (see § 1.3), the development of TW competence in the EIEE involves a combination of active and interactive learning methods, techniques, and technologies (including project-based learning, problem-based learning, and case studies).

The advantages of the project-based method are particularly evident in its high adaptability to various stages of teamwork organization. The problem-based learning method encourages students to independently search for information and identify teamwork strategies through solving professional-oriented problem situations. The use of the case-study method is driven by the need to demonstrate best practices and activity outcomes in the context of students’ future professions, which positively influences their understanding of the personal significance of teamwork [51].

Training technologies involve modeling various professional situations in which participants (instructors) collaboratively complete exercises to develop skills and abilities in using digital tools for organizing student teamwork. They gain experience in the step-

by-step organization of remote team interactions and modify these processes according to their professional needs. Instructors also analyze the teamwork process from both faculty and student perspectives [50].

Among the most effective tools for developing students' TW competence in the university's EIEE, we have identified virtual interactive whiteboards (e.g., Miro, MS Whiteboard, Google Jamboard), online calendars (e.g., Google Calendar), virtual team rooms (breakout room functions in Zoom or MS Teams), online team collaboration trackers (Trello, Asana, etc.), digital team reflection templates (Templates function in Miro or MS Whiteboard), and learning management systems (Microsoft Teams, Blackboard Learn, Canvas, Google Classroom, etc.).

The selection of tools for implementing the model in practice was based on the stages of psychological activity formation. At the personal-motivational stage, it is advisable to use virtual interactive whiteboards with multimedia materials to increase students' interest in a problem situation or case study. During the component-target stage of teamwork planning, students may be asked to record team agreements in an online calendar and distribute responsibilities among team members using online collaboration trackers. Timely updates in these trackers will allow instructors to monitor the progress of student teamwork in real-time. The file-sharing features embedded in modern learning management systems (e.g., the "Files" tab in Microsoft Teams) enable instructors to provide timely instructions for specific stages of teamwork in the online environment. For instance, in the event of conflict situations within a student team, an instructor can place a text file containing conflict resolution strategies in a designated folder and insert a hyperlink to the material in the virtual workspace of the team that requires it for continued productive collaboration.

At the structural-functional stage, the introduction of online team rooms will allow instructors to divide students into team spaces while keeping the main video conference open for immediate feedback if needed.

At the individual-psychological stage, digital team reflection templates will enable students to independently or with minimal instructor guidance reflect on the content,

methods, and results of their teamwork, assess participants' emotional states, and document future agreements.

The organizational-technological block of the model also includes the pedagogical conditions necessary for developing students' TW competence in the EIEE. These conditions are described in detail in § 1.5 of this chapter.

The *outcome-evaluation block* of the pedagogical model includes the components, criteria, and levels of TW competence formation in students, as well as diagnostic methods, which are described in detail in § 2.2.2.

To assess the formation of the motivational component of students' TW competence, a modified version of the "Assessment of Adolescent Attitudes toward the Collective" method [87] is proposed. This method identifies an individual's perception of the team as one of three types: collectivist, pragmatic, or individualistic (see Appendix F.1). These types of perception are directly linked to motivation for team participation. The collectivist perception type indicates intrinsic motivation, where the individual strives for active participation in teamwork and achieving shared goals. The pragmatic type reflects extrinsic motivation, based on personal benefits from team participation. The individualistic type may indicate low or no motivation for teamwork [78].

To diagnose the axiological component, the "Determining Indirect Group Cohesion" method [103, pp. 136–137] is applicable. This method helps determine the orientation of both individual students and the group as a whole toward specific team qualities (professional, moral, or emotional).

To assess the formation of the cognitive component of TW competence, a test was developed to evaluate students' knowledge of the rules and norms of team interaction in EIEEs (see Appendix F.2). The test consists of 10 questions assessing various aspects of remote teamwork. This test is custom (designed by the thesis's authors) and is planned to be expanded and tested on additional student groups in the future.

To diagnose the operational component, an expert evaluation method is used (by an instructor or a group of instructors) based on the methodologies "Expert Diagnostics of Small Group Interactions" by A. S. Chernyshov and S. V. Sarychev and "Expert Assessment of Interactive Coherence in Small Groups" by S. V. Sarychev [ibid., pp. 138–

140]. The evaluation criteria from these methodologies were modified and combined into a single expert assessment sheet (see Appendix F.3). The relationship between expert assessment criteria and students' teamwork skills within the operational component will be examined in Chapter 2.

The reflective component of TW competence is proposed to be measured using M. Grant's questionnaire "Level of Expression and Focus of Reflection" [47]. This method evaluates levels of self-reflection and social reflection in students. The most "adapted" level for teamwork is considered to be a moderate level of self-reflection and a high (above average) level of social reflection [ibid.].

In assessing the development of TW competence, we propose relying on three traditionally identified levels: low (threshold), medium (basic), and high (target) [31; 25]. Given the multi-level nature of TW competence, it is advisable to assess each component separately, producing five-dimensional histograms representing TW competence formation for each student and for the group as a whole. In large groups, elements of self-assessment or peer assessment can be used to reduce the instructor's workload while engaging students in the evaluation process. Each student evaluates themselves and their peers based on clear criteria, and the instructor can use this data to generate summary histograms. The inclusion of students in self- and peer-assessment processes fosters their reflective skills [112].

Thus, the structural-functional model for developing students' TW competence in the EIEE, regardless of the training field, reflects the results of the theoretical research key stages: refining key concepts, expanding the structure of TW competence, systematizing stages of its development, defining psychological and pedagogical characteristics of this process, and determining pedagogical conditions for TW competence development in a university's EIEE.

FINDINGS OF CHAPTER 1

In the first part of the study, six out of the seven research objectives outlined in the introduction were achieved:

1. The key concepts of "team," "virtual team," "teamwork," and "remote team interaction" were analyzed. It was established that teamwork in the modern world is a type of multi-faceted social interaction that can be conducted offline with or without ICTs or entirely in a digital environment. As a result, the boundaries between traditional and virtual teams are gradually fading, highlighting the need to prepare students for remote teamwork in the university's EIEE.

2. Based on an analysis of psychological and pedagogical literature on the research problem, the component structure of TW competence was refined in the context of education digitalization. The most comprehensive representation of students' TW competence includes five components: motivational, axiological, cognitive, operational, and reflective. The study of teamwork interaction in digital environments using ICTs revealed the necessity of supplementing each component with specific knowledge, skills, and abilities. These additions enable students to apply this competence both in traditional offline settings and online teams after completing their university education.

3. A review of methodological approaches to the development of TW competence in the university's EIEE revealed that researchers currently focus on three main directions: analyzing the didactic potential of ICTs in transferring existing teamwork practices from traditional to online environments, using project-based technology in the EIEE, and considering the specifics of CMC in organizing students' remote teamwork. However, none of these directions fully define the main stages of developing this competence in the EIEE, making it difficult to systematize the psychological and pedagogical characteristics of this process. To address this gap, we relied on the concept of activity systemogenesis. As a result, the structure of TW competence became isomorphic to the psychological structure of activity, allowing us to describe its development in the EIEE through the following stages: personal-motivational, component-target, informational, structural-functional, and individual-psychological, as established in § 1.2.

4. After defining the core processes underlying the structure of teamwork activity, we systematized the psychological and pedagogical characteristics of teamwork interaction at each of these stages, considering the influence of CMC factors. The relevance of these characteristics for Russian students was verified through a survey.

5. Once the stages and psycho-pedagogical characteristics of TW competence development in an EIEE were determined, we substantiated the pedagogical conditions that enhance the effectiveness of this process. To conduct an initial validation of the proposed pedagogical conditions and rank them by their necessity for inclusion in the educational process, an expert assessment was carried out.

6. The findings from the theoretical research, pilot study, and expert assessment formed the basis for developing a structural-functional model for the development of TW competence in a university's EIEE. This model consists of four key blocks: target, content-conceptual, organizational-technological, and outcome-evaluation.

CHAPTER 2. Experimental Work on the Implementation of the Model for Developing Students' Teamwork Competence in the University's Electronic Information and Educational Environment

This chapter provides a description and presents the results of the experimental work (hereinafter referred to as EW) aimed at implementing the structural-functional model for developing students' TW competence in the university's EIEE. The goal of EW is to test the research hypothesis.

Process and Stages of EW:

1. Conducting the stating experiment for identifying students' and teachers' attitudes toward the process of developing TW competence in the university's EIEE, assessing the motivation of educational process participants for remote teamwork, and determining the necessity of implementing the structural-functional model of TW competence development in the university's EIEE.

2. Conducting a diagnostic assessment in the control group (hereinafter referred to as CG) and the experimental group (hereinafter referred to as EG), followed by statistical analysis of the results and the formation of a TW competence development profile for each group at the initial stage of the EW.

3. Introducing the structural-functional model for developing students' TW competence in the university's EIEE during experimental training in the EG, with simultaneous video conferences held in the CG (a detailed description of the training is provided in § 2.3).

4. Conducting control assessments in both the EG and CG, followed by statistical analysis of the obtained results, as well as recording changes in the levels of TW competence development among students in both groups after the experimental training (see § 2.4).

5. Summarizing the EW results and developing methodological recommendations for instructors on developing students' TW competence in the university's EIEE.

2.1. Identification of Students' and Teachers' Attitudes Toward the Process and Outcome of Developing Teamwork Competence in the University's Electronic Information and Educational Environment (Stating Experiment)

The aim of the stating experiment is to identify the initial level of demand among students and teachers for the implementation of the structural-functional model for developing students' TW competence in the university's EIEE.

The objectives of the stating experiment are as follows:

- Obtain information on the level of students' motivation to develop TW competence in the university's EIEE.
- Determine whether students have sufficient experience in remote team interaction.
- Identify the difficulties faced by teachers in developing students' TW competence in the university's EIEE.
- Determine whether teachers require methodological support for organizing the process of developing students' teamwork competence in the EIEE.

The study was conducted in 2022–2023 at the Faculty of Psychology of Saint Petersburg State University (SPbU).

The primary *research method* was a survey. The sample consisted of 40 teachers and 155 students from socio-humanitarian fields of study (the average age of students was 20.5 years). The scientific and pedagogical activities of the teachers were mainly concentrated in the field of psychological and pedagogical sciences (81.8%). The length of service ranged from "1–3 years" to "more than 40 years," with 33.3% having more than 20 years of experience.

Two questionnaires were developed: one for students (see Appendix G.1) and one for teachers (see Appendix G.2). The questionnaires contained 13 single-choice and multiple-choice questions. The survey was conducted online using the Google Forms platform.

Main results of the student survey

To the question of how important students consider TW competence when studying academic disciplines remotely, 91 students selected the answer "rather important" and 50

– "consider it essential". Only 13 students indicated that TW competence is not important (see Figure H.1 in Appendix H). The overwhelming majority of students (118 out of 155 respondents) stated that they consider mastering TW competence at the university, including in the online format, essential (see Figure H.2).

Notably, 73% of students, when faced with a large academic task, would prefer to solve it as a team, indicating the need for teachers to create appropriate pedagogical conditions (see Figure H.3). At the same time, responses to the question of whether students have sufficient knowledge of remote teamwork and experience in online team interaction were roughly evenly divided (see Figure H.4).

Additionally, using the SPSS Statistics 20 software, correlation maps between survey responses were generated, allowing for several additional conclusions. For example, regardless of how often students have to work in teams, most of them answered the question "How important is it for you to be able to work in online teams?" with "rather important" (see Figure 2.1).

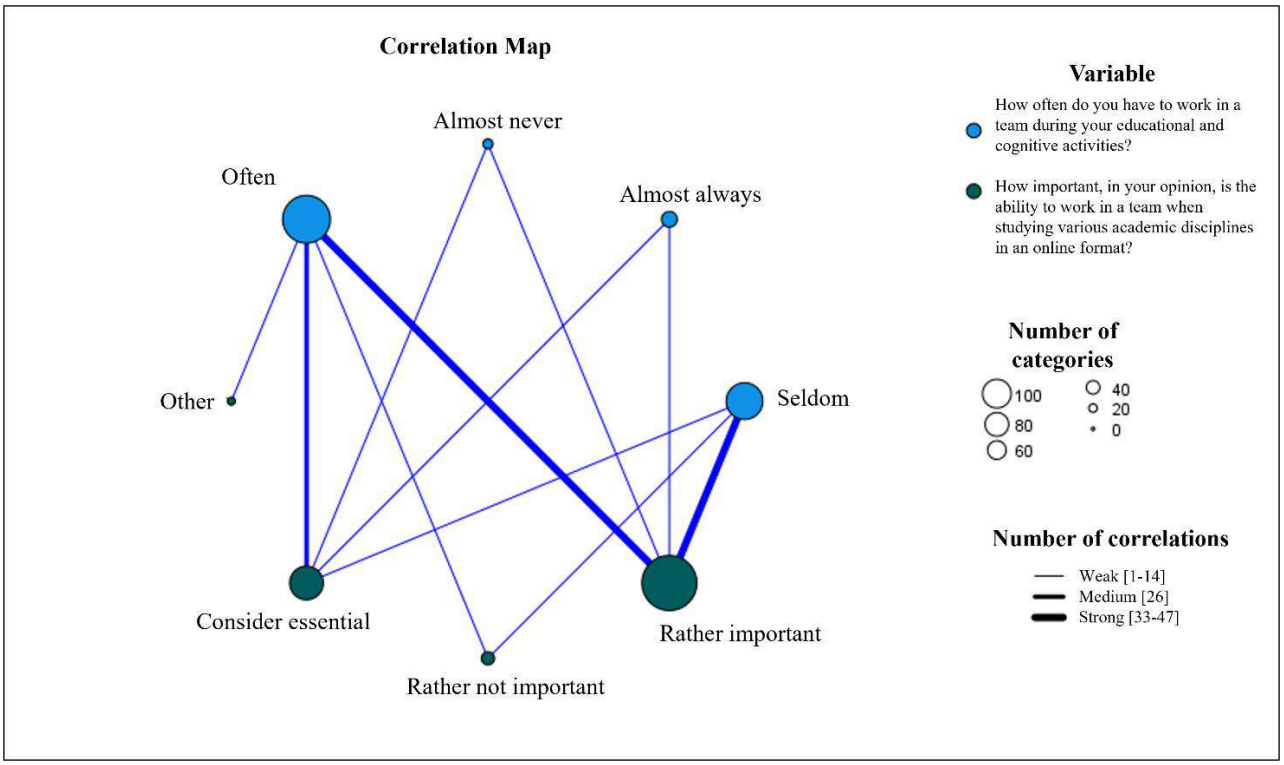

Figure 2.1. – Correlation map-1 between student survey questions

Most students also prefer to solve large academic tasks in teams, regardless of whether their approach to academic activities is individualistic or collectivistic (see Figure 2.2).

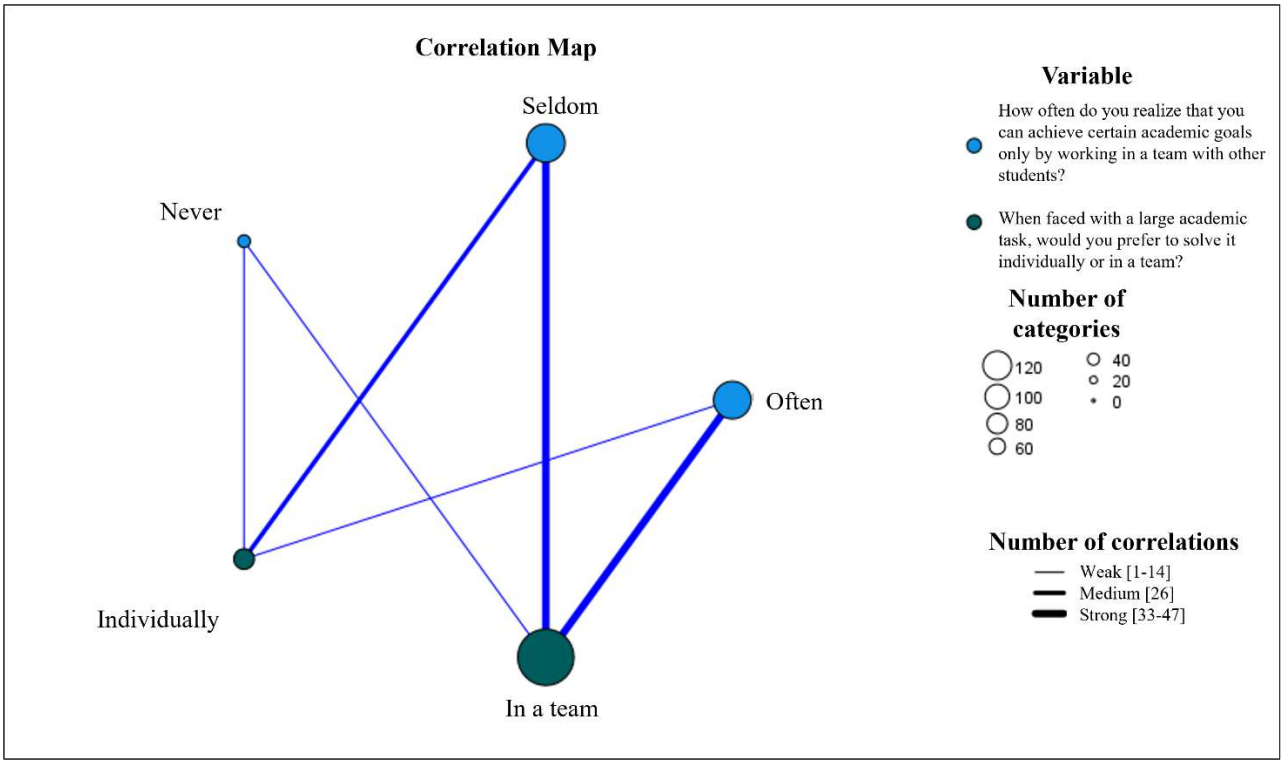

Figure 2.2. – Correlation map-2 between student survey questions

Thus, the analysis of students' responses to the survey questions revealed the following:

1. Students (76.1%) are motivated to develop TW competence in the university's EIEE.

2. Approximately half (42.6%) of the surveyed students lack experience in remote team interaction in academic activities.

Main results of the teacher survey

The majority of teachers surveyed (65%) noted that it is easier for them to organize students' teamwork offline rather than online (see Figure H.5).

Next, teachers were asked which skills they lack for organizing students' remote team interaction. The response options and percentage distribution are presented in Table 2.1.

Table 2.1. – Skills for organizing students' online teamwork that teachers lack

Response Options	Frequency	%	Cumulative %
Technical skills	16	40	40
Psychological and pedagogical skills	9	22,5	62,5
Pedagogical skills	6	15	77,5
Lacking all of the above skills	4	10	87,5
All of the above skills are sufficient	4	10	97,5
Other	1	2,5	100
Total	40	100	

As shown in Table 2.1, teachers most often lack technical skills for organizing online teamwork (40%). The questionnaire specified such skills as working with online resources for organizing student team interaction, proficiency in ICT for assessing teamwork results, and others. Additionally, 15% of respondents noted a lack of pedagogical knowledge about the methodology of organizing team activities in the university's EIEE (e.g., understanding the specifics of developing individual components of TW competence online). Psychological and pedagogical skills (e.g., experience in conflict resolution, conducting online team reflection) were lacking for 22.5% of the teachers surveyed.

It was found that in most cases, teachers experience difficulties in motivating students to work in online teams (35%), organizing team goal-setting (30%), and monitoring student interaction in the EIEE (35%) (see Figure H.6).

Additionally, 25 respondents (62.5%) expressed a desire to undergo training on organizing student team interaction in the university's EIEE (see Figure H.7), highlighting the need for the development of appropriate methodological recommendations, teacher training sessions, and the systematic integration of such training into continuing professional education programs.

Thus, teachers noted a lack of pedagogical knowledge and skills for developing students' TW competence in the university's EIEE and expressed a desire to receive additional training in this process.

The results of the student and teacher surveys confirmed the relevance of implementing the structural-functional model for developing students' TW competence in the university's EIEE.

2.2. Analysis of the Level of Development of Students' Teamwork Competence in the University's Electronic Information and Educational Environment at the Initial Stage of the Formative Experiment (Diagnostic Assessment)

The goal of the diagnostic assessment is to determine the initial level of formation of all components of students' TW competence in the EG and CG — that is, the factors that will be further monitored throughout the EW.

§ 2.2.1 describes the characteristics of the experimental and control groups and the results of identifying significant differences between the two samples.

§ 2.2.2 outlines the diagnostic tools used in the study, which were employed to assess the level of development of students' TW competence both at the initial stage of the formative experiment and at the concluding stage during the control assessment. It is important to note that the level of TW competence development was determined based on the levels of formation of each of the five components of this competence.

§ 2.2.3 presents the results of diagnosing the formation of each component of students' TW competence in the EG and CG, as well as diagrams reflecting the average level of TW competence development in both groups at the beginning of the experiment.

2.2.1 Description of the Students Samples in the Control and Experimental Groups

The formative stage of the experiment was conducted with fourth-year students from the Faculty of Psychology at SPbU in the field of study 37.05.02 "Psychology of Professional Activity" and fourth-year students from the Institute of Earth Sciences at SPbU in the field of study 05.03.02 "Geography," within the Microsoft Teams EIEE.

We selected students from different fields of study for the experiment to assess how future representatives of various professions work in teams within the EIEE. This also helped to determine whether the developed structural-functional model could be universally applied in education regardless of students' professional backgrounds.

The choice of senior students was based on the fact that by this stage, they have various experiences interacting in the educational environment (both offline and online) and are nearing the completion of their studies. At this stage, students can demonstrate a mature approach to interaction and consciously apply the knowledge they have gained about remote teamwork.

At the beginning of the experiment, two groups were formed: the control group consisting of psychology students, and the experimental group consisting of geography students. The number of students in the CG was 20, while the EG included 19 students. The average age of the students was 20.5 years. Students in both groups had annually studied academic disciplines within the Microsoft Teams EIEE.

The absence of significant differences between the two samples was confirmed by applying the Mann-Whitney U-test when analyzing the responses of students to the stating experiment questionnaire (see § 2.1). The goal was to determine the absence of statistically significant differences in the assessment by students of the EG and CG regarding the frequency of participation in team work at the university (Q1), the importance of developing TW competence (Q2), and the orientation toward teamwork when completing academic tasks (Q3) (see Table 2.2).

Table 2.2. – Initial Data for Calculations Using the Mann-Whitney U Test

#	Question	Answer option	Ranks
Q1	How often do you have to work in a team during your academic and cognitive activities?	Almost never	1
		Rarely	2
		Frequently	3
		Almost always	4
Q2	How necessary, in your opinion, is it to master the basic rules, methods, and technologies of teamwork (including in an online format) during your university education?	Hesitate to answer	1
		Do not consider it necessary	2
		Consider it necessary	3
Q3	When faced with a large academic task, would you prefer to solve it independently or in a team?	Individually	1
		In a team	2

Thus, at the initial stage of statistical analysis, two hypotheses were formed: the null hypothesis (H_0) and the alternative hypothesis (H_1).

H_0: The differences in the degree of homogeneity of the responses to the specified questions in the questionnaire are statistically insignificant.

H_1: The differences in the degree of homogeneity of the responses to the specified questions in the questionnaire are statistically significant.

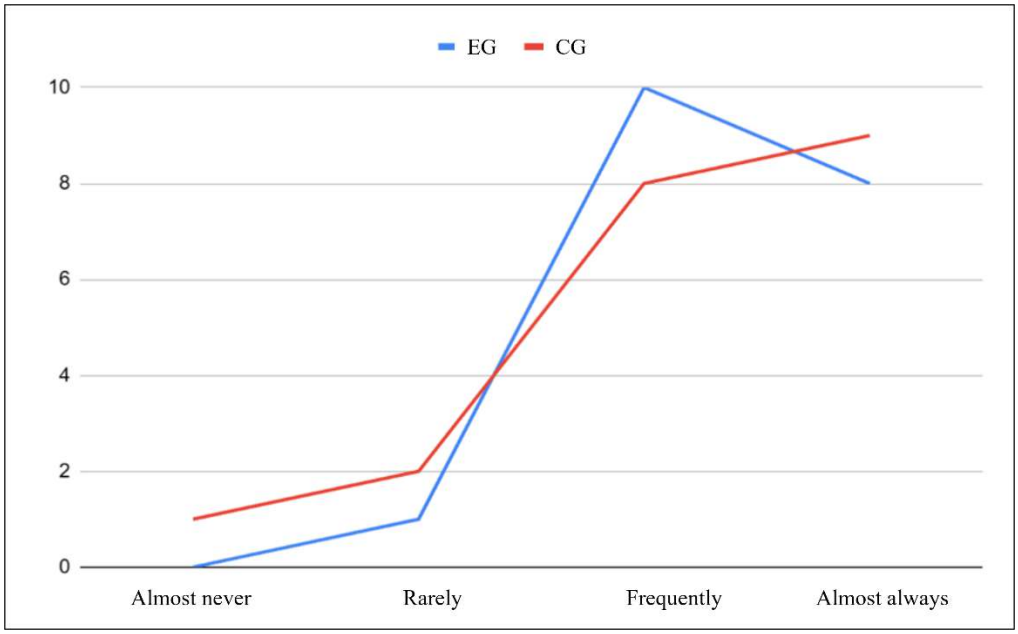

Figure 2.3. – Distribution of responses to question Q1

As seen in Figure 2.3, most of the responses to the question "How often do you have to work in a team during your academic and cognitive activities?" from representatives of both groups fall within the range of "frequently" and "almost always".

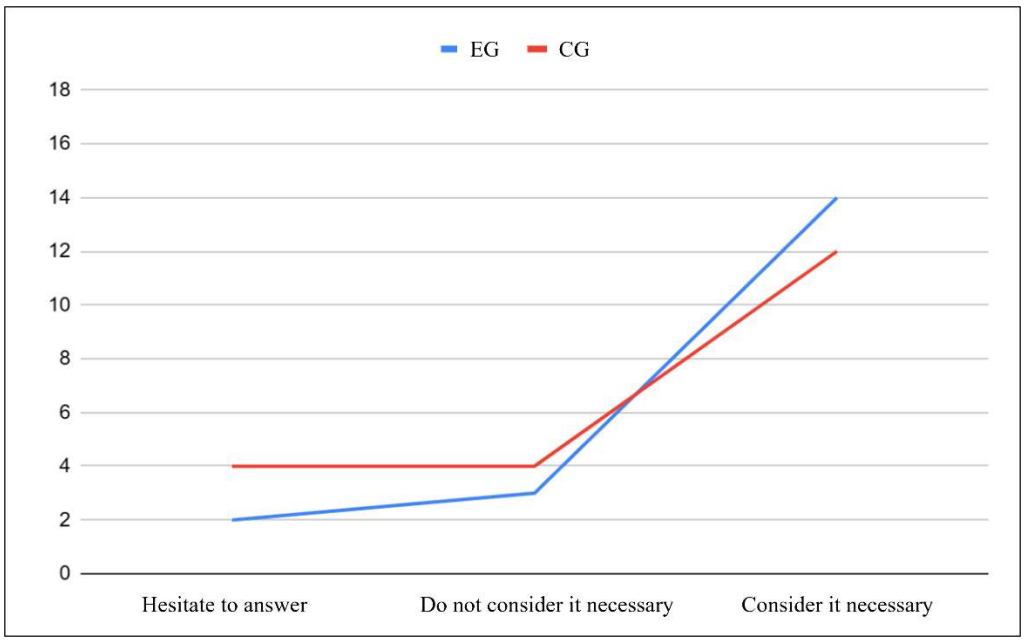

Figure 2.4. – Distribution of responses to question Q1

As shown in Figure 2.4, 14 out of 19 students from the EG and 12 out of 20 students from the CG, respectively, identified TW competence as a necessary educational outcome.

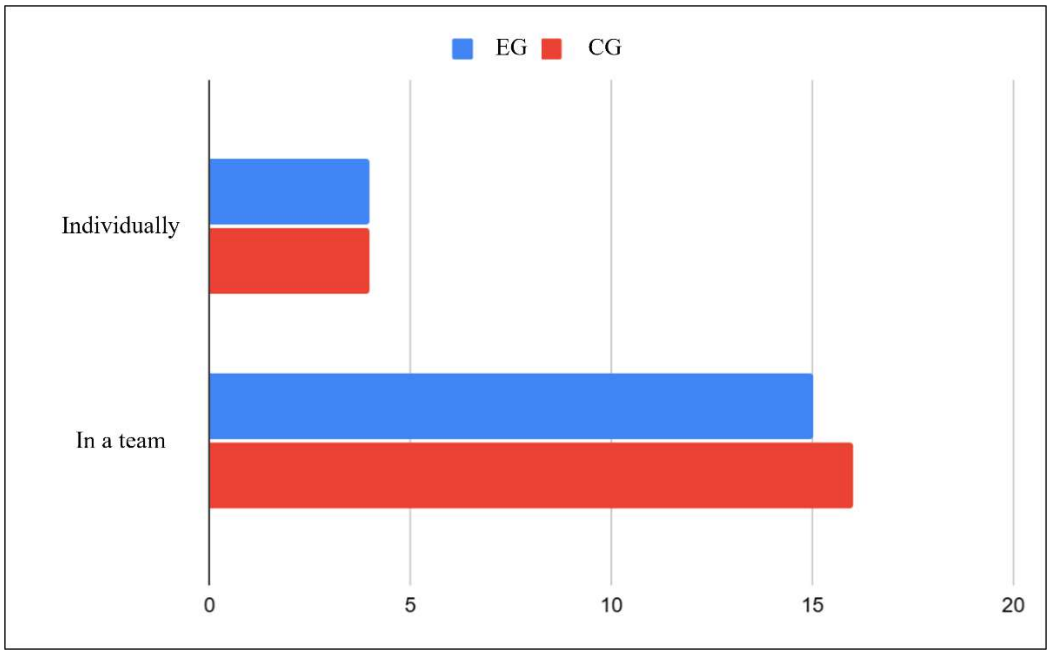

Figure 2.5. – Distribution of responses to question Q1

The data from Figure 2.5 indicate that the majority of students from both groups prefer to work in a team when faced with a large academic task (e.g., when preparing for seminars).

Since the respondents' answers are represented by non-parametric data with a non-normal distribution, we used the Mann-Whitney U-test to compare the mean values of responses between the EG and CG. For this, nominal variables (categorical data) were converted into numerical rank values (see Table 2.2).

Statistical analysis of the data was conducted using JASP version 0.18.3. The results of applying the Mann-Whitney U-test for the two student groups are presented in Table 2.3.

Table 2.3. – Results of applying the Mann-Whitney U-test to check the homogeneity of the EG and CG

Question	**W**	**p**	**α**
How often do you have to work in a team during your academic and cognitive activities?	196.000	0.864	0.05
How necessary, in your opinion, is it to master the basic rules, methods, and technologies of teamwork (including in an online format) during your university education?	218.000	0.354	0.05
When faced with a large academic task, would you prefer to solve it independently or in a team?	188.000	0.952	0.05

As shown in Table 2.3, we reject H_1 and accept H_0, as the differences in the average responses of the students are statistically insignificant ($p > 0.05$), meaning the samples are homogeneous.

2.2.2 Diagnostic Tools for Assessing the Level of Development of Students' Teamwork Competence in the University's Electronic Information and Educational Environment

For further assessment of the students' TW competence development level at the diagnostic and control stages, criteria corresponding to the five components of TW competence were identified, along with indicators of their formation, and the diagnostic tools (see Table 2.4).

Table 2.4. – Diagnostic tools for assessing the level of development of TW competence

Criteria	**Indicators of formation**	**Diagnostic Tools**
Motivational	Formed personal motivation for teamwork in the EIEE, recognition by the individual of a unified interaction goal, and the desire to contribute to teamwork.	"Assessment of a Teenager's Relationship with the Class" (adaptation)
Axiological	Formed personality traits that ensure effective participation in team interaction, such as collectivism, empathy, responsibility, and others.	"Determining Indirect Group Cohesion"
Cognitive	The student's mastery of a set of knowledge about the regulations of team interaction, communication norms within the team, and methods of remote teamwork.	Author's test for assessing knowledge about the team
Operational	The students' experience in implementing team activities, abilities and readiness to apply team interaction tactics and strategies, developed skills and competencies in teamwork, and experience in remote team interaction.	"Diagnostics of Interaction and Interactive Coherence in Small Groups" (adaptation)
Reflective	Skills of self- and mutual control at various stages of team activity, as well as proficiency in team and personal reflection techniques in the EIEE.	"Level of Expression and Focus of Reflection"

The application of the adapted methodology "Assessment of a Teenager's Relationship with the Class" by E. G. Rogov [87] (see Appendix F.1) is aimed at identifying the indicator of students' awareness of the significance of teamwork in the university's EIEE, as well as in academic and professional environments in general. This indicator (the formation of the *motivational component*) can be expressed at three levels:

- *Threshold level*: The individual perceives the team as an obstacle to their activities or relates to it neutrally (prevalence of an individualistic perception of the team) (from 0 to 4 points).
- *Basic level*: The individual perceives the team as a means of achieving individual goals; the team is viewed and evaluated in terms of its "usefulness" for the

individual (prevalence of a pragmatic perception type or an equal level of individualistic and collectivist perceptions of the team) (from 5 to 9 points).

- *Target level*: The individual perceives the team as an independent value; the problems of the team and its individual members come to the forefront, with interest in both the successes of each member and the team as a whole; there is a desire to contribute to the common cause (prevalence of a collectivistic perception of the team) (from 10 to 14 points).

The use of the methodology "Determining Indirect Group Cohesion" [103] was aimed at identifying the value-oriented unity of the team. In addition to calculating the overall team cohesion, the methodology allows for determining the specific percentage of selections of business, moral, and emotional qualities, in relation to which the team's value unity is formed. Following S. Krumm & J. Shulze [154], we believe that team values are universal regardless of the format of interaction. Therefore, the methodology was adopted without adaptation. The levels of formation of the *axiological component* with the results of the assessment according to this methodology in our work are as follows:

- *Threshold level:* The individual predominantly selects emotional qualities (cheerfulness, sociability, sincerity, etc.) as the main reference points in teamwork (from 0 to 1 selection of business qualities).
- *Basic level:* Along with the selection of emotional qualities, business (diligence, responsibility, etc.) and moral qualities (honesty, truthfulness, etc.) are present (from 2 to 3 selections of business qualities).
- *Target level:* The individual predominantly selects business qualities (4 or 5 selections of business qualities).

The diagnostic assessment of the formation of the *cognitive component* of TW competence was conducted using the author's test on the knowledge of the specifics of remote teamwork (see Appendix F.2). The test consists of ten closed-ended questions. The indicator of the formation of this component is the students' mastery of the system of knowledge about teams and teamwork in the EIEE. The levels of formation of this component are characterized as follows:

- *Threshold level:* The student has mastered the basic system of knowledge about team size, principles of setting a unified goal, and task distribution in the EIEE (0–3 correct answers).
- *Basic level:* The student has mastered not only basic knowledge about the team but also understands the principles of team goal-setting, types of online trackers for team work, and rules for team voting in the EIEE (4–7 correct answers).
- *Target level:* The student has fully mastered the system of knowledge for each stage of remote teamwork, including knowledge about roles, responsibilities, tools for monitoring teamwork, reflection methods, and feedback rules (8–10 correct answers).

The diagnostic assessment of the *operational component* was carried out using the method of expert evaluation by the teacher, based on the methodologies "Expert Diagnosis of Interaction in Small Groups" (by A. S. Chernyshov and S. V. Sarychev) and "Expert Evaluation of Interactive Coherence in Small Groups" (by S. V. Sarychev) [103]. In accordance with the boundaries of the study outlined in § 1.1, these methodologies were adapted for assessing the team actions and operations of individual students in the university's EIEE.

Furthermore, since each of the mentioned methodologies includes three factors (*the first* – hierarchy and variability of interaction, independence and initiative in interaction, engagement in interaction; *the second* – presence and quality of the plan, coherence and distribution of functions, correspondence of joint activities to the plan) with identical evaluation scales (from 1 to 7 points), we decided to combine the two methodologies into one assessment sheet (see Appendix F.3). It should be noted that, given the pedagogical focus of the study and the need to assess each student individually, the evaluation was conducted by a single teacher, rather than a group of experts. As a result, each student could receive between 7 and 42 points.

The levels of formation of the TW competence operational component are characterized as follows:

- *Threshold level:* The student does not strive to organize interaction or follow the plan, rarely ready to show initiative, tends to either take a leading position in interaction or distance themselves from the collective work (from 7 to 15 points).

- *Basic level:* The student strives to create a team activity plan, suggests ways of task distribution in the EIEE, regularly supports synchronizing activities and communication in the team (from 16 to 31 points).
- *Target level:* The student always participates in team goal-setting and strives to complete their work on time and in full, uses constructive methods to resolve intra-team contradictions online, actively participates in team reflection, and provides feedback to other team members; uses online trackers for teamwork and can adapt individual and team's activities when conditions change in the EIEE (from 32 to 42 points).

The formation of the *reflective component* is expressed in the students' predominant socio-reflective orientation, and in this study, it is determined using M. Grant's reflection questionnaire [47]. The questionnaire includes two scales (auto-reflection and socio-reflection), each with 10 questions, with assessment options from 1 to 6. Accordingly, the diagnosis results in two indicators—auto-reflection and socio-reflection—with scores ranging from 10 to 60 for each. Following the author of the methodology, we consider the medium level of self-reflection and high or above-average level of socio-reflection as most adapted for successful teamwork [ibid]. In our work, the assessment of the level of formation of the reflective component of TW competence in students will be based on the socio-reflective aspect.

Therefore, the criteria for the formation of the reflective component of TW competence can be described as follows:

- *Threshold level:* Low level of socio-reflection, low activity during the reflection stage of online team activity, brief or unconstructive feedback on the work of other team members in the EIEE, lack of reliance on the digital trace (from 6 to 30 points).
- *Basic level:* Average level of socio-reflection, participation in team activities aimed at mutual evaluation and recording agreements for the next iterations of team activities, with unexpressed initiative in organizing team discussions on the results, methods, and atmosphere in the team (from 31 to 50 points).
- *Target level:* High level of socio-reflection, clear orientation of the student towards joint discussions of work results and future plans, helping other team members identify the strengths and weaknesses of their activities in the team through reliance on

the digital trace in the EIEE, predominance of supportive feedback from the student at all stages of teamwork (from 51 to 60 points).

It should be noted that based on the competency-based approach to education, we believe that gaining insights into the motivational, value-oriented, and reflective spheres of personality is not only possible through studying students' self-reports but also through analyzing their activities. Therefore, the assessment of the formation of some aspects of the motivational, axiological, and reflective components of TW competence for its implementation in the EIEE (e.g., readiness to resume interaction in case of technical failures – for the motivational component (see Table A.1 in Appendix A)) was carried out during the diagnostic assessment of the operational component.

Thus, let us summarize the selected values for diagnosing the levels of formation of students' TW competence components in the university's EIEE in Table 2.5.

Table 2.5. – Range values for the assessment levels of the formation of students' TW competence components

Component of TW competence	**Levels of formation (in points)**		
	Threshold	Basic	Target
Motivational	0-4	5-9	10-14
Axiological	0-1	2-3	4-5
Cognitive	0-3	4-7	8-10
Operational	7-15	16-31	32-42
Reflective	6-30	31-50	51-60

The process of forming profiles of students' TW competence development in the university's EIEE based on the assessment of the formation of its five components is presented in the following section.

The diagnostic tools described ensure the acquisition of reliable information about the process and outcomes of developing students' TW competence in the university's EIEE.

2.2.3 Results of the Diagnostic Assessment of Teamwork Competence Development Level among Students in the University's Electronic Information and Educational Environment at the Initial Stage of the Formative Experiment

To determine the initial level of TW competence development among students in the CG and EG, a *diagnostic assessment* was conducted.

The results of the diagnostic assessment of the formation of the *motivational component*, based on the adapted methodology of E. I. Rogov "Assessment of a Teenager's Relationship with the Class," are presented in Table 2.6.

Table 2.6. – The diagnostic assessment results on the level of the students' TW competence motivational component formation

	Type of student's perception of the team														
	Collectivistic					Individualistic					Pragmatic				
EG	Σ	μ	σ	Mo	Me	Σ	μ	σ	Mo	Me	Σ	M	σ	Mo	Me
	138	7.3	2.2	7	7	91	4.8	2	4	5	37	1.9	1.1	1	2
CG	Σ	μ	σ	Mo	Me	Σ	μ	σ	Mo	Me	Σ	M	σ	Mo	Me
	137	7.2	1.6	7	7	97	5.1	1.8	4	5	31	1.6	0.8	2	2

As seen in Table 2.6, both groups show a trend toward a collectivist type of perception of the team. However, the average values on the collectivism scale are 7.3 and 7.2 points for the EG and CG, respectively. Considering the maximum value on this scale (14 points), we believe that targeted work on students' motivation for teamwork during the EW will contribute to an increase in the number of points (target value – from 10 to 14 points). The implementation of pedagogical conditions for developing the motivational component of TW competence in students ("Digital Skills," "Recursive Team Building" "Virtual Space," "Connection with Instructor," "Distributed Workload") will ensure a more significant gap between the collectivist and individualistic types of team perception, which will allow for the formation of a stable motivation for teamwork in the EIEE.

The diagnostic assessment of the formation of the *axiological component* using the methodology "Determining Indirect Group Cohesion" involved determining the percentage of choices made for business, moral, and emotional qualities by the group. Each student could choose the 5 qualities presented in the questionnaire. To determine the cohesion of the team, the original methodology required calculating the total number of chosen qualities by multiplying the number of subjects by 5, and then calculating the percentage of choices corresponding to emotional, business, and moral qualities (B, M, E) using the formula (1):

$$X_{(b,m,e)} = \frac{nx*5}{n*5} \times 100\% \quad (1)$$

If D > 55% or D + M > 60%, then the group cohesion is high. If M < 55%, the cohesion is average. If 35% < M < 55%, the cohesion is low.

The results of diagnosing the axiological component of students' TW competence in the EG and CG are presented in Table 2.7.

Table 2.7. – The diagnostic assessment results on the level of the students' TW competence axiological component formation

Category of qualities	**EG**		**CG**		**Team Cohesion**	
	% choices	μ points	% choices	μ points	EG	CG
Business	55%	2.7	57%	2.9	3 points (strong)	3 points (strong)
Moral	26%	1.3	24%	1.1		
Emotional	19%	0.9	19%	0.9		

As shown in Table 2.7, the highest percentage of selections in both groups is for business qualities, which ensures a high level of group cohesion. At the same time, the average score for business qualities relevant to teamwork is 2.7 for the EG and 2.9 for the CG. Since the processes of reflection and the development of personal qualities are inseparably connected psychological processes [109; 111], we believe that the

implementation of pedagogical conditions for the development of the axiological component of TW competence ("Team Reflection," "Interactive Peer Assessment"), as well as pedagogical conditions for the development of the reflective component ("Digital Footprint," "Prospective Reflection," "Evaluate & Discuss"), will help students to more frequently analyze the business qualities of their interaction partners and also strive to develop such personal qualities in themselves.

The diagnostic assessment of the formation of the *cognitive component* of students' TW competence was conducted based on the developed test for assessing knowledge about teams and teamwork (see Appendix F.2). According to the boundaries of the study outlined in § 1.1, the test includes questions mainly on the specifics of remote team interaction. The main results of the diagnostic assessment are presented in Table 2.8.

Table 2.8. – The diagnostic assessment results on the level of the students' TW competence cognitive component formation

Parameter	**EG**	**CG**
Mean	3.2	3.3
Standard deviation	1.8	1.6
Mode	4	2
Median	3	3

As shown in Table 2.8, the average scores on the test are low for both groups and correspond to the threshold level of formation of the cognitive component of TW competence for each group. The analysis of the questions that received the fewest correct answers revealed that, on average, students lack knowledge about team goal-setting methodologies, online teamwork trackers, and the principles of conflict-free team environments (see Table I.1 in Appendix I). The analysis indicated that during further experimental training, special attention should be given to formats, methods, and tools for presenting information about teams and teamwork in the EIEE to students through the implementation of pedagogical conditions such as "Advance Knowledge" and "Preliminary Self-Assessment".

The diagnostic assessment of the formation of the *operational component* was conducted after the first online session in the cycle of experimental training (see § 2.3).

It should be noted that six aspects of expert assessment reflect the level of development of team skills and abilities when students work in teams within the university's EIEE. This relationship is presented in Table J.1 in Appendix J.

The results of the diagnostic assessment of the level of formation of the operational component of TW competence in students, using the expert evaluation method by the instructor, are shown in Table 2.9.

Table 2.9. – The diagnostic assessment results on the level of the students' TW competence operational component formation

Diagnostics Parameters	**Values**									
	EG					**CG**				
	Σ	μ	σ	Mo	Me	Σ	M	Σ	Mo	Me
Hierarchy and variability	81	4.2	1.9	5	5	82	4.3	1.9	4	5
Independence and initiative	77	4.1	1.7	3	4	79	4.2	2	3	4
Engagement in interaction	87	4.6	1.6	5	5	89	4.7	1.9	5	5
Presence and quality of the plan	89	4.7	1.4	5	5	99	5.2	1.6	6	6
Coherence and distribution of functions	86	4.5	1.4	4	4	87	4.6	1.7	4	4
Correspondence of joint activities to the plan	105	5.5	1.3	6	6	104	5.5	1.3	4	6

As shown in Table 2.9, both groups are generally homogeneous in the level of formation of the operational component. The highest scores were achieved in the aspects of the presence and quality of the team plan, as well as the correspondence of joint activities to the plan. At the same time, during the training, particular attention should be given to developing the skills and abilities underlying the coherence and distribution of functions, independence and initiative, hierarchy and variability of team interaction through the implementation of pedagogical conditions such as "Synchronizing Meetings" and "Virtual Sandbox."

The diagnostic assessment of the formation of the *reflective component* of students' TW competence indicates generally high values for both auto-reflection and socio-reflection (see Figure 2.6).

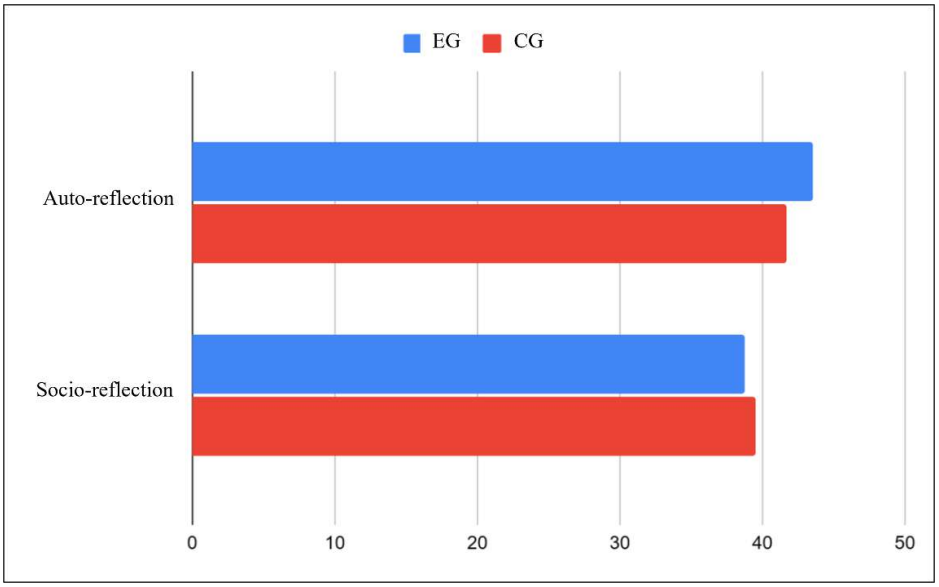

Figure 2.6. – The relationship between the two types of reflection in the EG and CG

At the same time, a slight predominance of auto-reflection has been noted (see Table 2.10). It is expected that during the experimental training, the sequential development of the reflective component with the implementation of pedagogical conditions such as "Prospective Reflection" and "Evaluate & Discuss" will result in a noticeable predominance of socio-reflection over auto-reflection. Socio-reflection involves the awareness and analysis not only of one's own behavior but also of the dynamics of interaction with other team members, which is essential for effective collaborative work.

Table 2.10. – The diagnostic assessment results on the level of the students' TW competence reflective component formation

Parameters	**Values**							
	EG				**CG**			
	M	σ	Mo	Me	M	Σ	Mo	Me
Auto-reflection	43,5	5,9	45	45	41,7	5,4	35	42
Socio-reflection	38,8	5,1	40	39,5	39,5	5,7	35	40

To process the results obtained during the diagnostic assessment, a comparison of the mean values between the two groups was performed. Since the distribution of values for each component follows a normal distribution (checked by the Shapiro-Wilk test) and the variances do not significantly differ (checked by the Levene's test), we can apply the Student's t-test to compare the mean values for each diagnostic methodology.

The results of the final statistical processing of the data are reflected in Table 2.11.

Table 2.11. – Results of the comparison of mean values between the EG and CG

TW Competence Component	**Diagnostic Tool**	**M**		**Σ**		**t**	
		EG	**CG**	**EG**	**CG**	**t**	**p**
Motivational	"Assessment of a Teenager's Relationship with the Class" (adaptation)	7.26	7.15	2.23	1.59	0.183	0.856
Axiological	"Determining Indirect Group Cohesion"	2.73	2.85	1.04	1.04	-0.339	0.737
Cognitive	Author's test for assessing knowledge about the team	3.15	3.3	1.8	1.55	-0.264	0.794
Operational	"Diagnostics of Interaction and Interactive Coherence in Small Groups" (adaptation)	28.42	27.1	7.42	6.63	0.587	0.561
Reflective	"Level of Expression and Focus of Reflection"	38	36.1	4.39	4.67	1.174	0.248

As shown in Table 2.11, *the differences in the mean values of the results between the two groups are statistically insignificant*. Therefore, at the beginning of the experimental training, the levels of formation of each component of TW competence among the students in the EG and CG are approximately equal.

Based on the data from Table 2.11, the level of TW competence development in students in the EG and CG was established. The quantitative results are shown in Figures 2.7 and 2.8 for the EG and CG, respectively.

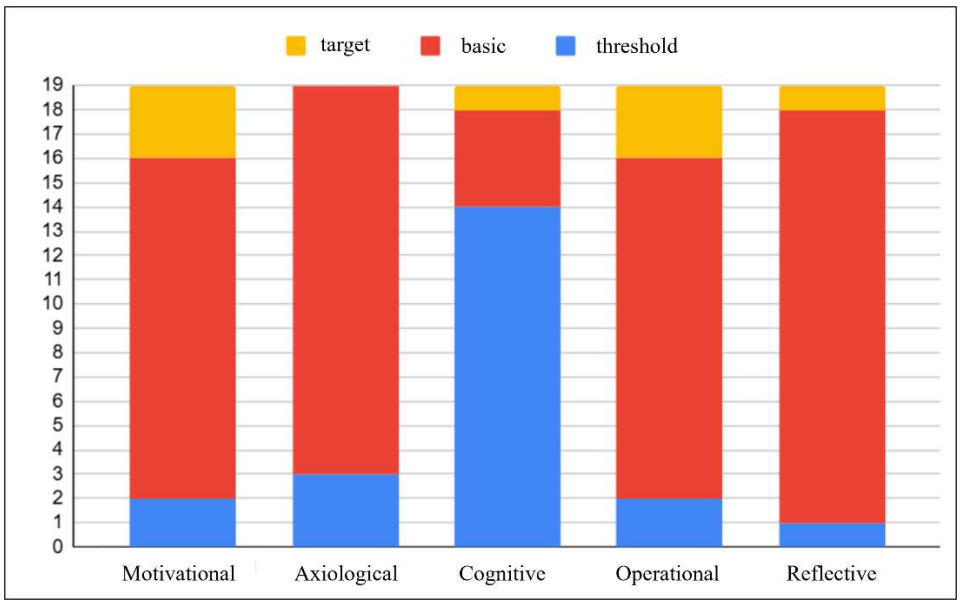

Figure 2.7. – Profile of the development of students' TW competence in the EG

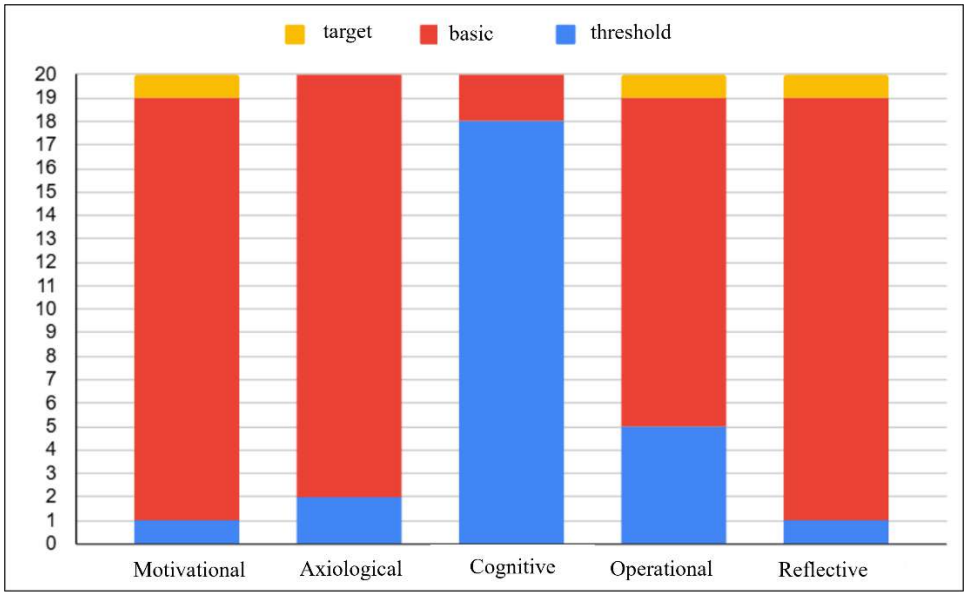

Figure 2.8. – Profile of the development of students' TW competence in the CG

As shown in Figures 2.7 and 2.8, the formation of all components of TW competence, except for the cognitive component, is generally at the basic level for students in both the EG and CG. In both groups, the majority of students (14 and 18 people, respectively) were diagnosed with the threshold level of the TW competence cognitive component development.

To create a visual five-point diagram of the profile of TW competence development in students for the entire group (see Figure 2.9), the average scores obtained by students

for each diagnostic methodology were converted into percentages (see Table K.1 in Appendix K).

Representing the level of TW competence development in students by group in percentages allows for the creation of a five-point radial diagram, which includes values from 0 to 100% for each component of competence separately for the EG and CG (see Figure 2.9).

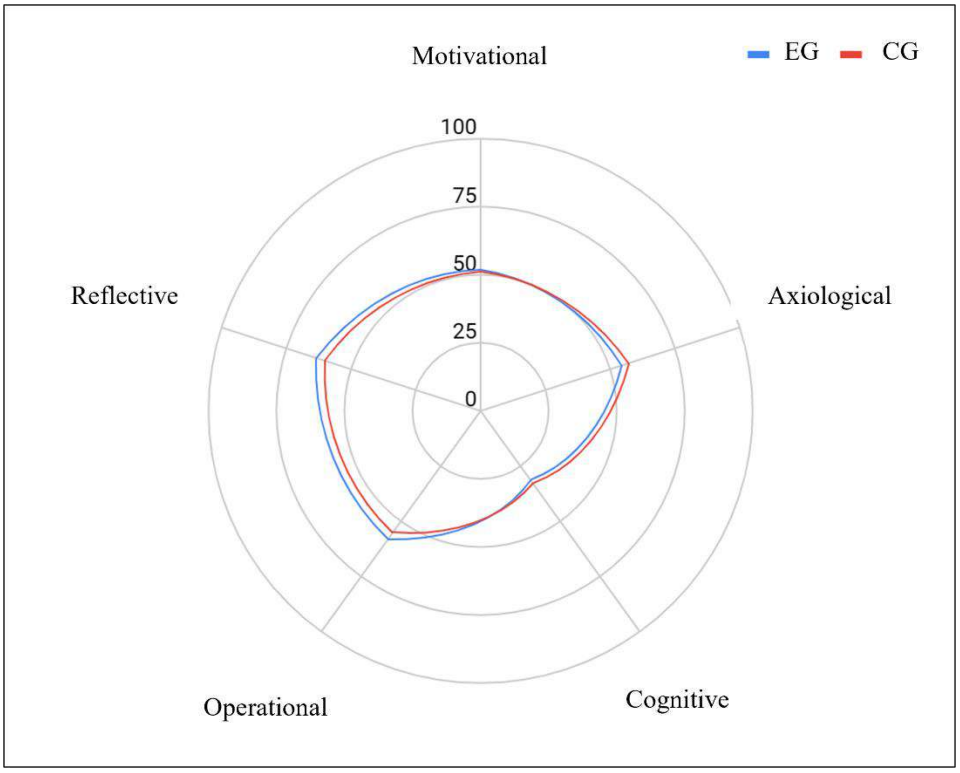

Figure 2.9. – Profiles of the development of students' TW competence in the EG and CG relative to the maximum possible values based on the results of the diagnostic assessment

Thus, the diagnostic assessment revealed that students in both groups demonstrated a medium level of motivation for teamwork.

Group cohesion was high in both the EG and CG. However, students did not always choose business qualities as their primary traits, and the level of formation of the axiological component of TW competence was determined to be at the basic level on average across both groups.

Knowledge about the specifics of teamwork in the EIEE among students in both groups is at the threshold level.

Within the operational component, high scores were assigned to students in both the EG and CG in aspects such as the presence and quality of the team plan, as well as the correspondence of joint activities to the plan. This allowed for the achievement of a basic level of formation of the operational component on average across the groups. However, insufficient formation of skills and abilities underlying the coherence and distribution of functions, independence and initiative, hierarchy and variability of online team interaction was identified.

Finally, despite the generally basic levels of the reflective component, a predominance of auto-reflection over socio-reflection was found in both groups. However, for successful teamwork, the latter is considered more significant.

2.3. Experimental Verification of Pedagogical Conditions for Developing Students' Teamwork Competence in the Microsoft Teams Electronic Information and Educational Environment (Formative Experiment)

Experimental training on the development of students' TW competence in the university's EIEE was implemented within the courses "Pedagogy and Psychology" for geology students (bachelor's, 4th year, EG) and "Pedagogy" for students studying in the field of "Psychology of Professional Activity" (bachelor's, 4th year, CG). A detailed description of the sample is provided in § 2.2.1.

The topics of the lessons for the EG included: "Main properties of attention and their consideration in education", "Sensation and perception", "Memory processes and conditions for effective memorization in learning", "Character and temperament", and others.

Among the topics for the CG students were, in particular: "Pedagogy of the great Russian educator K. D. Ushinsky", "Soviet pedagogy", "Family education", "Pedagogy of general care by I. P. Ivanov", and others.

Within the framework of experimental training, 8 online sessions were conducted in the Microsoft Teams EIEE for both the CG and EG. This resource was chosen due to its widespread use at SPbU, where the research was conducted. However, other EIEEs, distance learning systems, and online services can also be used for organizing remote

team interaction among students, such as Google Classroom, Canvas, TalentLMS, Teachbase, 360 Learning, and others [12, 119].

For CG students, the lessons were organized in the format of video conferences, where in the first part, the instructor presented theoretical material with the aid of a multimedia presentation, and in the second part, there was a Q&A session and team discussions of various situations in break-out rooms (separate virtual rooms for teams, which students move to from the main video conference without interrupting the online session). For example, in the second part of the online lesson on the topic "Pedagogy of the great Russian educator K. D. Ushinsky", students were asked to develop a national ideal for the 21st century in teams and present the results using multimedia tools: presentations, videos, digital diagrams, and drawings. At the end of the lesson, the results of the teamwork of CG students were evaluated according to various criteria: the thematic and stylistic integrity of the project, completeness of the topic, involvement of all team members in presenting the results, design of multimedia materials, etc. The evaluation of the results of teamwork was given to all team members collectively.

In addition to participating in the classroom (synchronous) online sessions, CG students also did preparatory homework. For this, the instructor sent the group assignments in advance (see Appendix L). While students were not limited in the opportunity to collaborate on the homework, they were not given specific instructions on how to divide the workload among themselves, whether to hold synchronizing meetings, use online teamwork trackers, etc.

For EG students, each lesson included stages of pedagogical interaction developed during the design of the pedagogical model: personal-motivational, target-component, informational, structural-functional, individual-psychological (see § 1.4). At each stage, the components of students' TW competence were sequentially developed, and the corresponding pedagogical conditions for the development of these components were implemented (see § 1.5).

In general, the lessons in both groups included team-oriented tasks and were aimed at developing students' TW competence in the university's EIEE. However, in the CG, the lessons were not structured in strict accordance with the stages of competence

development, and the pedagogical conditions provided in the structural-functional model were not implemented.

The further description of the experimental training process will mainly focus on the EG.

A typical lesson plan aimed at developing students' TW competence in the university's EIEE for the EG is provided in Table M.1 of Appendix M.

Let us examine each stage in detail *following this logic*: the name and goal of the stage, the components of TW competence developed in students, the pedagogical conditions implemented, the online resources used, the course of work, and the description of the main results.

1. Personal-motivational stage.

The *goal* of the stage is to develop students' personal motivation for teamwork in the EIEE.

Components of TW competence being developed: motivational.

Implemented pedagogical conditions: "Digital Skills", "Virtual Space", "Connection with Instructor", "Virtual Sandbox".

Online resources used: Microsoft Teams, Outlook Calendar, Polly, Google Forms, Microsoft Whiteboard, Miro.

Course of work and description of results. First, EG students were added to a closed channel in the Microsoft Teams EIEE. Welcome messages, information about the course’s goals and objectives, and basic instructions for using the platform were already posted in the channel.

In accordance with the pedagogical condition "Digital Skills," an online survey was posted in the channel before the first lesson, aimed at identifying students with insufficient experience using virtual boards, online teamwork trackers, and digital storage (see Figure N.1 in Appendix N). Depending on the results of the initial diagnostics, additional information, instructions, and screencasts for working with digital tools were sent to the students who had insufficient experience with online team tools, either in private messages or in the group chat (see Figure N.2).

After reviewing the instructions and additional materials on working with team online resources, students with limited experience were offered to move to a specially organized training space, where further instructions and exercises were prepared (e.g., creating a digital Kanban board). The creation of this training space is part of the implementation of the pedagogical condition "Virtual Sandbox". Although this condition was classified as part of the development of the operational component in the theoretical section, it is considered a continuation of the "Digital Skills" condition, so it can also be implemented during the personal-motivational stage of students' teamwork in the EIEE.

For training purposes, an online Microsoft Whiteboard was created in the EIEE, where students were asked to perform actions aimed at forming initial skills for working with online tools (see Figure N.3). The board was placed in a separate tab in the Microsoft Teams channel. Using access settings, it could be hidden from students who did not need additional training. Meanwhile, the instructor could see all updates on the board and provide feedback on the completion of training exercises, as well as support students in the online chat, which is provided for in the pedagogical condition "Connection with Instructor".

The schedule and topics for all 8 online lessons were posted in the shared Outlook online calendar, which allowed for the automatic start of video conferences at the scheduled time, as well as the setting of additional notifications a day and an hour before the lessons began (see Figure N.4). For each online lesson (in the video conference format), a separate shared virtual Microsoft Whiteboard was prepared, where team sectors for work in breakout rooms were pre-created. During specified parts of the lesson (e.g., at the beginning of the lesson, during the discussion of results, during synchronizing meetings), students could easily see the work sectors of other teams and the general sections of the board (e.g., evaluation criteria), which is part of the pedagogical condition "Virtual Space".

At the beginning of each online lesson, to activate students' motivation for teamwork and to form personal meaning, stimulating multimedia material and interactive tasks were presented to initiate student discussion on the topic of the lesson.

For example, Figure N.5 shows how the topic and goal of the lesson, as well as stimulating multimedia material, were placed on the virtual board to activate students' verbal and cognitive activity on the topic of "Attention". As seen in the figure, the interactive board (Microsoft Whiteboard, Miro, Google Jamboard) allows for organizing initial communicative interaction among students using online stickers, emojis, or reactions during the discussion of a problem situation. As a result, students' anxiety levels at the beginning of the online session may be reduced, as they do not have to immediately speak out loud. Furthermore, the use of digital tools for supporting teamwork allows team members and the instructor to assess the level of engagement of individual students in different stages of remote teamwork. This later facilitated the implementation of the pedagogical condition "Digital Footprint" during the individual-psychological stage of students' teamwork in the EIEE during team reflection, as digital data from various parts of the online board (stickers, reactions, annotations, etc.) can be used to evaluate the involvement of participants in the work.

To stimulate students' personal significance of the process and results of teamwork in the EIEE, at the beginning of the lesson, the instructor initiated a discussion where students expressed their opinions about the importance and applicability of various psychological and pedagogical knowledge in their professional activities or personal lives. These tasks were most often placed on the virtual board with prepared empty stickers, where students placed their ideas within 2-3 minutes (see Figure N.6). Afterward, the ideas were discussed synchronously. Further formation of personal meaning of teamwork was achieved by presenting specially organized educational tasks, which involved the synergistic combination of students' resources to complete the task.

2. Component-target stage.

The *goal* of the stage is to ensure that students set team goals and define the parameters for the results of teamwork in the EIEE.

TW competence components being developed: motivational, operational, cognitive.

Pedagogical conditions implemented: "Recursive Teambuilding", "Distributed Workload", "Connection with Instructor".

Online resources used: Microsoft Tasks, Asana, Microsoft Whiteboard.

Course of work and description of results. At the beginning of the component-target stage, the instructor organizes team-building activities for the students, which take place in the breakout rooms of each team. It should be noted that during the experimental training, students were randomly divided into teams (5–7 people), and the teams remained the same throughout the entire course (8 lessons). However, student teams can be divided differently, and the duration of working in one team can last for several lessons, after which new teams can be formed.

To implement the pedagogical condition "Recursive Teambuilding", such activities were present at the beginning of each lesson to maintain team cohesion and motivate students for teamwork in the EIEE. For example, in Figure N.7, there is a team sector of the Microsoft Whiteboard online board, where students were asked to write their favorite movies, books, activities, and places, and later the entire team tried to guess who wrote each sticker.

After the team-building activities, students, relying on evaluation criteria, set a common goal and then decomposed it into tasks, distributing the workload evenly among all team members with the instructor’s guidance, taking into account their abilities and interests.

On one hand, during this process, students relied on the evaluation criteria for the results of teamwork, which were placed in the general section of the virtual board for each lesson. On the other hand, all agreements, plans, and tasks were placed into the online teamwork tracker. In our case, Microsoft Tasks was chosen as it could be integrated into the Microsoft Teams channel as a separate tab. However, other teamwork trackers exist, such as Asana, Yougile, and Yandex Tracker.

An example of how students distributed tasks in one of the first lessons on the topic "Sense and Perception" is shown in Figure N.8. As seen in this figure, at the initial stage of experimental training, students formulated their tasks briefly and not very informatively. However, the instructor, joining the breakout rooms of the teams, gradually helped students formulate their tasks fully and meaningfully (e.g., using the SMART methodology).

The introduction of online teamwork trackers in the EIEE is a mandatory requirement for the implementation of the pedagogical condition "Distributed Workload". As a result, this helped to eliminate the phenomenon of social loafing and allowed for control over the even distribution of academic workload among the members of online teams.

These trackers assist the instructor in monitoring the remote team interaction of students and joining the virtual room of a specific team when difficulties are detected, which is an implementation of the pedagogical condition "Connection with Instructor". This approach helps develop the proper level of student autonomy, while ensuring that the instructor remains informed and ready to act as a facilitator of teamwork in the EIEE.

3. Informational stage.

The *goal* of the stage is to ensure that students master the system of knowledge about teams and teamwork in the EIEE.

TW competence components being developed: cognitive.

Pedagogical conditions implemented: "Advance Knowledge", "Preliminary Self-Assessment".

Online resources used: Microsoft Files, LearningApps.

Course of work and description of results. The system of knowledge about teams and team interaction was presented to students primarily in two ways: before the lesson began – in accordance with the pedagogical condition "Advance Knowledge", and during the lesson at certain stages.

In the first option, students were asked to read, watch, or listen to educational materials that revealed the specifics of online teamwork. Most often, the file storage built into Microsoft Teams was used, where instructions for organizing remote team interaction, team goal-setting technologies, manuals for conflict resolution tactics in teams, etc., were placed. The necessary information could also be shared via hyperlinks in the course channel or on the EIEE's start page (see Figure N.9).

In accordance with the pedagogical condition "Preliminary Self-Assessment", after familiarizing themselves with the theoretical material, students were asked to answer verification questions with automatic feedback, designed using the LearningApps

resource. The combination of mastering theoretical information and completing verification tasks formed the regular homework for each online lesson.

If certain educational material needed to be introduced (or repeated) during the online lesson, the instructor placed pre-prepared multimedia material on the general part of the virtual board. After students became familiar with the presented educational information, they were offered either questions for team discussion, self-assessment tasks, or training exercises to apply the newly acquired knowledge in practice.

Figure N.10 shows an example of placing a video on the virtual board about the process of goal setting using the SMART methodology. After watching this video, students formulated team goals based on the five components of SMART goals. The instructor moved between breakout rooms and, when necessary, helped adjust students' formulations.

4. Structural-functional stage.

The *goal* of the stage is to develop and improve students' teamwork skills and the ability to work in a team in the EIEE.

TW competence components being developed: operational.

Pedagogical conditions implemented: "Synchronizing Meetings", "Distributed Workload", "Virtual Space," "Connection with Instructor", and "Digital Footprint".

Online resources used: Microsoft Whiteboard, Microsoft Tasks.

Course of work and description of results. The development of students' teamwork skills was based on a four-stage model [9; 30].

In the first stage – *preliminary* – students were introduced to the educational task and performed actions according to a strictly defined template. For example, when developing the skill of distributing team tasks in an online tracker, students were first asked to familiarize themselves with a filled-in tracker and pay attention to the components of this digital resource (including the indication of responsible persons, deadlines for tasks, multiple categories of tasks, etc.). To highlight the necessary elements of the online tracker, the digital tools of Microsoft Whiteboard were used at this stage.

In the second stage – *analytical* – students were asked to distribute tasks in the online tracker according to the plan on the virtual board. At this stage, students still

worked within the framework of a simulated problem situation provided by the instructor. For example, on the virtual board, the instructor placed a text describing the plans of the student community to raise funds for charity, where some tasks were already completed, others were in progress, some had not been started, and the results of certain completed tasks were under review by the vice rector for educational work. Students were asked to categorize the tasks according to the conditions of the problem situation. The instructor joined the breakout rooms of the teams and helped students fill in all the tasks correctly, ensuring the inclusion of responsible people, deadlines, and lists of actions required for task completion.

In the third stage – *synthetic* – students themselves created tasks in the online teamwork tracker while working with the goals of a specific lesson. Students used one tool proposed by the instructor (Microsoft Tasks) and distributed tasks into pre-defined categories ("To be done", "In progress", "Completed", "Under review", "Returned for revision").

In the fourth stage – *automation*, which most often occurred in the subsequent lesson – students tried to create online trackers using other resources (e.g., Asana) and used digital templates in Microsoft Whiteboard to distribute tasks and monitor their progress (see Figure N.8). At this stage, the instructor’s control over students' actions was minimal.

The development of teamwork abilities occurred through gradually increasing the complexity of the educational situations set by the instructor. For example, to develop students' ability to initiate team brainstorming sessions and synchronizing meetings, the instructor distributed parts of the educational task among teams, requiring students to move between teams, clarify missing information, and then, upon returning to their breakout rooms, update their action plan.

For example, in the lesson on the topic "Temperament and the Nervous System: Considerations in Pedagogical Practice", one of the criteria for receiving the highest score was diagnosing the strength of the nervous system in at least two team members. In the first team's file storage, only theoretical information about the relationship between temperament and the type of nervous system was available. In the second team's

materials, explanations of three characteristics of the nervous system – strength, balance, and mobility – were given. The third team's materials included instructions for conducting a tapping test, which allowed (at least roughly) determining the strength of the nervous system. To complete the educational task, students had to synchronize independently. Each team decided who would be responsible for performing the task and directed those members to a synchronization online room. There, with the instructor's support, students exchanged the missing information and, upon returning to their breakout rooms, updated the overall activity plan. For instance, they chose two team members to conduct psychological diagnostics during a separate video conference or as part of their homework.

In the development of students' teamwork abilities in the EIEE, the pedagogical conditions "Virtual Space" and "Synchronizing Meetings" were implemented. At a certain point in the lesson, usually in the middle, students from different teams were brought together in a common synchronization room (see Figure N.11). This allowed the instructor to simultaneously update the activity plan for all teams.

To provide timely feedback during the students' actions and operations that formed the basis of team skills and abilities, the instructor also relied on the students' named digital cursors on the virtual board (see Figure N.12). Recording the individual digital trace allowed the instructor to give personalized feedback (usually in a private chat) and identify students who, for various reasons, were not fully participating in the remote team interaction.

At the end of the structural-functional stage, the results of the teams' work were presented, and the results were evaluated by the instructor. Most often, the results were presented as a digital canvas containing videos and audio files, images, hyperlinks, diagrams, etc. (see Figure N.13). Students who had performed part of the work in written (handwritten) form, such as the results of psychological diagnostics of other students, could upload a photo of their notes to the virtual board. It should be noted that Figure N.13 shows the general appearance of the virtual canvas where students presented the results of their teamwork. The actual content of the virtual canvas changed from lesson to lesson, so the purpose of the figure is not to reflect the detailed content.

Thus, during the structural-functional stage, students developed the skills and abilities that are part of the operational component of TW competence.

5. Individual-psychological.

The *goal* of the stage is to conduct team and personal reflection by students on the results of teamwork in the EIEE.

TW competence components being developed: reflective, axiological.

Pedagogical conditions implemented: "Prospective Reflection", "Evaluate & Discuss", "Interactive Peer Assessment", "Digital Footprint", "Team Reflection".

Online resources used: Microsoft Whiteboard, Google Forms.

Course of work and description of results. For conducting team reflection, pre-designed digital templates for team reflection were used on the virtual board in Microsoft Teams (see Figure N.14). The availability of built-in digital templates for team reflection allowed the use of pre-prepared graphically designed materials and reduced the preparation time for the instructor before the online session.

To implement the pedagogical condition "Prospective Reflection", the information summarizing the agreements made during the reflection process was copied to the virtual boards for subsequent lessons.

The instructor's involvement in the reflection process in team rooms was necessary to initiate additional discussions by students about the strengths and weaknesses of their team interaction, in order to implement the pedagogical condition "Evaluate & Discuss".

After the team reflection, the lesson was concluded. Personal reflection was carried out by students through filling out interactive reflective sheets on Google Forms.

Thus, during the experimental training, the complex of pedagogical conditions for developing students' TW competence in the university's EIEE was tested.

2.4. Analysis of the Students' Teamwork Competence Development Level at the Final Stage of the Formative Experiment (Control Assessment)

To analyze the effectiveness of the experimental training and to evaluate the dynamics of the TW competence components development in students of the EG and CG, a control assessment was conducted.

The same methodologies for assessing competence components formation were used in the control assessment as in the diagnostic assessment (see § 2.2.2 of this chapter).

The dynamics of the **motivational component** development in EG students after the experimental training is shown in Figure 2.10.

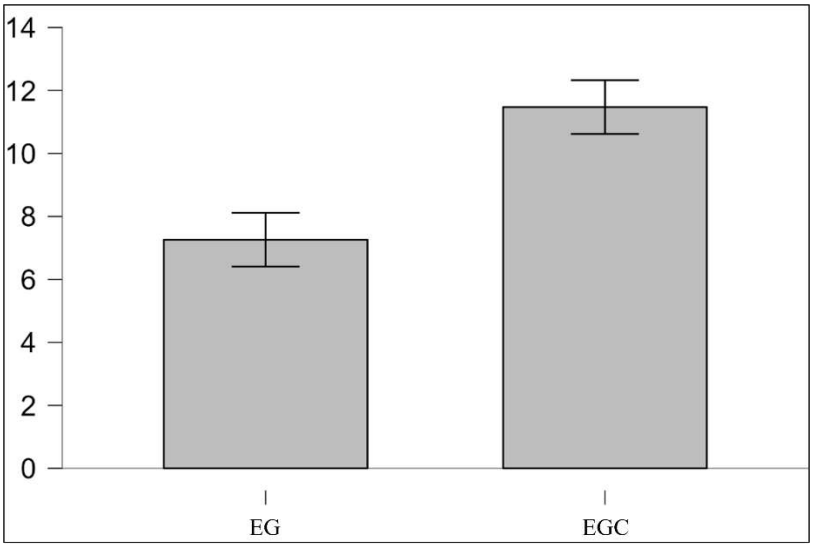

Figure 2.10. – Box plot of the results for EG at the beginning (EG) and the end (EGC) of the experiment

As shown in Figure 2.10, the average score on the collectivist perception scale of the team at the end of the experiment in the EG was 11.4 points, with a minimum value of 8 points and a maximum of 14 points, which corresponds to the target level of formation of this component.

19 out of 20 EG students indicated that they like teams where everyone is interested in improving the overall results. Additionally, all EG students responded that they value the team's overall success most, especially when they contributed to it. We believe that the formation of such a team perception and positive motivation for teamwork was supported by the implementation of the pedagogical conditions "Distributed Workload" and "Team Reflection".

At the same time, 10 EG students mentioned that they prefer not to be disturbed while performing tasks in a team, indicating the need for further development of educational scenarios aimed at fostering cross-functional interaction skills.

The analysis of the dynamics of the motivational component development in CG students using the Student's t-test revealed that, despite a slight increase in the average score (from 7.2 to 7.6) and a decrease in the standard deviation (from 1.6 to 1.2) in the control assessment results, there were no statistically significant differences between the diagnostic and control assessments ($t = -1$; $p = 0.165$). Therefore, the level of formation of the motivational component of TW competence in CG students did not change, but a trend toward its increase was observed.

In the control assessment of the level of formation of the **axiological component** of TW competence, it was found that all EG students showed an increase in the number of choices of business (team-relevant) personality traits (see Figure 2.11). Among the most frequent choices were: *organization* (15 choices), *diligence* (13 choices), and *responsibility* (10 choices). In comparison, at the diagnostic stage, the most popular emotional qualities were *friendliness* (11 choices), *cheerfulness* (9 choices), and *neatness* (9 choices).

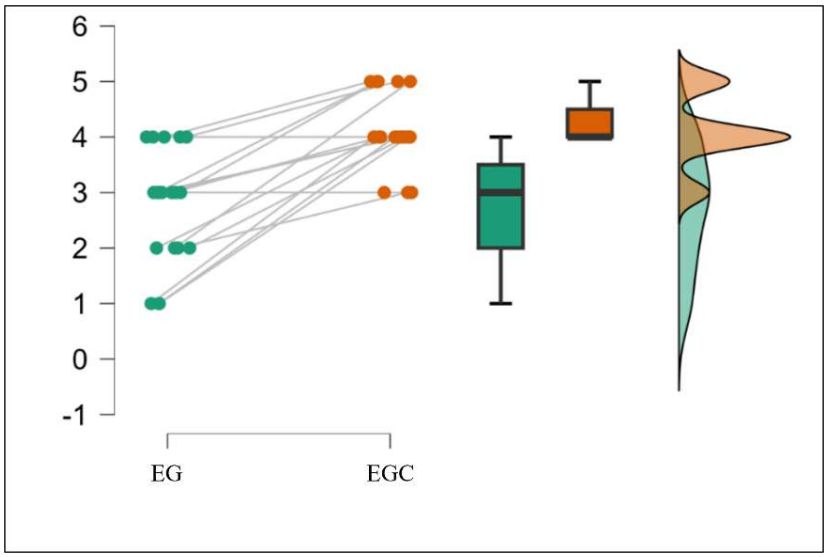

Figure 2.11. – Cloud plot for the results of the diagnostic (EG) and control (EGC) assessments of the TW competence axiological component formation level in EG students

In Figure 2.11, the lines between the green (diagnostic assessment) and orange (control assessment) points reflect the individual changes in the level of formation of the axiological component in students from the EG before and after the training. The shift in

the points and the shape of the distribution indicate an overall increase in the level of the axiological component formation. The orange area on the right shows a more pronounced concentration of values at higher scores compared to the green area on the left. The boxplot in the center of the figure visualizes the main characteristics of the data distribution – median, interquartile range, and score range. The orange "box" is positioned higher than the green one, indicating an increase in the average and median values of the level of the axiological component formation at the end of the experiment.

We believe that the focus of EG students on team-relevant personality traits was supported by the implementation of online teamwork trackers as part of the pedagogical condition "Distributed Workload", which allowed for the assessment of each student's contribution to the overall result during team reflection. Additionally, by the end of the experimental training, EG students began to identify significantly more team-relevant personality traits in each other compared to the start of the experiment. The increase in socio-reflection among students was facilitated by the implementation of the pedagogical conditions "Evaluate & Discuss" and "Prospective Reflection".

In general, the average level of the axiological component formation in EG students increased from 2.73 in the diagnostic assessment to 4.2 in the control assessment, reaching the target level. The statistical significance of the results was confirmed by the Student’s t-test ($t = -5.344$, $p < 0.001$).

For the CG, positive dynamics are less pronounced, and three cases of regression were observed, the reasons for which are difficult to determine given the small sample size (see Figure 2.12).

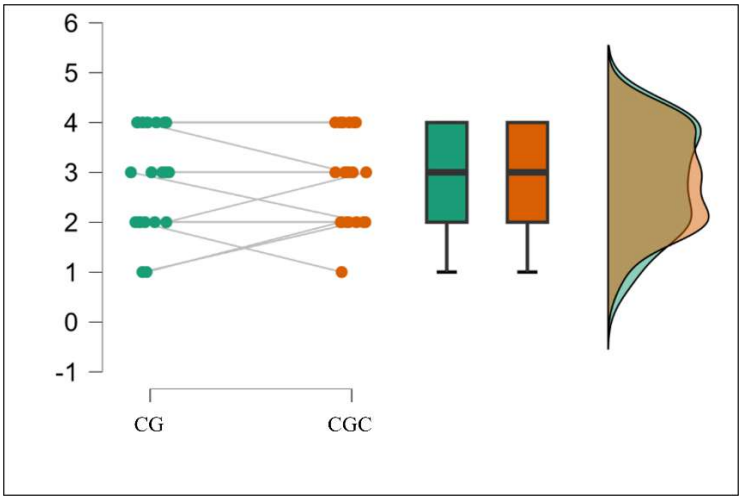

Figure 2.12. – Cloud plot for the results of the diagnostic (CG) and control (CGC) assessments of the TW competence axiological component formation level in CG students

Based on the distribution of points in Figure 2.12, it can be established that in the CG, significant changes between the diagnostic (green color) and control (orange color) assessments are observed less frequently than in the EG. The orange and green "boxes" on the graph for the CG are almost unchanged, indicating the absence of a significant increase in the scores. The shape and position of the distribution clouds almost coincide, which points to minor changes in the axiological component of CG students.

An increase in the scores for the formation of the **cognitive component** was noted in both the EG and the CG. At the same time, the average score for EG students in the control assessment was 9 points, while the average score for CG students was 4 points (see Figure 2.13).

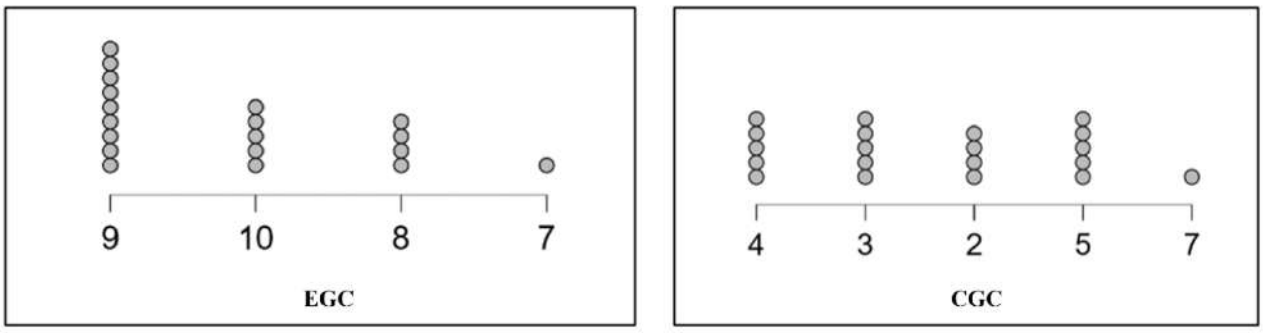

Figure 2.13. – Comparison of the scores of EG students (EGC) and CG students (CGC) on the test for knowledge about teams and teamwork at the end of the experiment

To confirm the statistical significance of the differences in the development of the cognitive component of TW competence between the two groups, the Student's t-test was applied to the obtained data (see Table 2.12).

Table 2.12. – Comparison of the mean values of EG and CG at the beginning and end of the experiment regarding the level of the cognitive component formation

Group	**t**	**p-value**	**α**	**Conclusion**
EG	-13.472	<.001	0.05	The levels of development of the cognitive component at the beginning and end of the experimental training are statistically significantly different in both the EG and CG
CG	-3.327	0.002	0.05	

As shown in Table 2.12, the statistically significant increase in test scores for knowledge about teams and team interaction in both the EG and CG was facilitated by the placement of digital educational materials in the EIEE (in our case, the start page of teams in Microsoft Teams and Microsoft Drive). CG students also had access to online articles and digital documents where they could study the specifics of remote team interaction. However, due to the lack of a specially organized EIEE space for applying the acquired knowledge in practice, the level of knowledge retention among CG students was significantly lower compared to the EG.

Therefore, the significant increase in the EG, as well as the lower values of standard deviation, mean square deviation, and the coefficient of variation (see Table 2.13), were achieved through the implementation of the pedagogical conditions "Advance Knowledge" and "Preliminary Self-Assessment".

Table 2.13. – Descriptive statistics of the results of the control assessment for the level of the cognitive component development in EG and CG

Group	**M**	**SD**	**SE**	**Coefficient of variation**
EG	8.947	0.848	0.195	0.095
CG	3.750	1.333	0.298	0.355

Thus, the process of developing the cognitive component of TW competence in EG students progresses significantly faster than in CG students.

The average values for the level of formation of the TW competence **operational component** in EG students increased from 28.4 to 39.5 points. The most significant dynamics in the development of team skills and competencies were observed in the aspects of *hierarchy and variability of interaction, independence and initiative in interaction, and the coherence and distribution of functions* (see Figure 2.14).

In EG students, the development of the following skills was noted: identifying team roles according to the interests and abilities of participants, initiating brainstorming sessions, conducting synchronizing meetings, determining the scope of individual tasks, and engaging in cross-functional interaction.

During the experimental training, there was an improvement in the skills of task distribution and assignment of responsibilities in online trackers, creating digital "roadmaps", using digital visualization tools, and planning work in the online calendar.

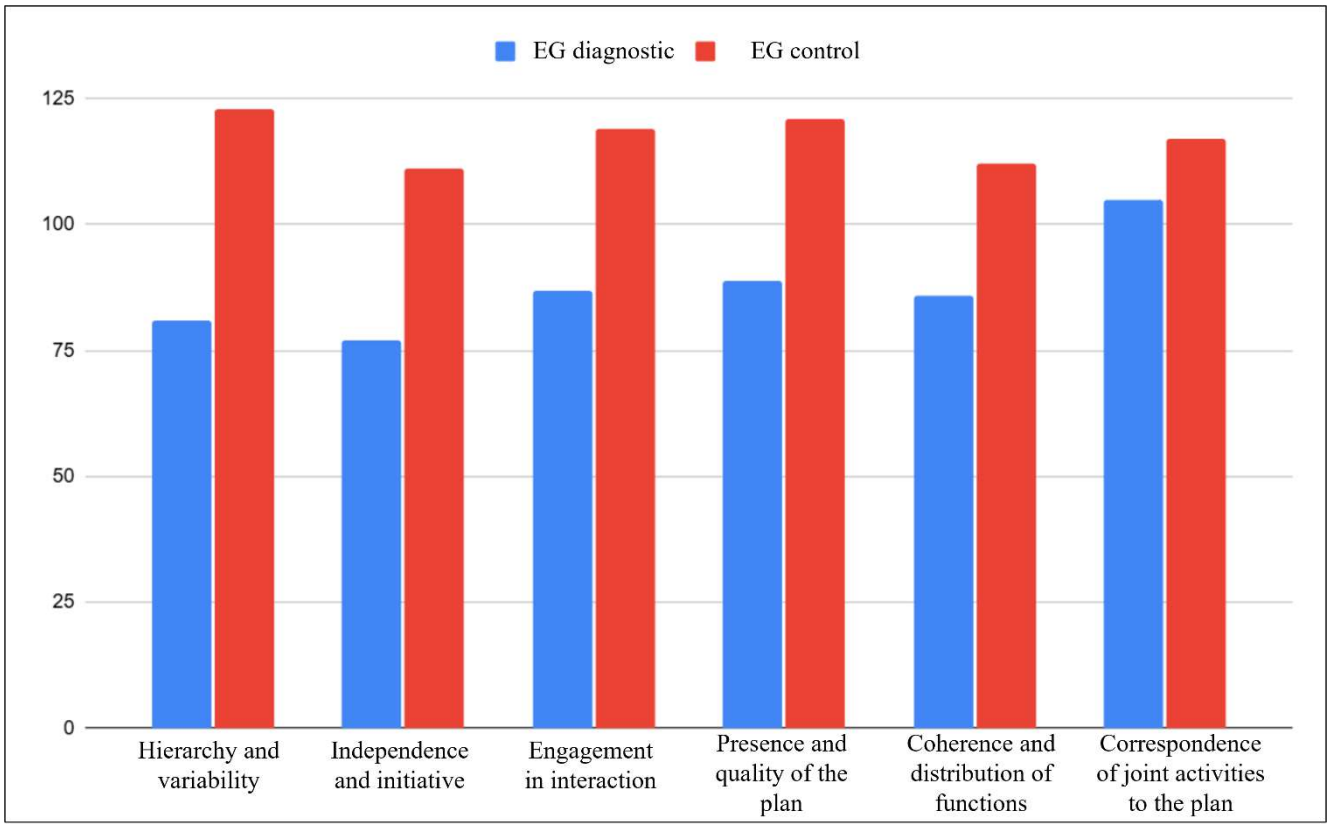

Figure 2.14. – The total scores obtained by EG students for each aspect of the expert evaluation of the level of the activity component formation

As shown in Table 2.14, the average value of the level of the activity component formation in CG students increased slightly (from 27.1 to 27.4 points).

Table 2.14. – The average values of the level of the TW competence activity component formation in EG and CG students at the end of the experiment

Descriptive statistics	**EG**	**CG**
Existing	19	20
Mean	39.579	27.350
Standard deviation	2.795	6.260
Minimum	35	17
Maximum	45	37

The statistical significance of the above differences between EG and CG students was confirmed through the application of the Student's t-test ($t = 7.804$, $p < 0.001$).

The results of the diagnostic assessment of the **reflective component** development level in students from both groups are shown in Figure 2.15.

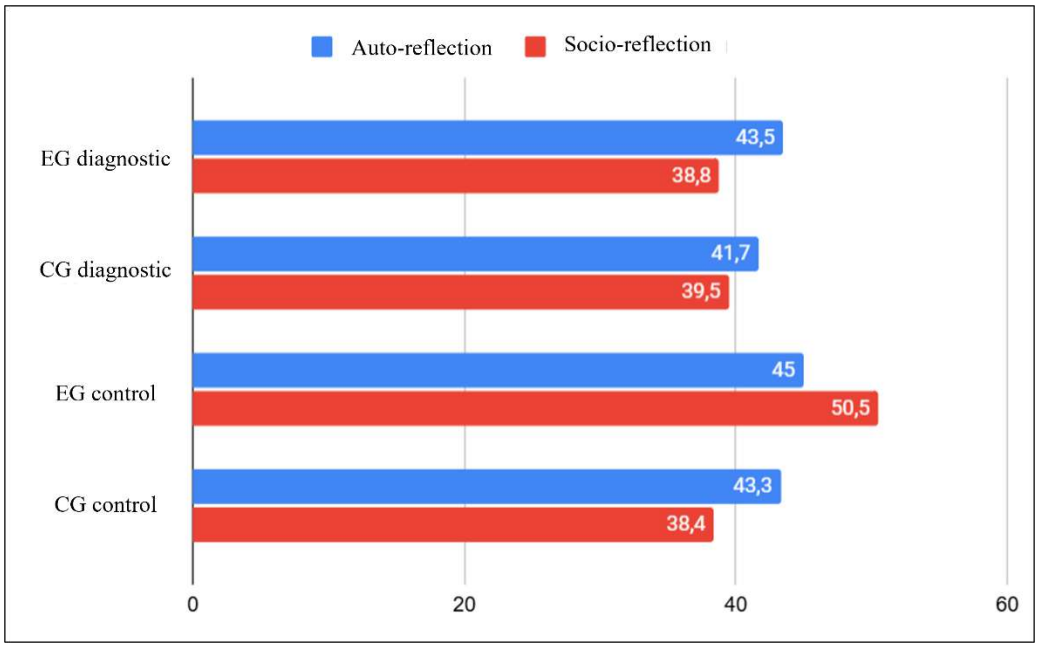

Figure 2.15. – Comparison of the dynamics of the TW competence reflective component development in students

As seen in Figure 2.15, the level of socio-reflection in EG students increased by almost 12 points compared to the results of the diagnostic assessment. At the same time, the levels of auto-reflection and socio-reflection in CG students remained at the same level.

The increase in the EG scores was achieved through the implementation of the pedagogical conditions "Digital Footprint", "Prospective Reflection", and "Evaluate & Discuss". However, it should be noted that on average the level of formation of the reflective component of TW competence in EG students did not reach the target value. This indicates the need for further research into the specifics of team reflection among students in the university's EIEE.

Overall, by the end of the experimental training, the levels of development of each component of TW competence in EG and CG students changed as follows (see Figures O.1 and O.2 in Appendix O):

- **Motivational component**: EG – The number of students with the target level increased from 3 to 14; CG – The number of students with the target level increased from 1 to 2.
- **Axiological component**: EG – The number of students with the target level increased from 0 to 15; CG – The number of students with the target level increased from 0 to 3, and the number of students at the threshold level decreased from 2 to 1.
- **Cognitive component**: EG – The number of students with the target level increased from 1 to 18; CG – The number of students with the target level increased from 0 to 2, and the number of students at the basic level increased from 2 to 12.
- **Activity component**: EG – The number of students with the target level increased from 3 to 16; CG – The number of students with the target level increased from 1 to 4.
- **Reflective component**: EG – The number of students with the target level increased from 1 to 13; CG – The number of students with the target level increased from 1 to 4.

To compare the independent samples of EG and CG, the Student's t-test was applied again during the analysis of the diagnostic and control assessment data. The results of the statistical test are reflected in Table 2.15.

Table 2.15. – Results of the mean values comparison between EG and CG at the end of the diagnostic (DA) and control (CA) assessments

Statistics	**Competence Component**	**DA**		**CA**	
		t	**p**	**t**	**p**
Student's t-test	Motivational	0.183	0.856	5.448	<.001
	Axiological	-0.339	0.737	4.831	<.001
	Cognitive	-0.264	0.794	14.441	<.001
	Operational	0.587	0.561	7.804	<.001
	Reflective	1.174	0.248	8.318	<.001
Level of statistical significance α		0.05			
Interpretation of results		H_0 is accepted, there are no statistically significant differences between the groups		H_0 is rejected, the student groups statistically significantly differ	

As shown in Table 2.15, the levels of TW competence components formation in EG and CG students based on the results of the diagnostic assessment statistically significantly differ.

To recreate the five-point diagram of the profile of TW competence development for students on average per group, as was done during the diagnostic assessment stage, the average scores obtained by students for each diagnostic methodology were converted into percentages (see Table K.2 in Appendix K).

Figure 2.16 displays the diagram of the TW competence development dynamics in students within the university's EIEE at the end of the experimental training.

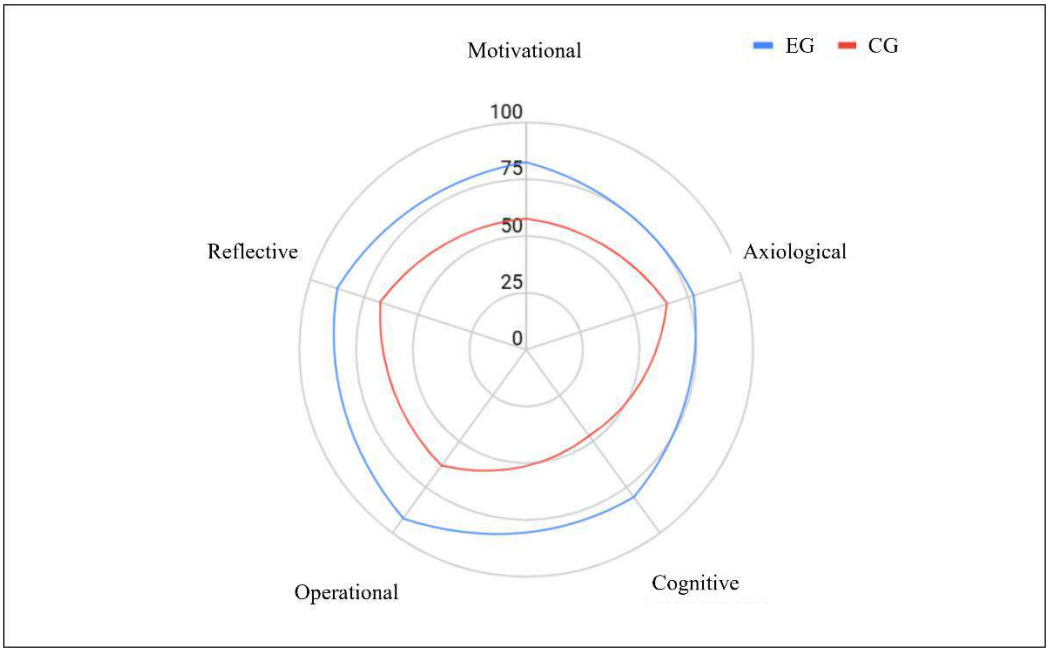

Figure 2.16. –TW competence development dynamics in students in the university's EIEE (control assessment)

As shown in Figure 2.16, the levels of formation of all components of TW competence have increased in both the EG and CG compared to the diagnostic assessment (see Figure 2.9). However, the values for the EG significantly exceed those for the CG.

Thus, after conducting the formative stage of the pedagogical experiment, the following conclusions were made:

1. There was detected a noticeable difference in the levels of formation of all TW competence components between the experimental and control groups. The average increase for the experimental group was 32.2% across all components, while the increase for the control group was only 8.8%.

2. Based on the assessment of the statistical significance in the TW competence development levels between students, it can be concluded that the experimental training structured according to the developed pedagogical conditions proved effective.

Considering the confirmed effectiveness of the developed model, methodological recommendations were prepared for the academic and teaching staff of universities on organizing remote team interaction among students in the university's EIEE (see Appendix P).

FINDINGS OF CHAPTER 2

As a result of the experimental work on implementing the structural-functional model for the development of TW competence in students within the university's EIEE, the following findings were made:

1. The implementation of specially organized methods, tools, and technologies for developing TW competence in students within the university's EIEE is in demand. The majority of respondents in the stating phase of the experiment (both teachers and students) consider the formation of TW competence to be an essential component of a modern professional profile (90% of teachers and 76.6% of students, respectively). However, half of the students (42.6%) reported that they lack experience in remote team interaction during their higher education studies.

2. The results of the diagnostic assessment at the initial stage of the formative experiment showed that the majority of third- and fourth-year students had not yet reached the target level of TW competence. The least developed component among both EG and CG students was the cognitive component.

3. During the formative experiment, pedagogical conditions for developing TW competence in the university's EIEE were sequentially implemented in the EG according to the stages of team activity systemogenesis and the characteristics of the development of each competence component in CMC. For CG students, lessons were conducted in the traditional video conference format, which included team activities.

4. The results of the control assessment showed that the dynamics of the development of TW competence in the two groups statistically significantly differ. After implementing the pedagogical conditions for developing TW competence in the EIEE during experimental training, the number of EG students with target levels of competence increased from 3 to 15, while in the CG, it increased from 2 to 4 students.

Thus, during the experimental work, the effectiveness of the developed pedagogical conditions was assessed, key conclusions were drawn, and methodological recommendations for instructors were developed.

The main focus during the pedagogical experiment described in this chapter was:

a) The sequential implementation of stages of TW competence development in students within the university's EIEE according to the concept of the psychological structure of activity systemogenesis.

b) The introduction of a set of developed pedagogical conditions at each of these stages to the educational process.

c) The identification of the most appropriate ICT tools that enable the organization of effective remote team interaction among students.

The diagnostic data obtained indicate the effectiveness of the developed structural-functional model for developing TW competence in students within the university's EIEE.

CONCLUSION

The study found that the development of students' teamwork competence using the electronic information and educational environment of the university represents a complex pedagogical issue and requires further research.

The relevance of solving this problem is linked to the growing need for training specialists capable of working effectively in distributed teams. The development of students' teamwork competence, for its subsequent implementation both offline and online, enhances their competitiveness in the labor market and promotes the development of interpersonal and professional interaction skills in modern conditions.

The scientific value of the work lies in clarifying the structure of students' teamwork competence in the modern world and in systematizing the psychological and pedagogical characteristics of its online development. Adding specific skills and abilities for working in a digital environment to the traditional components of the competence has enriched the theoretical foundation of research in the field of digital didactics.

The results of the study are of practical significance for educators working in the context of educational digitalization. The developed structural-functional model for the development of students' teamwork competence in the university's electronic information and educational environment enables the effective and purposeful integration of modern information and communication technologies into the educational process. The methodological recommendations based on the results of the experiment describe the stages of developing the structure of remote team activity and reveal the pedagogical conditions for the effectiveness of this process.

Among the recommendations for the practical application of the research results are: the testing of the model for developing teamwork competence within various disciplines, implemented fully or partially in a remote format; the adaptation of the content of academic disciplines that aim to develop students' teamwork competence in accordance with the stages of competence development described in the study; the gradual implementation of the proposed pedagogical conditions to determine the most optimal composition for specific student groups or programs; the enrichment of the

university's electronic information and educational environment with online resources as presented in the description of the experimental training.

Thus, the research was completed in full accordance with the tasks and goal set. The results of the empirical study confirmed the hypothesis.

The prospects for further research include the implementation of the developed structural-functional model for various student training programs, the modification and testing of diagnostic tools for more accurate and less labor-intensive assessment of teamwork competence, a detailed description of the technological component of the electronic information and educational environment for student teamwork, and the development of educational technology for student teamwork in the context of remote and blended learning.

LIST OF ABBREVIATIONS AND CONVENTIONS

1. ICTs – Information and Communication Technologies.
2. IBA – Information Basis of Activity.
3. CMC – Computer-Mediated Communication.
4. TW Competence – Teamwork Competence.
5. NAWA – Normatively Approved Way of Activity.
6. EW – Experimental Work.
7. RSCI – Russian Science Citation Index.
8. EIEE – Electronic Information and Educational Environment.
9. ERIC – Education Resources Information Center.

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APPENDIX A

The Structure of Students' Teamwork Competence at the Modern Stage of Education Digitalization

Table A.1. – The components of the TW competence of students at the modern stage of education digitalization, their content and indicators of formation

TW competence component	**Component content**	**Indicator of formation**	**Necessary additions for its implementation in a digital environment**
Motivational	Sustainable motivation for teamwork as a means of self-improvement; a developed personal meaning of teamwork, the ability to set collective goals and distribute tasks effectively.	Actively participates in team goal-setting, defines their role and tasks based on the cooperation strategy to achieve the set goal, and encourages other participants to engage actively in teamwork.	Motivation for teamwork in an online format; willingness to resume interaction in case of technical issues; quick and active engagement in online team communication.
Axiological	A value-based and meaningful attitude towards interaction partners, willingness for mutual learning and development, and the formation of team-significant personal qualities (diligence, organization, responsiveness, etc.).	When fulfilling their role in teamwork, they take into account the behavior and interests of other participants, recognize the value of team interaction in achieving socially and personally significant goals, are able to request and provide developmental feedback, and offer support to other team members.	Persistence in mastering ict for remote team interaction; recognized value of using ict in the teamwork process; utilization of the digital footprint to provide team members with well-founded developmental feedback.

Cognitive	Established knowledge of the team as a social entity, its structure, the specifics of the overall team goal, as well as the planning and organization of joint activities; the ability to find, store, and share subject-specific knowledge within the team.	Exchanges information, knowledge, and experience with team members, considering the specifics of team activities; builds interaction based on the specifics of team goal-setting and role distribution; engages in mutual exchange of task-relevant information; adheres to the rules of teamwork.	Knowledge of the specifics of distributed team activities at each of its stages; knowledge of key online teamwork trackers and the specifics of their interfaces; knowledge of conflict resolution strategies in online teams; knowledge of information visualization specifics, considering cognitive load factors; knowledge of methods for structuring information in digital knowledge bases.
Operational	Mastery of teamwork experience, including techniques of dialogic communication, task distribution and delegation, planning and discussing activities, updating and adjusting the team plan, and other related skills.	Builds productive team interaction while considering the potential consequences of personal actions in achieving the team goal; monitors and evaluates each stage, and designs future cycles of team interaction based on previous team experience.	Skills in using virtual interactive whiteboard tools; ability to monitor team activities using online trackers; skill in preparing and conducting online voting; ability to use digital nonverbal reaction tools; ability to conduct and participate in team online reflection; skill in organizing and presenting team activity results in a digital environment.
Reflective	Proficiency in self-control, self-assessment, and self-analysis skills; ability to provide feedback to other team members; developed capacity for both auto-reflection and socio-reflection (with a predominance of the latter).	Evaluates their own ideas and actions, as well as the ideas and contributions of other team members, to achieve the set team goal; analyzes the result and suggests improvements.	Ability to search for and analyze digital footprints of online team participants; ability to forecast future work based on reflection in a digital environment; development of team-significant personal qualities through reflection in a digital environment.

APPENDIX B

Psychological and Pedagogical Characteristics of the Development of Students' Teamwork Competence in the Electronic Information and Educational Environment of a University

1. Characteristics of Motivational Component Development [133; 158; 162; 134]:

1. The motivation to participate in online teamwork decreases as students face more difficulties in using digital resources.
2. The stages of team formation in an online environment are recursive rather than linear: team-building activities are not only concentrated at the beginning but are distributed throughout the entire teamwork process.
3. The motivation of individual students depends on the composition of the online team and increases with the possibility of switching teams, reviewing the results of other teams, and communicating with other participants.
4. Students' motivation for online team interaction increases with timely feedback from the instructor.
5. When setting a team goal and decomposing it, the predominant tactic in online teams is conflict avoidance.

2. Characteristics of Axiological Component Development [162; 123; 124]:

1. The level of trust in online teams is higher when participants are more familiar with each other’s strengths and weaknesses.
2. Team cohesion improves when there is an opportunity to evaluate each participant’s contribution to the overall task.
3. The relative anonymity of each participant in a virtual environment may contribute to the phenomenon of "social loafing."
4. Online team members tend to feel uncertain when assessing the behavior and intentions of others due to the lack of physical contact and limited ability to interpret nonverbal communication cues, leading to a decreased sense of psychological safety.

3. Characteristics of Cognitive Component Development [145; 167; 142]:

1. There is a limited cognitive capacity for processing educational information through visual and auditory perception within a given time frame.

2. The process of knowledge acquisition in an online environment is predominantly inductive, focusing on the analysis and synthesis of information from various sources.

3. Information about students' current knowledge level in a subject area, obtained before the start of an online class, contributes to more effective learning during synchronous online interaction.

4. Characteristics of Operational Component Development [165; 130; 164]:

1. In an online environment, students tend to be more focused on the task itself rather than on interaction.

2. In the absence of physical contact, members of remote teams experience a higher level of uncertainty in their actions.

3. The speed of skill improvement in a subject area within an online environment depends on the level of digital competency of each individual student.

5. Characteristics of Reflective Component Development [159; 155]:

1. The success of students’ reflective and evaluative actions depends on the completeness of the digital footprint of the online team available for analysis.

2. Mutual positive feedback among online team members during reflection has a greater positive effect on motivation and interest in online teamwork than peer assessment.

3. In peer evaluation of teamwork results in an online environment, the positive effect on students is greater when feedback comments are more detailed and substantive.

APPENDIX C

Results of a Pilot Study on the Relevance Assessment of Psychological and Pedagogical Characteristics in the Development of Students' Teamwork Competence in the Electronic Information and Educational Environment of a University

Table C.1. – Mean and median values of the psychological and pedagogical characteristics relevance in the development of students' TW competence in the EIEE of a university (based on the results of a pilot study on a sample of Russian students)

TW competence component	**Characteristics of component development in the EIEE**	**Question (statement)**	**Code**	**μ**	**Me**
Motivational	The dependence of a student's motivation to participate in an online team on the level of their digital skills development.	If I encounter technical difficulties during remote learning, my motivation to work in an online team decreases.	QM1	5,64	5
	The recursive nature of team-building activities.	I quickly lose my sense of belonging to an online team without regular online meetings and team-building activities.	QM2	5,85	6
	The dependence of motivation to participate in teamwork on the composition of the online team and the openness of the virtual space.	I feel more confident if I can choose the members of my online team and observe the progress and results of other teams' work.	QM3	7,55	8
	Students' motivation for online team interaction increases with prompt feedback from the instructor.	I feel more confident when I receive regular feedback from the instructor while working in online teams.	QM4	8,48	10

	When setting a team goal, members of online teams tend to avoid conflicts.	I will not overly insist on my point of view when discussing ideas or an action plan in an online team, striving to avoid unnecessary conflicts in the process of remote learning.	QM5	5,91	6
Axiological	The level of trust in online teams is higher when participants are more familiar with each other's strengths and weaknesses.	I am more likely to trust an online team partner if I learn about their strengths and weaknesses.	QA1	7,45	8
	Team cohesion increases when there is an opportunity to evaluate each participant's contribution to the overall task.	I feel a greater sense of personal significance when working in an online team if not only the overall team result is evaluated but also my individual contribution to achieving learning goals.	QA2	7,03	8
	The relative anonymity of each participant in the virtual environment may contribute to the occurrence of social loafing.	When working in an online team, I sometimes take advantage of the relative anonymity of the online environment and seize the opportunity to receive credit for the overall team result while reducing my efforts.	QA3	3,79	3
	A decrease in the sense of psychological safety during teamwork in a virtual environment.	It is more difficult for me to assess and interpret the words and actions of my online team members, which makes me feel less confident when engaging in remote teamwork.	QA4	4,09	3
Cognitive	Limited cognitive load for processing educational information online.	It is difficult for me to simultaneously listen to information and read the it on presentation slides during online classes.	QC1	3,45	1
	Inductive process of acquiring a system of knowledge online.	It is easier for me to first independently search for information to solve a learning task and then, during a video conference, summarize all the information and verify my understanding.	QC2	7,48	8

	Information about the current level of knowledge in a subject area contributes to more effective online learning.	I learn new material online more effectively if I know my current level of knowledge on the topic before the lesson.	QC3	6,27	7
Operational	While online, students are more focused on the task rather than on interaction.	When working in an online team, I am more focused on the task rather than on interaction.	QD1	7,06	8
	Remote teammates experience a higher level of uncertainty in their actions.	When working in an online team, I feel more uncertain about my actions than when working in an offline team.	QD2	2,85	1
	The speed of skill improvement in an online environment depends on the level of digital competence.	The more I get used to the online learning environment, the easier it becomes for me to acquire new knowledge and ways of working within the academic discipline.	QD3	7,21	8
Reflective	The success of students' reflective and evaluative actions depends on the completeness of the team's digital footprint.	It is easier for me to analyze team and individual results and working methods if the virtual environment retains key team work outcomes at each stage of interaction (e.g., a recorded video of the session is available).	QR1	6,45	6
	Mutual positive feedback among online team members has a greater positive effect on motivation for remote teamwork than peer assessment.	In an online team, I prefer discussing each participant's contribution to the overall result rather than assigning a grade to my teammates for their individual work.	QR2	6,88	8
	In peer assessment online, the positive effect on a student's future activities is greater when the feedback comment is more detailed and substantive.	I value not so much the assessment of my work by other team members but rather a detailed and substantive comment on that assessment, which will help me work more effectively next time.	QR3	7,70	8

APPENDIX D

The Correlation between Psycho-Pedagogical Characteristics and Pedagogical Conditions for Developing Students' Teamwork Competence in the Electronic Information and Educational Environment of a University

Table D.1. – The correlation between psychological and pedagogical characteristics and pedagogical conditions for developing students' TW competence in the EIEE

TW competence component	**Psycho-pedagogical characteristics**	**Pedagogical condition for the development of students' TW competence**
Motivational	The dependence of a student's motivation to participate in an online team on the level of their digital skills development.	**"Digital Skills":** Establishing a uniform level of students' digital skills for working with online tools before team interaction through preliminary technical sessions and/or providing instructions and screencasts on digital services in a shared digital repository and/or conducting diagnostic testing to identify students with insufficiently developed required digital skills (followed by additional training).
	The recursive nature of team-building activities.	**"Recursive Team Building":** Implementing recursive (rather than linear) team-building techniques during the remote learning process to sustain students' motivation for online teamwork by distributing team-building activities throughout the entire interaction cycle (e.g., conducting introduction quizzes, online quests, and virtual warm-up exercises).
	The dependence of motivation to participate in teamwork on the composition of the online team and the openness of the virtual space.	**"Virtual Space":** Organizing a digital environment that allows students to move between team zones by dividing it into a simultaneously functioning general space and team breakout rooms, as well as facilitating student collaboration on a unified virtual interactive whiteboard.

	Students' motivation for online team interaction increases with prompt feedback from the instructor.	**"Connection with Instructor":** Providing students with the opportunity to communicate with the instructor both synchronously (moving from the team breakout room to the general room, using online chat) and asynchronously (email communication) at every stage of remote team collaboration.
	When setting a team goal, members of online teams tend to avoid conflicts.	**"Distributed Workload":** At the team goal-setting stage, the instructor should join online teams to facilitate idea generation, followed by organizing task distribution in an online tracker (e.g., Asana, MS Tasks, etc.) to monitor workload allocation among participants in the format of "task – deadline – responsible person."
Axiological	The level of trust in online teams is higher when participants are more familiar with each other's strengths and weaknesses.	**"Team Reflection":** Conducting online team reflection in a format that involves digitally recording the team's successes and challenges in the current work cycle, as well as discussing their correlation with the qualities, skills, and knowledge of the current team members (e.g., "Sailboat" retrospective or "Start/Stop/Continue" method). The goal is to help participants recognize each other's strengths and weaknesses as team partners.
	Team cohesion increases when there is an opportunity to evaluate each participant's contribution to the overall task.	**"Interactive Peer Assessment":** Implementing digital tools for open, interactive peer assessment of each student's contribution to key work outcomes during the team reflection stage, followed by synchronous discussion to enable students to engage in mutual monitoring and evaluation.
Cognitive	The relative anonymity of each participant in the virtual environment may contribute to the occurrence of social loafing.	**"Advance Knowledge":** Primarily fostering students' understanding of teamwork in advance by introducing educational materials on the specifics of team interaction before or at the beginning of an online session through video lectures, hyperlinks to online articles, and digital documents in various formats, followed by self-assessment tasks.

	A decrease in the sense of psychological safety during teamwork in a virtual environment.	**"Preliminary Self-Assessment":** Implementing students' preliminary self-assessment of their teamwork knowledge before the start of an online learning session to enhance their focus on identifying and acquiring missing information during the learning process.
Operational	Limited cognitive load for processing educational information online.	**"Synchronizing Meetings":** The necessity of conducting regular synchronizing online meetings (with cameras on) to update the team activity plan and shift students' focus toward the teamwork process.
	Inductive process of acquiring a system of knowledge online.	**"Virtual Sandbox":** Creating an additional virtual space to provide students with low digital proficiency the opportunity to practice and automate their skills in using digital tools (e.g., team trackers, virtual whiteboards, etc.) in a safe training environment.
Reflexive	Information about the current level of knowledge in a subject area contributes to more effective online learning.	**"Digital Footprint":** When designing reflective and evaluative stages of remote teamwork, the instructor should ensure that students refer to relevant sections of the virtual space where key results of that interaction phase were recorded (e.g., a section of the team's virtual whiteboard with planning outcomes: ideas, named sticky notes, voting results, etc.).
	While online, students are more focused on the task rather than on interaction.	**"Prospective Reflection":** Prioritizing reflection techniques that focus on discussing the strengths and weaknesses of the team while emphasizing each participant's positive contribution to different aspects of the work (e.g., digital reflection templates like "4L," "Sailboat," or "Start/Stop/Continue").
	Remote teammates experience a higher level of uncertainty in their actions.	**"Evaluate & Discuss":** The stage of assessing teamwork results by the instructor, as well as peer assessment among participants regarding the achievement of the common goal, should conclude with a synchronous online meeting. This meeting facilitates discussion and clarification of each team member's evaluation by all participants in the learning process, under the supervision and guidance of the instructor.

APPENDIX E

Example of Instructions and Questionnaire for Expert Assessment by Instructors on Pedagogical Conditions for Developing Students' Teamwork Competence in the Electronic Information and Educational Environment of a University

Dear Colleagues,

As part of a research study on the development of students' teamwork competence in a virtual educational environment, conducted at the Faculty of Psychology of St. Petersburg State University, we invite you to participate in this survey. The estimated time to complete the survey is approximately 30 minutes.

The purpose of this survey is to provide an expert assessment of the results of summarizing and systematizing the pedagogical conditions for developing students' teamwork competence in the university's electronic information and educational environment (hereinafter referred to as EIEE).

Please note that all responses are anonymous. You will only need to indicate the broad field of specialties in which you conduct your teaching activities, your years of experience, and your gender.

This expert assessment questionnaire consists of five sections (in addition to the introductory section for collecting biographical information). Each section is dedicated to one of the five components of teamwork competence: motivational, axiological (value-based), cognitive, activity-based, and reflective. The structure of each section is as follows:

1. A brief description of the teamwork competence component.
2. Identified characteristics of the development of this component in the university’s EIEE, based on scientific research.
3. Pedagogical conditions proposed for the effective development of this component of teamwork competence in the EIEE, derived from scientific analysis.
4. An evaluation section, where you will be asked to provide an expert assessment (on a scale from 1 to 5) of each pedagogical condition based on five criteria:

- The correspondence of the pedagogical condition to the identified characteristics of the development of the teamwork competence component.
- The importance of the pedagogical condition in developing this component.
- The variability/invariance of implementing the pedagogical condition in the educational process when developing students' teamwork competence in the university's EIEE.
- The feasibility of implementing the pedagogical condition in practice.
- The level of dependence of the pedagogical condition on the teacher's digital competence.

<…>

1. **The Motivational Component of Teamwork Competence** refers to an individual's intrinsic motivation for teamwork, the recognition of a shared goal in collaboration, and the ability of team members to set common objectives and conceptualize a model of the desired outcome.

2. **Psychological and Pedagogical Features of the Development of the Motivational Component in EIEE**, identified through a systematic review of scientific literature:

- Motivation to participate in online teamwork decreases as students encounter more difficulties in using digital resources (i.e., a lack of digital skills negatively impacts intrinsic motivation for online team interaction).
- Team formation stages in an online environment are **recursive rather than linear**: team-building activities are not concentrated solely at the beginning of the work but are distributed throughout the entire interaction process.
- Individual student motivation depends on the **composition of the online team** and increases when students have the opportunity to move between teams, review the work of other teams, and communicate with other participants.
- Students' motivation for online teamwork improves with **prompt feedback from the instructor**.

- When setting team goals and breaking them down into sub-tasks, the predominant strategy in online teams is **conflict avoidance**, which leads to decreased creativity of ideas and an unequal distribution of academic workload.

3. **Proposed Pedagogical Conditions for the Effective Development of the Motivational Component of Teamwork Competence in EIEE:**

Pedagogical Condition 1: Establishing a uniform level of students' digital skills for working with online tools before initiating team collaboration. This can be achieved through preliminary technical sessions, and/or providing instructions and screencasts on using digital services in a shared digital repository, and/or conducting diagnostic testing to identify students with insufficient digital skills, followed by targeted training.

Pedagogical Condition 2: Implementing **recursive (rather than linear) team-building techniques** throughout the distance learning process to sustain students' motivation for online teamwork. This includes distributing team-building activities across the entire cycle of interaction (e.g., icebreaker quizzes, online quests, virtual warm-ups).

Pedagogical Condition 3: Creating an **open virtual space** where students can move between team areas. This can be facilitated by:

- Dividing the virtual space into a general room and multiple **breakout rooms** for teams,
- Assigning **team "scout" roles** to students who can temporarily switch between virtual teams to gather and bring back new information,
- Using a **shared virtual interactive board** to promote collaborative engagement.

Pedagogical Condition 4: Ensuring students have **access to the instructor** for guidance at all stages of distance teamwork, both synchronously (e.g., transitioning from team breakout rooms to the main room, using an online chat) and asynchronously (e.g., email communication, feedback forms).

Pedagogical Condition 5: During the **team goal-setting stage**, the instructor should actively engage with online teams to facilitate idea generation. Following this, tasks should be assigned and tracked using an **online project management tool** (e.g.,

Asana, MS Tasks, etc.) to ensure an even distribution of workload among team members in a structured **"task – deadline – responsible person"** format.

4. Below are five questions for the expert assessment of the proposed pedagogical conditions based on five different criteria. We kindly ask you to respond to each question for each pedagogical condition by assigning scores on a scale from **1 to 5**.

Pedagogical Condition 1: Establishing a uniform level of students' digital skills for working with online tools before initiating team collaboration. This can be achieved through preliminary technical sessions, and/or providing instructions and screencasts on using digital services in a shared digital repository, and/or conducting diagnostic testing to identify students with insufficient digital skills, followed by targeted training.					
1. Evaluate the correspondence of the pedagogical condition with the aforementioned characteristics of the development of the motivational component of students' teamwork competence in an online environment (where **1** = does not correspond at all, and **5** = fully corresponds).	1	2	3	4	5
2. Evaluate the importance of the pedagogical condition in the development of the motivational component of students' teamwork competence in an online environment (**1** = not important at all, **5** = very important).					
3. Evaluate the pedagogical condition for the development of the motivational component of students' teamwork competence in an online environment in terms of its invariance/variability in the learning process (**1** = variable (optional), **5** = invariant (mandatory)).					
4. Evaluate the pedagogical condition for the development of the motivational component of students' teamwork competence in an online environment in terms of its practical implementation difficulty (**1** = nearly impossible to implement, **5** = fully implementable).					
5. Evaluate the dependence of the pedagogical condition for the development of the motivational component of students' teamwork competence in an online environment on the instructor's level of digital competence (**1** = requires an advanced level, **5** = does not require special skills).					

APPENDIX F

Diagnostic Methods for Assessing the Level of Development of Students' Teamwork Competence in the University's Electronic Information and Educational Environment

F.1. The modified method "Assessment of the Adolescent's Relationship with the Class" (E. I. Rogov) for evaluating the level of development of the students' teamwork competence motivational component

1. I consider the best partners in a team to be those who: a) know more than I do; b) strive to solve all problems together; c) do not distract the teacher's attention.
2. The best teachers are those who: a) use an individual approach; b) create conditions for assistance from others; c) create an atmosphere in the team where no one is afraid to speak up.
3. I am happy when my team partners: a) know more than I do and can help me; b) can achieve success independently without disturbing others; c) help others when the opportunity arises.
4. I like it most when in a team: a) there is no one to help; b) no one distracts me while performing the task; c) others are less prepared than I am.
5. I feel I can perform at my best when: a) I can get help and support from others; b) my efforts are sufficiently rewarded; c) I have the opportunity to show initiative that benefits all team members.
6. I like teams where: a) everyone is interested in improving the results of all; b) everyone is busy with their own work and does not disturb others; c) each person can use others to solve their own tasks.
7. My peers consider the worst teachers to be those who: a) create a competitive spirit between team members; b) do not pay enough attention to them; c) do not create conditions for the team to help them.

8. The most satisfaction in teamwork comes from: a) the ability to work when no one interferes with you; b) the ability to receive new information from other participants; c) the ability to do something useful for other team members.

9. The main role should be: a) in raising people with a developed sense of duty to others; b) in preparing people who can live independently; c) in preparing people who know how to get help through communication with others.

10. If the team faces a problem, I: a) prefer that others solve the problem; b) prefer to work independently without relying on others; c) strive to contribute to the team's collective solution to the problem.

11. I would learn best if the teacher: a) had an individual approach to me; b) created conditions for me to receive help from others; c) encouraged student initiatives aimed at achieving common success.

12. There is nothing worse than: a) being unable to achieve success on your own; b) feeling unnecessary in the team; c) not receiving help from team partners.

13. I value most: a) personal success in which my team partners have contributed; b) collective success in which I have a contribution; c) success achieved through my own efforts.

14. I would like to: a) work in a team where the main methods and techniques of teamwork are used; b) work individually with the teacher; c) work with experts in the field.

F.2. The test to assess students' knowledge of online teamwork and the development of the cognitive component of their teamwork competence.

1. Among the listed options, the goal-setting technique is: (K.I.S.S.; GROW; OKR; ABCD).

2. In the SMART goal-setting methodology, the letter R stands for: (Reactive; Refined; Relevant; Reflective).

3. The minimally sufficient categories in an online teamwork tracker are: (backlog; to be executed; in progress; done; not completed; delegated; sent for reconsideration).

4. When evaluating the individual work of another team member, it is recommended to use the principle of: ("hamburger"; "Pareto"; "hot dog"; "hear, see, feel").

5. The conditions for effective team "brainstorming" include: (the inadmissibility of judging or criticizing others' ideas; participants should be encouraged to suggest the most outlandish solutions that come to mind; after generating ideas, a plan of action should not be immediately developed; it is important to discuss as many ideas as possible in the hope that quantity will lead to quality; the author of the best idea should be rewarded in advance; participants should complement, integrate, and develop ideas already proposed by others).

6. The following are not principles of team collaboration: (openness; coordination; healthy competition; delegation; acceptance of a unified goal; avoidance of conflicts; collective responsibility for the result).

7. If two team members have a conflict over the choice of a platform for developing the presentation, the conflict can be resolved most quickly using the tactic of: (suppression; shifting attention; reassessing the cause of the conflict).

8. To assess the successful and unsuccessful actions of the team during team reflection, the template to use is: ("What’s on your radar?"; "Start – Stop – Continue"; "Sailing Ship"; "Draw a character").

9. When an individual part of the work is completed ahead of schedule, help should be provided to the person who: (has a high risk of not completing the task by the deadline; has a large volume of work; whose results impact the successful completion of tasks for other members; lacks the courage to ask for help; has the least amount of data to solve the given task).

10. When holding an online team meeting, it is important to: (send the agenda and approximate discussion plan to all participants in advance; ask questions to the entire team, not specific individuals; inform participants that silence means agreement;

schedule time in the online calendar with extra time, for example, if the meeting is planned for 30 minutes, book a 45-minute slot; assign a facilitator to manage the meeting process and the direction of discussion; send a memo with the meeting outcomes to participants who request it at the end of the meeting).

F.3. Expert assessment form for evaluating the level of development of the students' teamwork competence operational component (example)

Instructions: In each section, circle one of the 7 manifestations of interaction characteristic of the team being studied.

Expert evaluation form:

I. *Hierarchy and variability of interaction*.

1. The student finds it practically impossible to change the interaction. Their interaction is inadequate for the situation of joint activity in the EIEE and disorganized. The student does not participate in the distribution of tasks and roles in the online tracker according to their interests and abilities.

2. The student experiences difficulties in adapting their interaction according to the situation. This requires significant effort and time. While the student participates in verbal discussions on task and role distribution, they do not use digital tools to record agreements.

3. The student is only partially able to change the interaction. While some team members initiate changes, the student tends to stick to the habitual spontaneous approach. They do not take the initiative in creating an overall work plan, although they may record individual parts of tasks in the online tracker.

4. The student has a noticeable desire to change the interaction, but this is often limited to intentions. They do not initiate synchronizing meetings to update the work plan. Communication from their side is mostly in writing via online chat, and participation in discussions is sporadic.

5. The student actively participates in the process of changing the interaction. They contribute to discussions (mostly written), based on which the team forms a new, more detailed work plan, agreed upon with the current conditions.

6. The student demonstrates the ability to flexibly vary the interaction. They actively participate in finding optimal ways of collaboration. When conditions change or new tasks arise, they take part in synchronizing meetings, use brainstorming tools, online voting, and help record agreements in the team’s online tracker.

7. The student demonstrates a high level of awareness and flexibility in changing the interaction. They consider the possible consequences of changes for the team and relate them to the likelihood of achieving better results. The student actively participates in using digital tools for brainstorming, voting, task distribution, and responsibility assignment, as well as analyzing the consequences of decisions during team reflection. Based on this, the team records optimal interaction methods for future work cycles.

APPENDIX G

Questionnaires Used at the Stage of The Stating Experiment to Identify the Attitudes of Students and Teachers towards the Process and Outcomes of Developing Teamwork Competence in the University's Electronic Information and Educational Environment

G.1. Questionnaire for Students

Dear Students,

As part of a research study on the possibilities of developing teamwork competence in the university's electronic information and educational environment, conducted at the Faculty of Psychology of St. Petersburg State University, we invite you to participate in this survey. The estimated completion time is approximately 3 minutes.

The purpose of this questionnaire is to assess your attitude towards various aspects of developing teamwork competence in the context of online learning. Your participation will help identify the role of teamwork skills in your academic activities and highlight any challenges you may encounter while working in online team formats.

The results of this study will serve as the foundation for developing a model for fostering universal teamwork competence in the university’s electronic information and educational environment.

Please note that all responses are anonymous. You will only need to indicate your level of higher education (Bachelor’s/Specialist/Master’s/PhD), year of study, gender, and academic program.

Thank you for your cooperation!

1. What level of higher education are you currently pursuing? (Bachelor’s; Specialist; Master’s; PhD; Other)
2. What year of study are you in? (1; 2; 3; 4; 5; Other)
3. What academic program are you enrolled in? (Your answer)
4. Please indicate your gender. (Male; Female)

5. How often do you have to work in a team as part of your academic learning activities? (Almost never; Rarely; Often; Almost always; Other)

6. In your opinion, how important is teamwork competence when studying various academic disciplines in an online format? (I do not consider it necessary; Rather unimportant; Rather important; I consider it essential; Other)

7. How often do you realize that achieving certain academic goals is only possible when working in a team with other students? (Never; Rarely; Often; Other)

8. When faced with a complex academic task, would you prefer to solve it independently or in a team? (Independently; In a team; Other)

9. Do you agree that engaging in teamwork in an online format is more challenging than in a classroom setting? (Agree; Rather agree; Rather disagree; Strongly disagree; Other)

10. Do you feel that you have sufficient knowledge of organizing teamwork in an online format and enough experience in remote team collaboration? (Definitely not enough; Rather not enough; Rather enough; Definitely enough; Other)

11. Do you think you are given enough team-based assignments in the online learning process across various disciplines? (Sufficient; Insufficient; Unsure; Other)

12. Would you like to work in a team more often when completing assignments as part of the course curriculum in an online format? (Yes; No; Unsure; Other)

13. In your opinion, how necessary is it to master the fundamental rules, methods, and technologies of teamwork (including online formats) during your university studies? (Not necessary; Necessary; Unsure; Other)

G.2. Questionnaire for Instructors

Dear Colleagues,

As part of a research study on the possibilities of developing teamwork competence in a virtual educational environment, conducted at the Faculty of

Psychology of St. Petersburg State University, we kindly invite you to participate in this survey. **The estimated completion time is approximately 3 minutes**.

The purpose of this questionnaire is to identify the challenges you encounter in fostering the universal competence "Teamwork and Leadership" (hereinafter referred to as teamwork competence) among students in the context of distance learning.

The results of this study will serve as the foundation for developing a model for enhancing teamwork competence in a virtual educational environment.

Please note that all **responses are anonymous**. You will only need to indicate your field of study, the subject(s) you teach, your years of experience, gender, and age.

Thank you for your cooperation!

1. In which field of study do you conduct your teaching activities? (e.g., Physical and Technical Sciences and Technologies, Psychological Sciences, Economics and Management, etc.)
2. Which subject(s) do you teach?
3. What is your academic teaching experience (work experience in a university)? (Less than 3 years; 3–5 years; 5–10 years; 10–15 years; 15–20 years; More than 20 years; Other)
4. Please indicate your age. (21–25 years; 26–35 years; 36–45 years; 46–55 years; 56–65 years; 66–75 years; Other)
5. Please indicate your gender. (Male; Female)
6. Do you consider it necessary to develop students' teamwork competence not only in classroom settings but also in online formats? (Yes; No; Unsure; Other)
7. Which is easier for you to organize: student teamwork online or offline? (Easier offline; Easier online; No difference; Other)
8. How often do you find yourself lacking information on how to organize students’ teamwork on academic assignments in a remote format? (Never; Rarely; Occasionally; Often; Other)

9. Which aspects of organizing online teamwork among students do you find most challenging? (Technical: Internet resources for collaborative work, online tools for assessing teamwork outcomes, etc.; Pedagogical: knowledge of methods for organizing teamwork, understanding the development of specific teamwork competence components in an online format, etc.; Psychological-pedagogical: experience in conflict resolution among students in an online environment, knowledge of motivation techniques for online learning, conducting online reflections on teamwork outcomes, etc.; I have sufficient skills in all these areas; I lack skills in all these areas; Other)

10. Which stage of teamwork is the most challenging for you to organize in a remote learning environment? (Motivating students to work in a team; Organizing team goal-setting; Coordinating collaborative planning of activities; Implementing the teamwork plan and monitoring students' learning progress; Assessing the results of teamwork; Conducting team reflections on academic activities in online teams; Other)

11. Based on your experience, how prepared are students to work in teams in a remote format? (Not prepared at all: they show no willingness to work in online teams, complete assignments reluctantly, and struggle to organize their activities; Insufficiently prepared: they show interest in working in online teams but struggle to effectively coordinate and execute teamwork; Moderately prepared: they demonstrate sufficient motivation for teamwork and can organize and execute remote collaboration with instructor support; Fully prepared: they are motivated, complete assignments effectively, and do not experience difficulties in organizing online teamwork; Other)

12. How successfully do students complete assignments requiring teamwork in a remote format, in your opinion? (Students experience difficulties; They partially succeed; They generally succeed; They experience no difficulties; Other)

13. Would you like to receive training on organizing students' remote teamwork? (Yes; No; Unsure; Other)

APPENDIX H

Visual Materials Illustrating the Results of the Stating Experiment

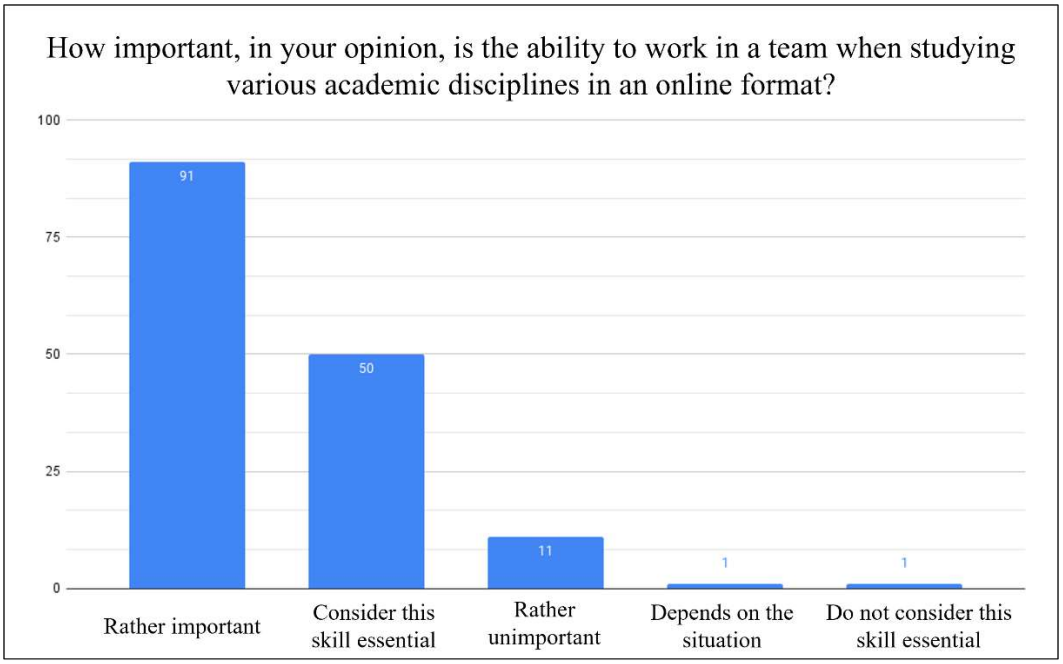


Figure H.1. – Distribution of responses on the importance of TW competence in online interaction mode

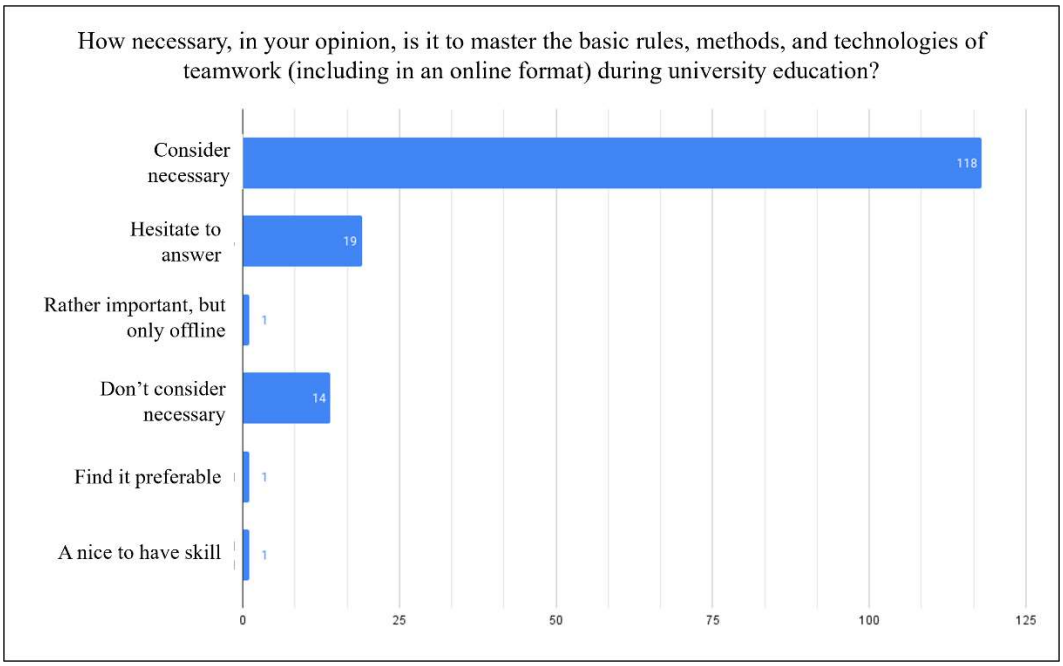


Figure H.2. – Distribution of responses to the question on the importance of mastering TW competence during professional training

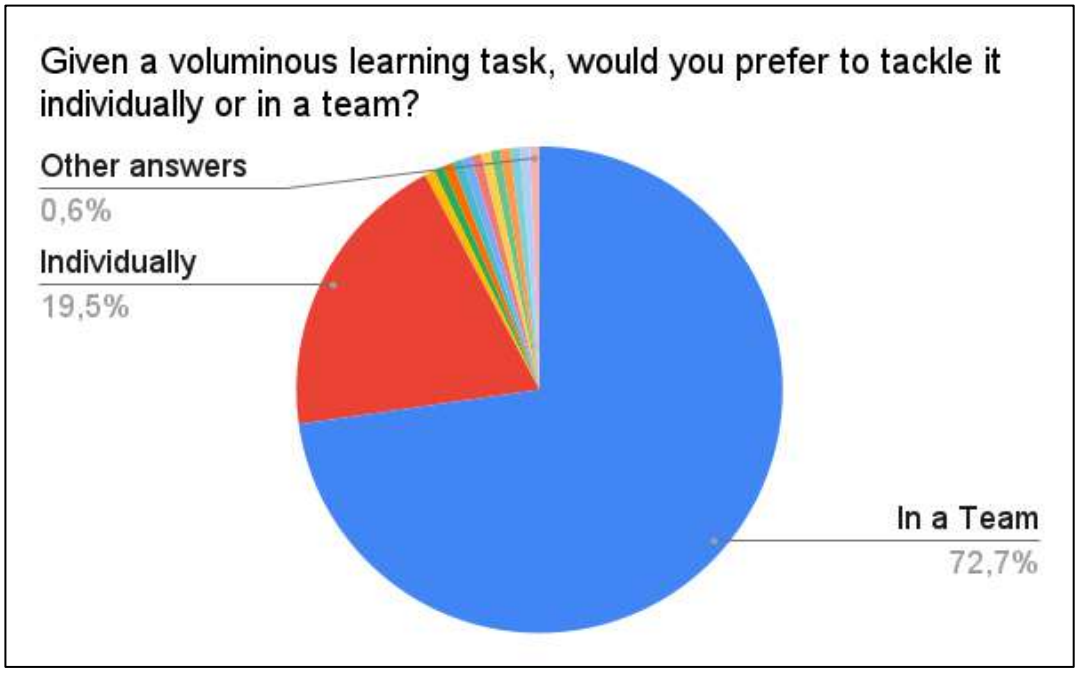


Figure H.3. – Students' preferences regarding teamwork when faced with a large academic task

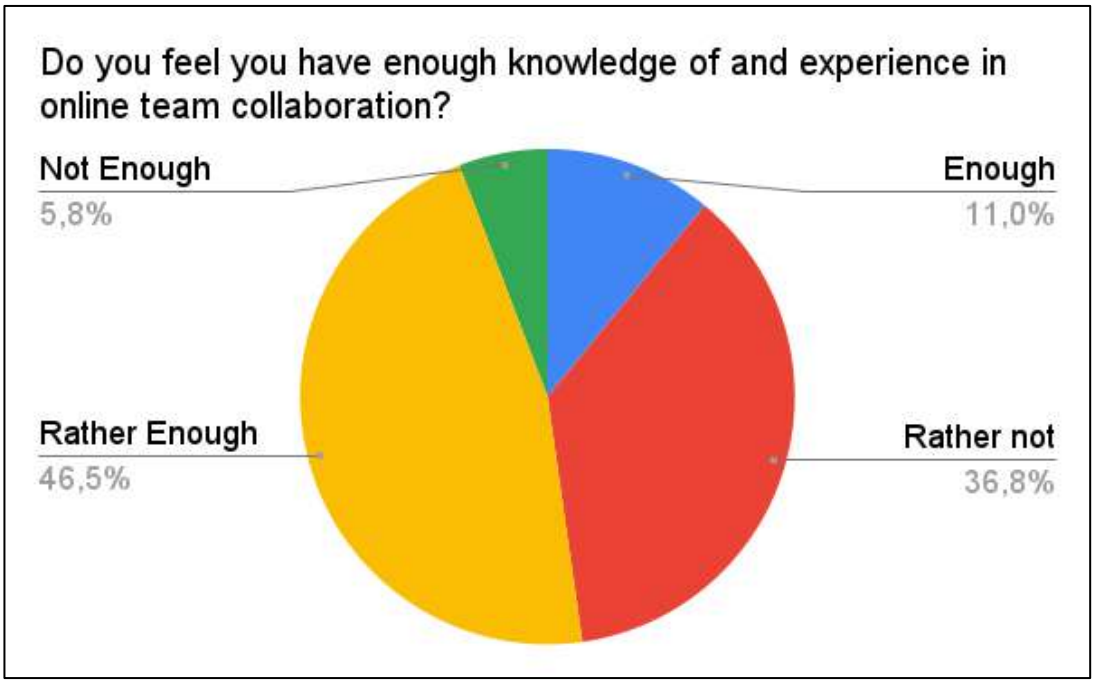


Figure H.4. – Respondents' opinions on whether they have sufficient experience in remote team interaction

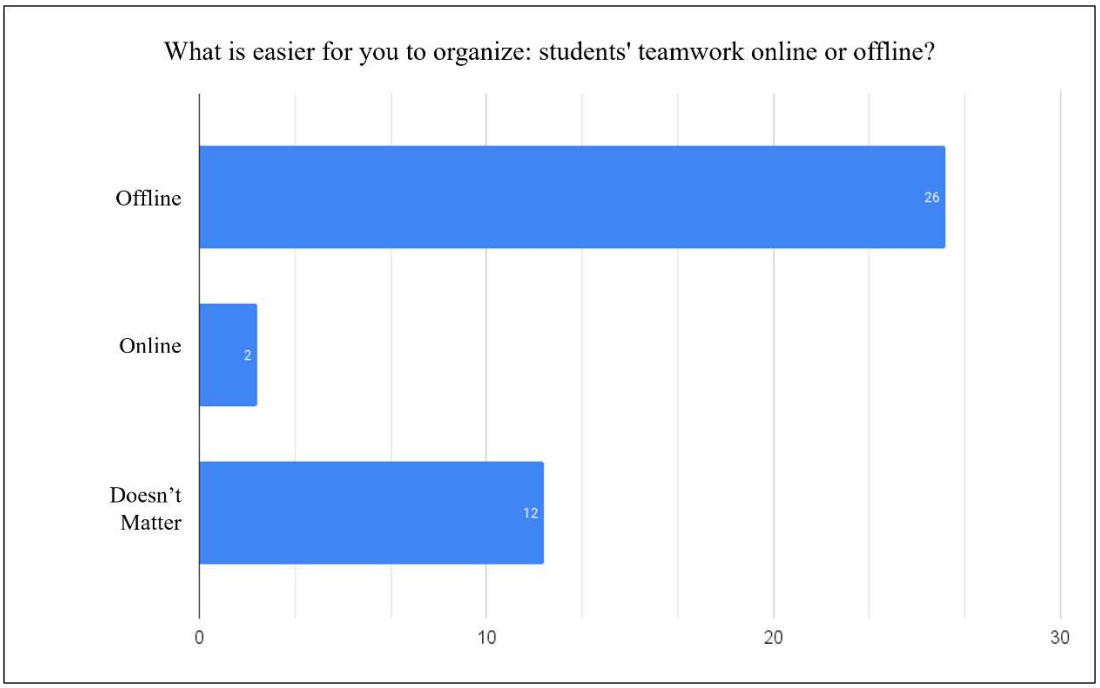


Figure H.5. – What is easier for you to organize: students' teamwork online or offline?

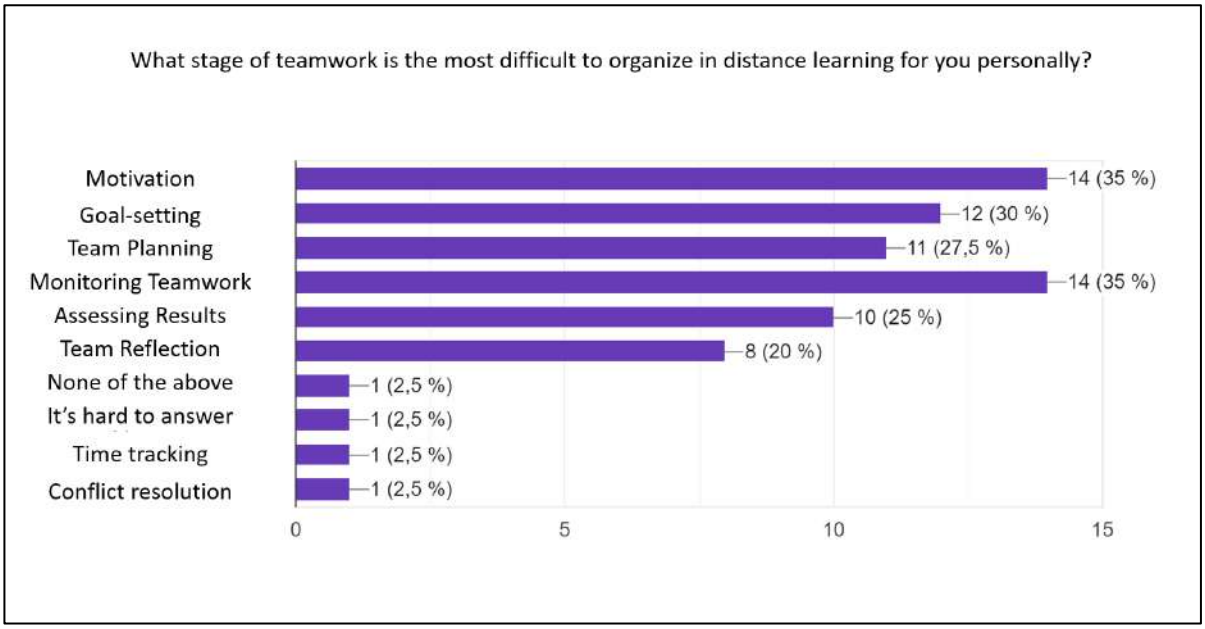


Figure H.6. – Which stage of teamwork is the most difficult for you to organize in a virtual learning environment?

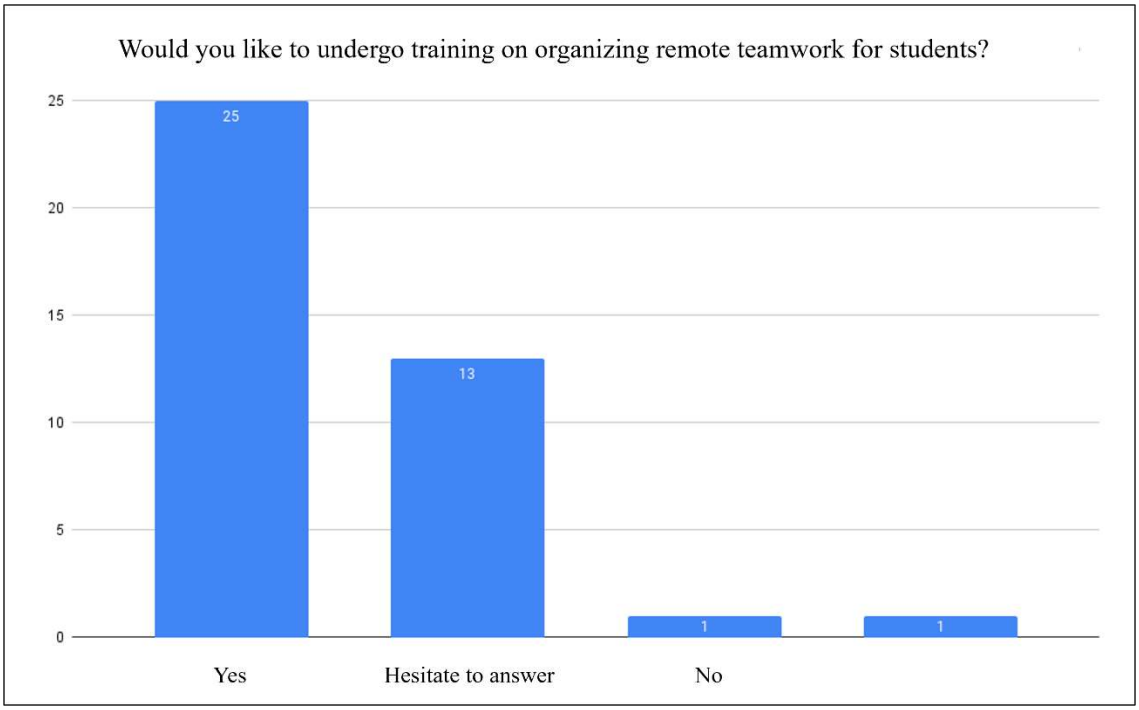


Figure H.7. – Distribution of responses to the question on undergoing additional training in organizing student teamwork online

APPENDIX I

The Diagnostic Assessment Results on the Level of the Students' Teamwork Competence Motivational Component Formation at the Stating Experiment Stage

Table I.1. – Test questions with the lowest number of correct answers from students

Question	**Number of correct answers**	
	EG	**CG**
Among the listed options, the goal-setting methodology is: (KISS, GROW, OKR, ABCD).	9/19	8/20
The minimally sufficient categories in an online team workflow tracker are: (To Do, In Progress, Done, Not Completed, Delegated, Backlog, Sent for Approval).	5/19	5/20
The conditions for an effective team brainstorming session include: (No criticism or judgment of others' ideas, No immediate development of an action plan after idea generation, etc.).	5/19	6/20
The following are not principles of teamwork: (Openness, Coordination, Healthy Competition, Conflict Avoidance, etc.).	3/19	2/20
If two team members have a conflict over the choice of a platform for developing a presentation, the fastest way to resolve this conflict is through the tactic of: (Suppression, Distraction, Reassessment of the Conflict's Cause).	3/19	4/20

APPENDIX J

Correlation Between Aspects of Expert Assessment of the Operational Component in Teamwork Competence and its Underlying Skills and Abilities

Table J.1. – Alignment of expert assessment aspects for the operational component of competence with skills and abilities for online teamwork

Criterion	**Subskill**	**Ability**
Hierarchy and variability	Task distribution and assignment in an online tracker.	Assign team roles based on participants' interests and abilities.
Independence and initiative	Work planning in an online calendar.	Initiate brainstorming sessions and synchronization meetings.
Engagement in interaction	Navigation in virtual space and connection to virtual team rooms.	Plan virtual communication according to changing team conditions.
Presence and quality of the plan	Creating digital “roadmaps” and using visualization tools.	Develop a team activity plan based on the learning task and participants' competencies.
Coherence and distribution of functions	Decomposition of goals into subtasks and assigning responsibilities in an online team tracker.	Define the scope of individual work and ensure cross-functional collaboration.
Correspondence of joint activities to the plan	Updating individual task progress in an online tracker.	Adjust the team activity plan based on interim results.

APPENDIX K

Conversion of the Average Values of the Experimental and Control Groups for Each Component from Points to Percentages (Diagnostic and Control Assessments)

Table K.1. – Conversion of the average values of the experimental and control groups for each component from points to percentages (diagnostic assessment)

TW Competence Component	**Diagnostic Tool**	**μ**	
		EG	**CG**
Motivational	"Assessment of a Teenager's Relationship with the Class" (adaptation)	51.9%	51.1%
Axiological	"Determining Indirect Group Cohesion"	54.6%	57%
Cognitive	Author's test for assessing knowledge about the team	63%	66%
Operational	"Diagnostics of Interaction and Interactive Coherence in Small Groups" (adaptation)	58%	55.3%
Reflexive	"Level of Expression and Focus of Reflection"	63.3%	60.2%

Table K.2. – Conversion of the average values of the experimental and control groups for each component from points to percentages (control assessment)

TW Competence Component	**Diagnostic Tool**	**μ**	
		EG	**CG**
Motivational	"Assessment of a Teenager's Relationship with the Class" (adaptation)	82.3%	57.5%
Axiological	"Determining Indirect Group Cohesion"	77.7%	65.3%
Cognitive	Author's test for assessing knowledge about the team	80.1%	47.1%
Operational	"Diagnostics of Interaction and Interactive Coherence in Small Groups" (adaptation)	92.4%	63.3%
Reflexive	"Level of Expression and Focus of Reflection"	87.8%	67.4%

APPENDIX L

Examples of Learning Tasks for Students in the Control Group during Experimental Training

Task 1. Fill in *Table 1* with the key dates from the life of K. D. Ushinsky, and *Table 2* with the characteristics of the socio-pedagogical movement in Russia during the 1820s–1860s.

Table L.1. – Life and Pedagogical Work of K. D. Ushinsky

Key periods	**Description**	**Where to find**	**What to pay attention to**
1824		pp. 9-10	Origin, family
1835 – *enrollment in a gymnasium*		pp. 11-17	Gymnasium life, head of the gymnasium, academic performance
1840's		pp. 18-23	University life
1846		pp. 23 - 24	Employment at the lyceum, speech *"On Cameral Education"*
1850–1852's		pp. 25 - 27	Conflict with authorities, resignation from the lyceum, departmental service, *Sovremennik* journal
1855–1859's		pp. 28 - 33	Gatchina Institute
1859–1862's		pp. 33 – 41	Smolny Institute, key reforms
1862		pp. 41 - 43	Resignation from Smolny Institute
1862–1867's		pp. 41	Life in Switzerland, friendship with N. I. Pirogov, works
1870			

Task 4. Read the beginning of Chapter 6 (pp. 121–124) and Chapter 8 (pp. 157–166). Prepare for a discussion on the following questions (take notes if necessary):

- What is narodnost in education?

- Why is there no universal education system for all nations?
- What is the key condition for the effectiveness of public education, according to K. D. Ushinsky?

Reflect on K. D. Ushinsky's statement: *"The national ideal of a person, no matter which era it belongs to, is always good relative to that era"*. Based on Ushinsky's idea of the national ideal (pp. 121–124), develop a project outlining a **modern public ideal of education**. Describe this ideal in as much detail as possible:

- Which literary or cinematic characters (or real figures) represent it?
- What virtues does it embody? Which flaws are forgivable?
- Why should contemporary Russian society adopt it as a model?
- What conditions of public education could foster the development of future generations in line with this ideal?
- How could you personally contribute to shaping individuals who align with this national ideal?

Important: The assignment can be presented in **text form, as a drawing, or in a diagram.**

APPENDIX M

A Typical Lesson Plan in the University's Electronic Information and Educational Environment for the Experimental Group

Table M.1. – A typical lesson plan in the EG aimed at developing students' TW competence in the university's EIEE

Stage	**Instructor's Actions**	**Students' Actions**	**Outcome**
Organizational	Launching a video conference; checking the availability of audio and video communication; notifying students about the topic and purpose of the online lesson.	Connecting to the video conference via the online calendar; checking audio and video communication; turning on cameras and reviewing the topic and objectives of the online lesson.	Students are in a shared virtual learning space and have been informed about the topic and objectives of the lesson.
Personal-motivational	Presenting stimulus material to activate students' speech and cognitive activity in the shared virtual space; organizing an online discussion on the personally significant outcomes of the lesson.	Recording personally significant goals of the online lesson in the virtual space.	Activating students' motivation for teamwork and helping them develop a personal sense of engagement in the activity.
Target-component	Displaying the lesson goal and a model-image of the expected teamwork outcome in the shared virtual space; dividing students into virtual teams; facilitating the distribution of academic workload in an online tracker.	Creating a preliminary team activity plan based on evaluation criteria; breaking down the team goal into individual tasks; entering tasks into the online team tracker with assigned deadlines and responsibilities.	Teams set a common goal and then break it down into smaller tasks, with the instructor facilitating an even distribution of workload among all participants.

Informational	Uploading step-by-step instructions for each stage of teamwork into a unified digital knowledge base; providing targeted reference materials on teamwork for specific teams; placing instructional materials in virtual team workspaces.	Reviewing instructions on teamwork in an online environment; playing multimedia materials during different stages of teamwork; checking comprehension through interactive tasks.	Students acquire knowledge about teams and teamwork in an online environment.
Structural-functional	Monitoring progress in online trackers; joining teams to facilitate and support the teamwork process; adjusting the student teamwork plan based on synchronization meetings.	Carrying out team actions and operations according to the activity plan; updating online team trackers; joining synchronization rooms for plan adjustments.	Developing and refining teamwork skills and enhancing students' ability to work in an online team.
Individual-psychological	Presenting digital reflection templates in virtual team spaces; sharing interactive self-reflection sheets in the general online chat.	Recording teamwork results; discussing strengths and weaknesses of team interaction; setting goals for improving specific aspects of collaboration.	Fostering team-relevant personal qualities through group and individual reflection.
Final	Assessing students' teamwork results; summarizing the lesson outcomes.	Comparing team activity results with other teams; matching the achieved outcome with the benchmark; summarizing the lesson.	Assessing students' teamwork results in the online environment.

APPENDIX N

Illustrations of the Learning Process of Students in the Experimental Group during Experimental Training

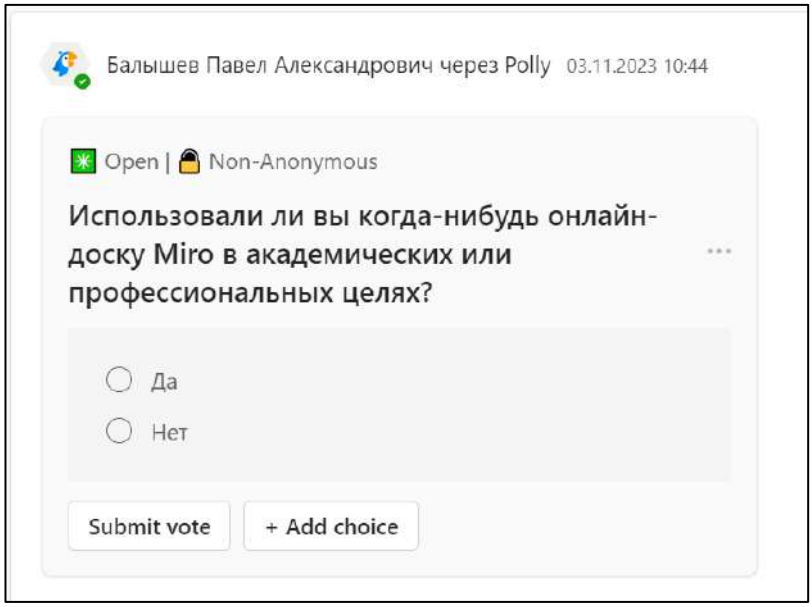


Figure N.1. – Example of posting a survey on past experience with an online team board in the university's EIEE using Polly

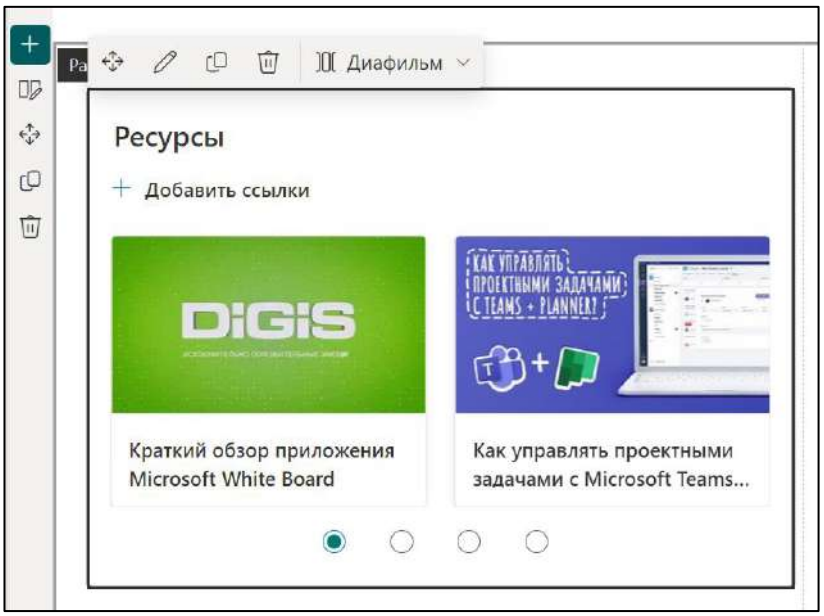


Figure N.2. – Posting links to video instructions on using online team tools in the university's EIEE

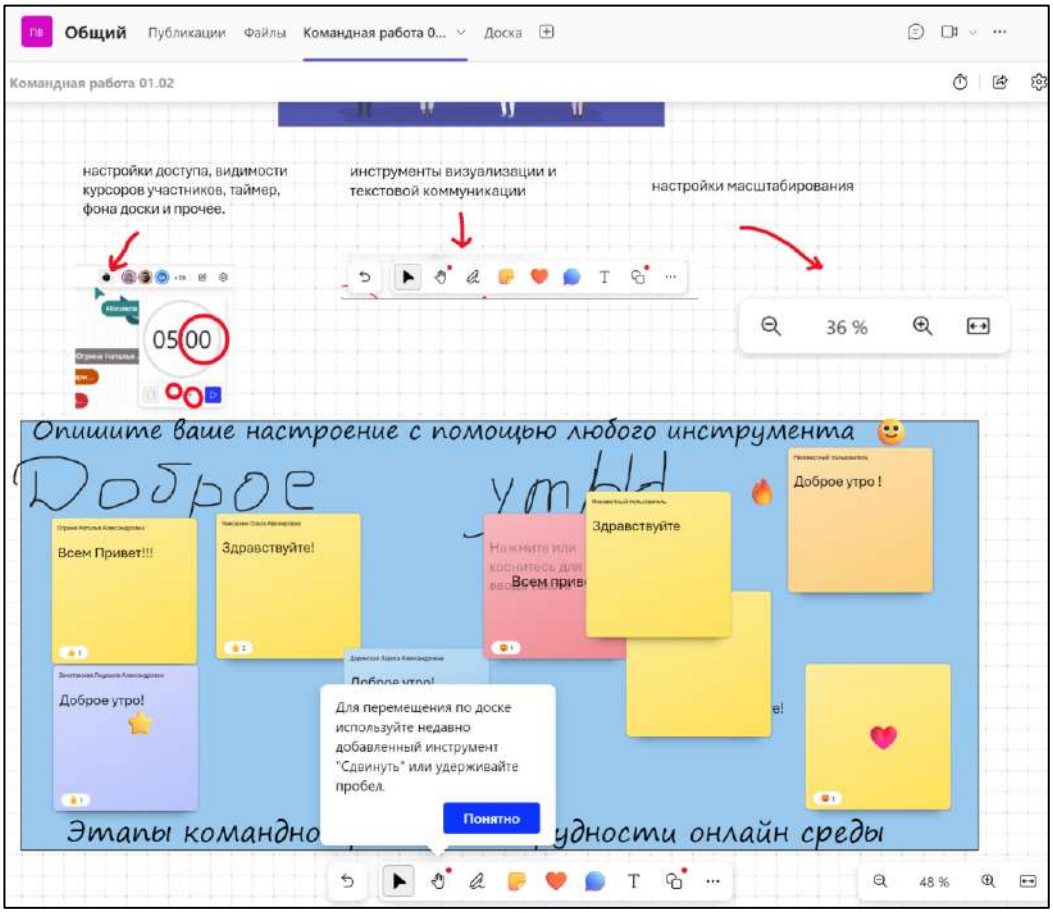


Figure N.3. – Organization of a training space ("Virtual Sandbox") for improving students' technical skills

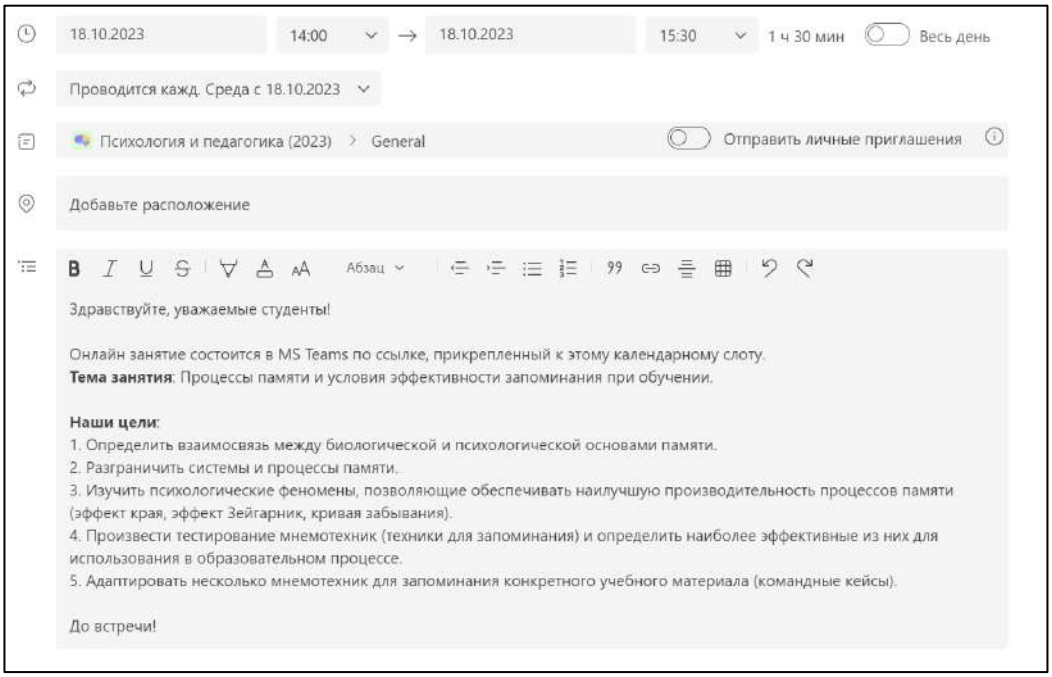


Figure N.4. – Description of an upcoming online lesson in the online calendar (on the example of Microsoft Teams)

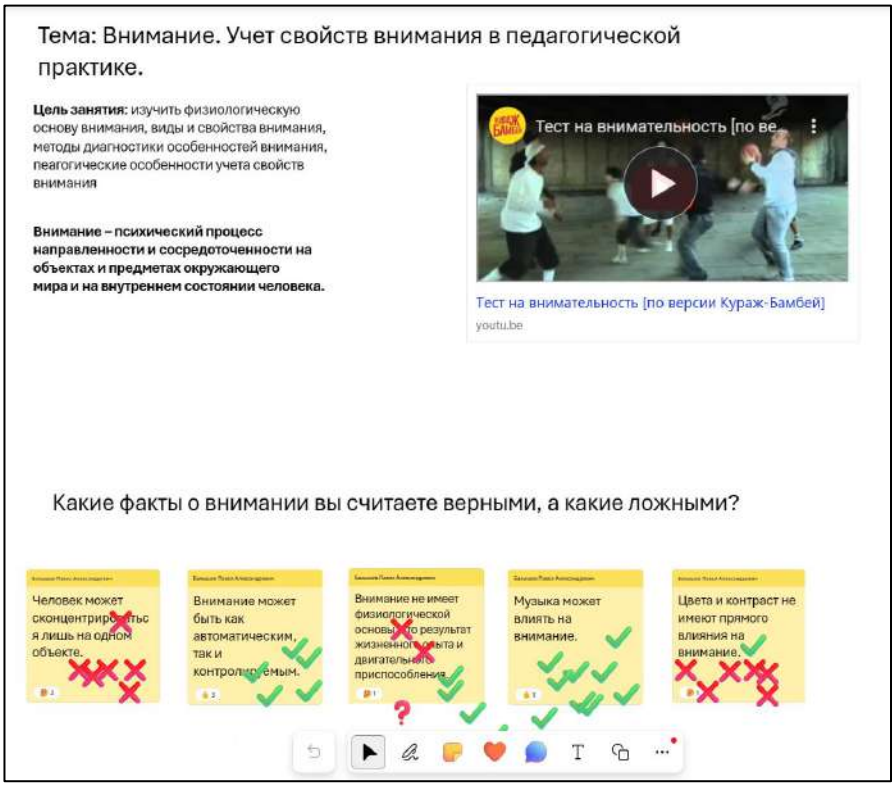


Figure N.5. – A section of the interactive board in the shared virtual space with synchronized multimedia playback and online voting functionality

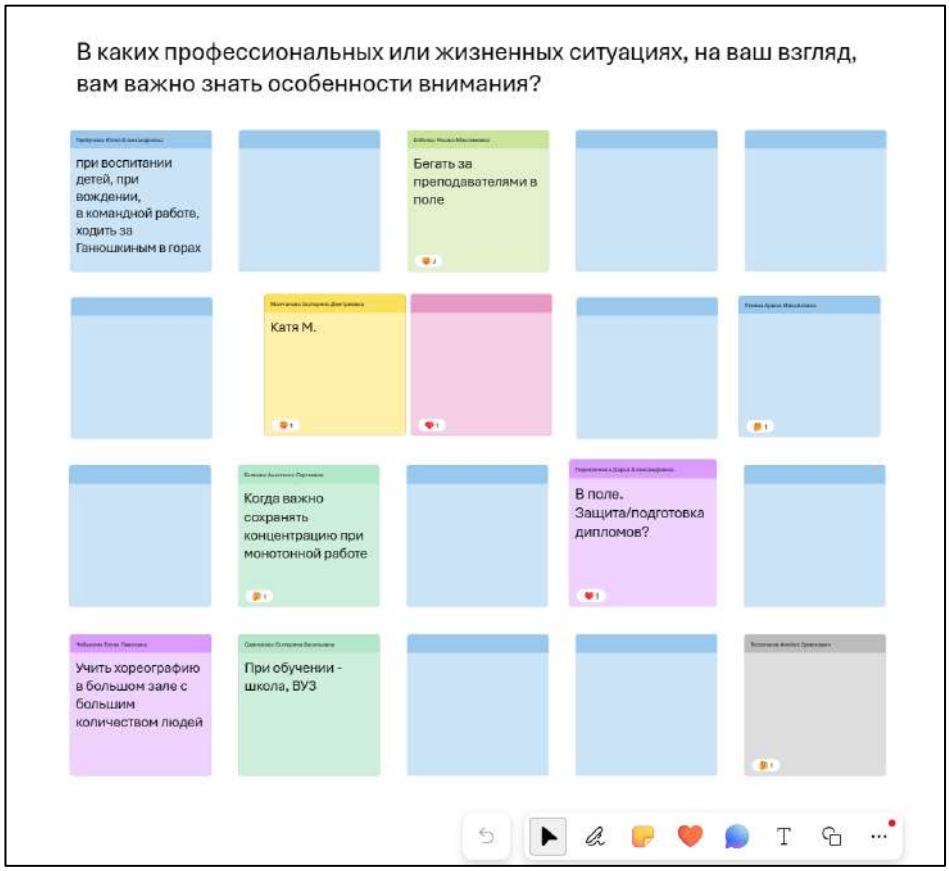


Figure N.6. – Online sticky notes with a feature displaying their creators

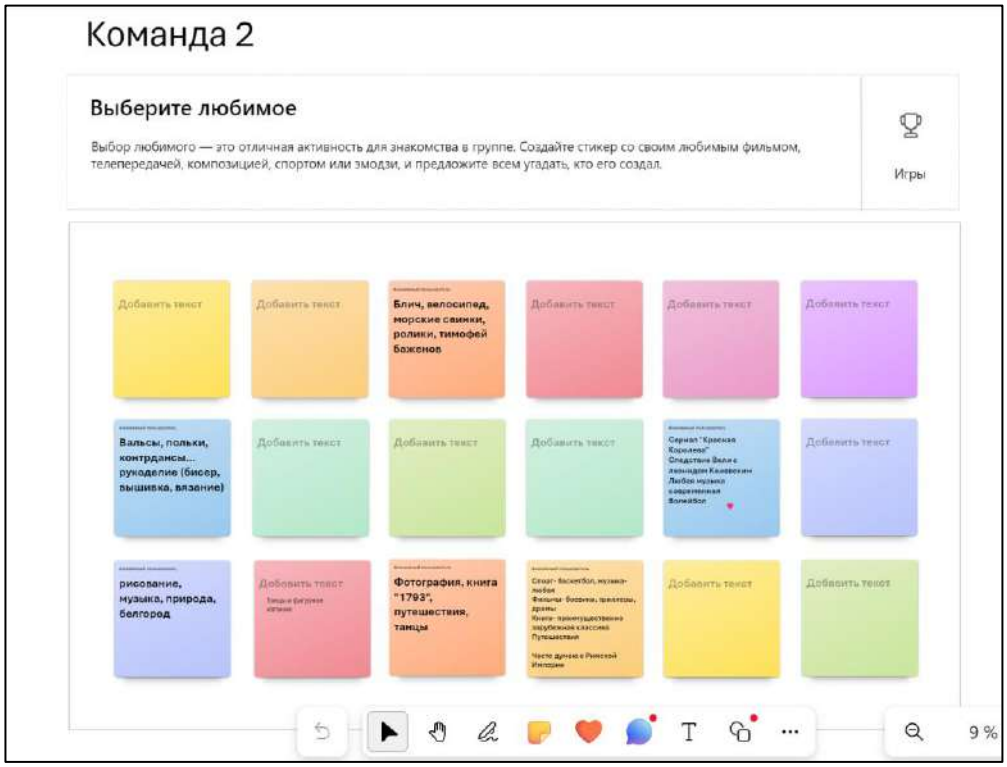


Figure N.7. – Team-building activity "Choose Your Favorite" on the Microsoft Whiteboard online board

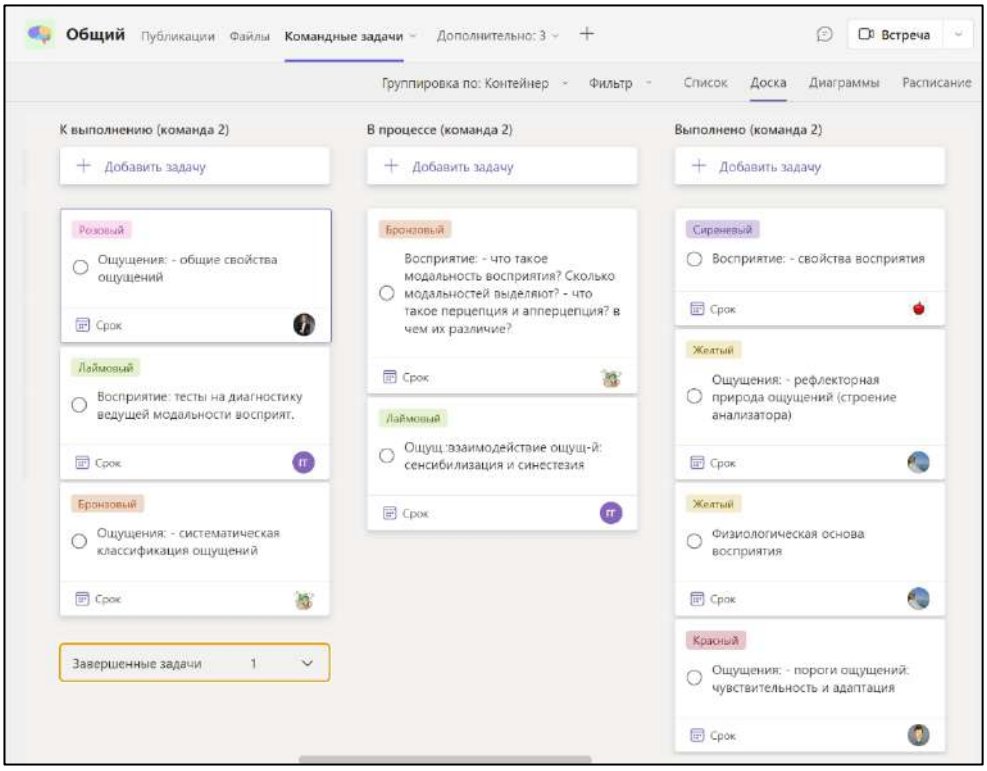


Figure N.8. – Assignment of team tasks in the online student teamwork tracker

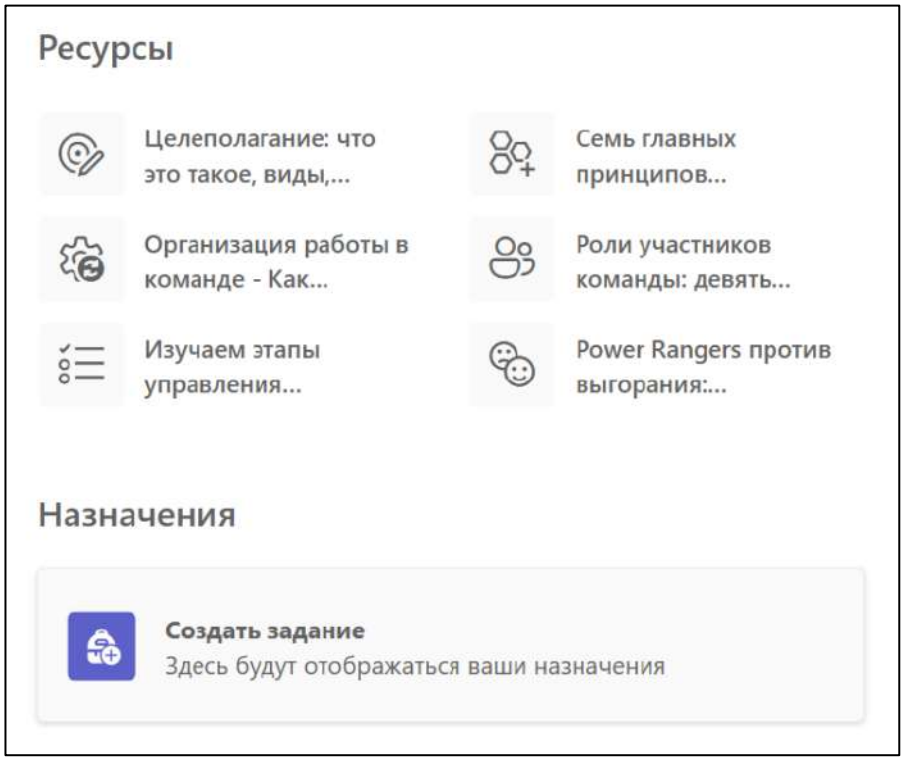


Figure N.9. – Posting links to materials on teamwork and team interaction on the course homepage

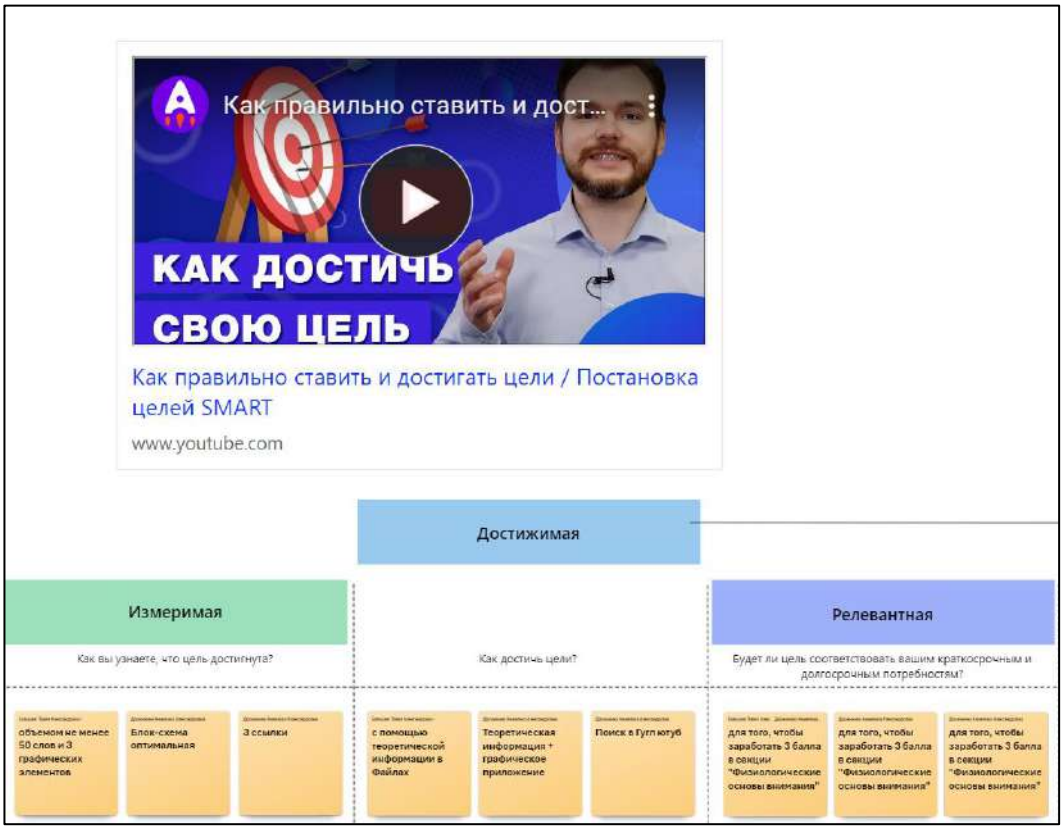


Figure N.10. – Example of presenting learning material during an online lesson followed by a training exercise

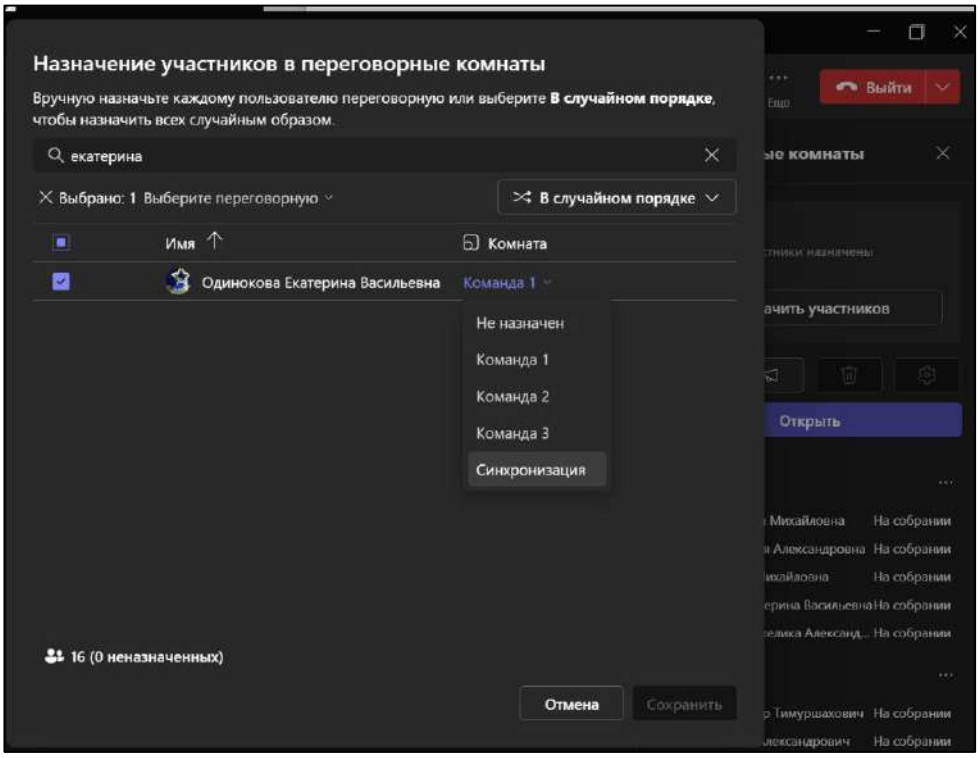


Figure N.11. – Opening a synchronization online room for representatives of online teams

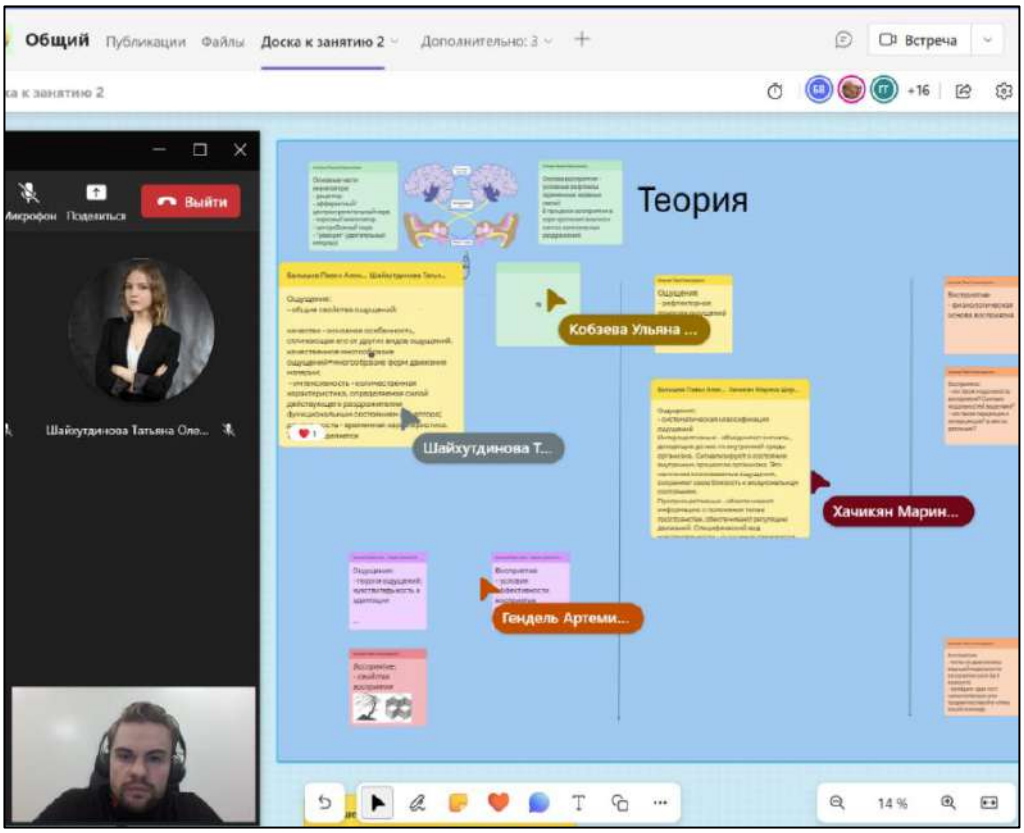


Figure N.12. – Named digital cursors as a digital footprint of online team participants

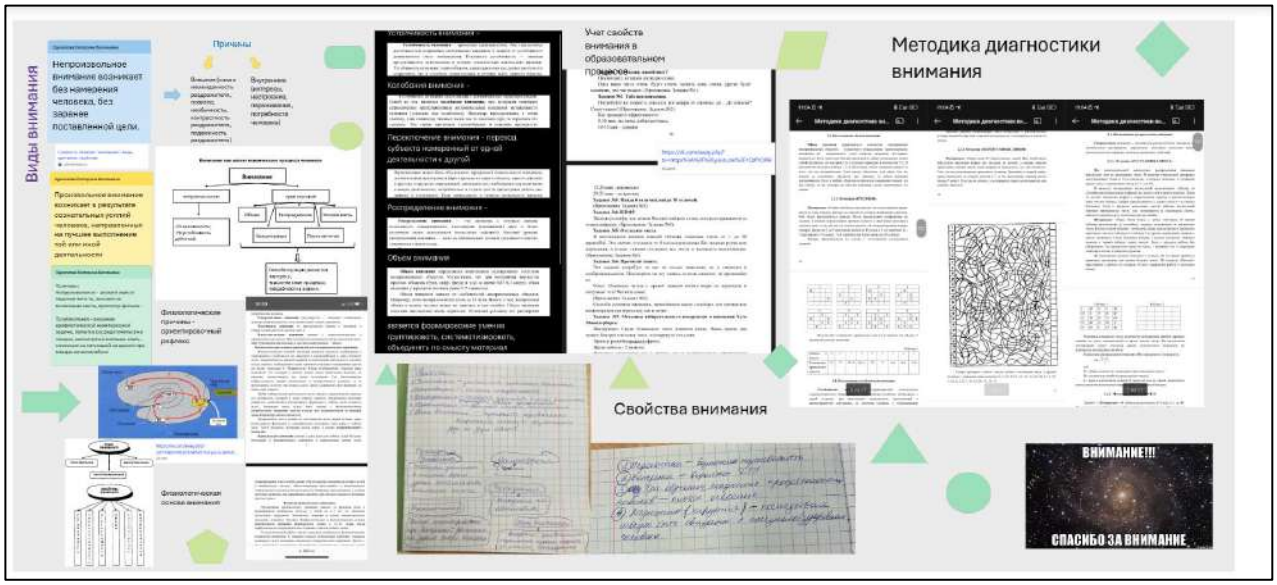


Figure N.13. – The final result of the work of one of the virtual student teams

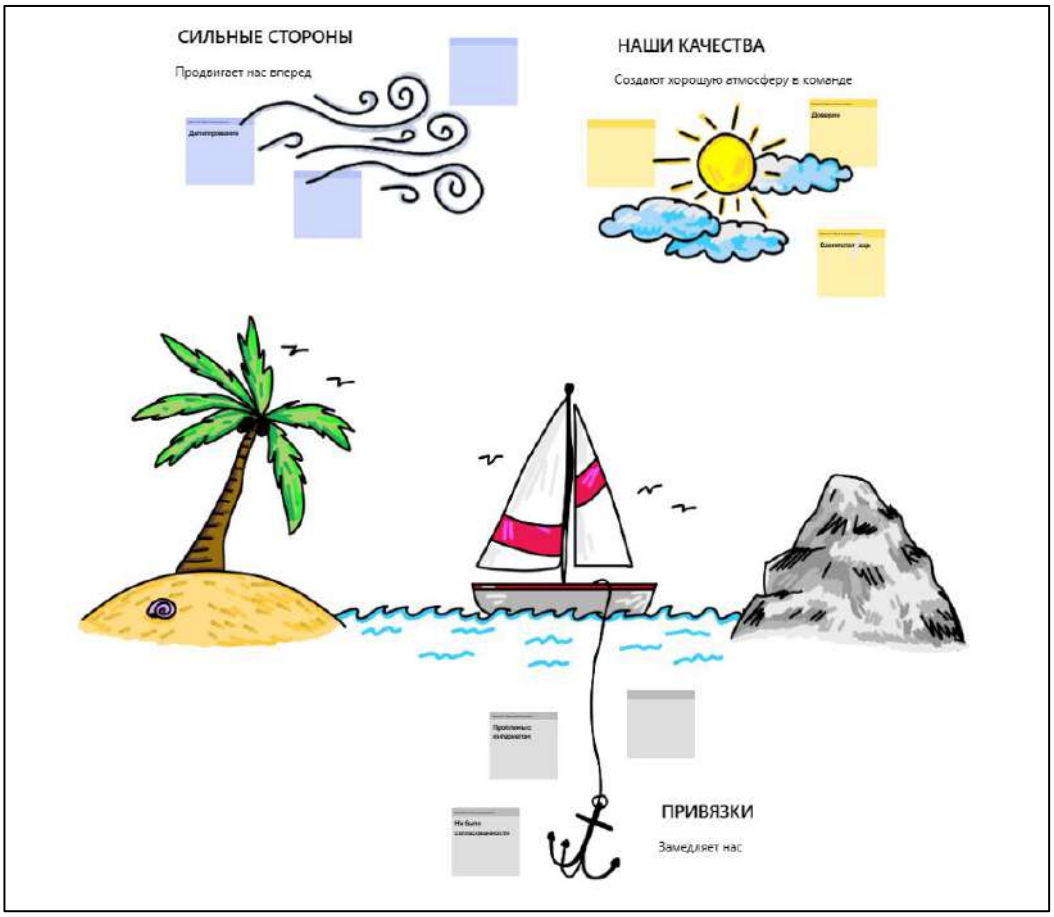


Figure N.14 – Digital template for team reflection "Sailboat"

APPENDIX O

Dynamics of Teamwork Competence Development in Students of the Control and Experimental Groups in the University's Electronic Information and Educational Environment by the end of the Experiment

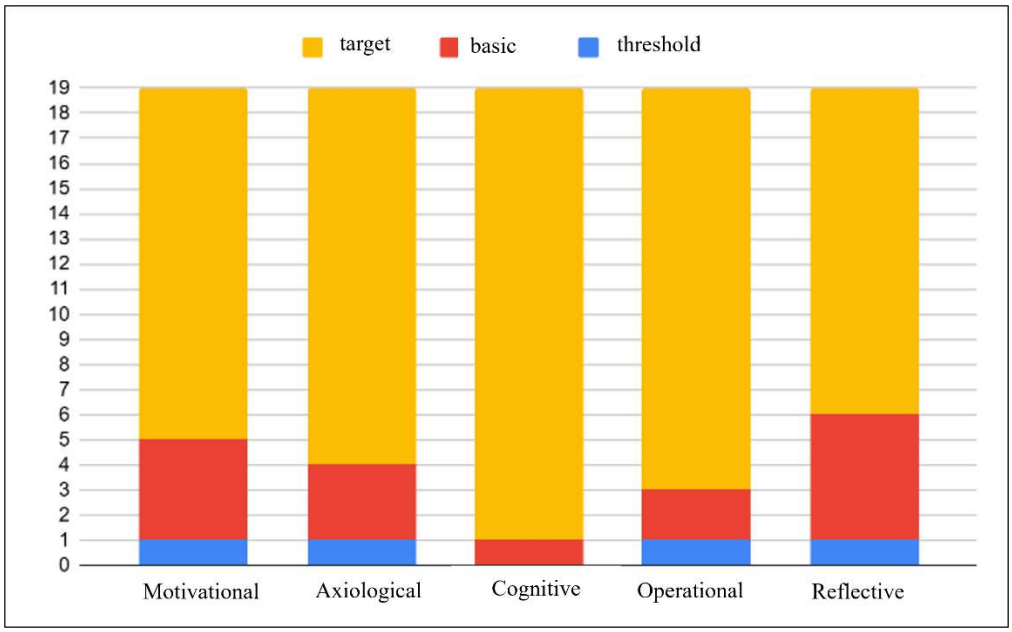


Figure O.1. – Profile of TW competence development in students of the experimental group based on the results of the final assessment

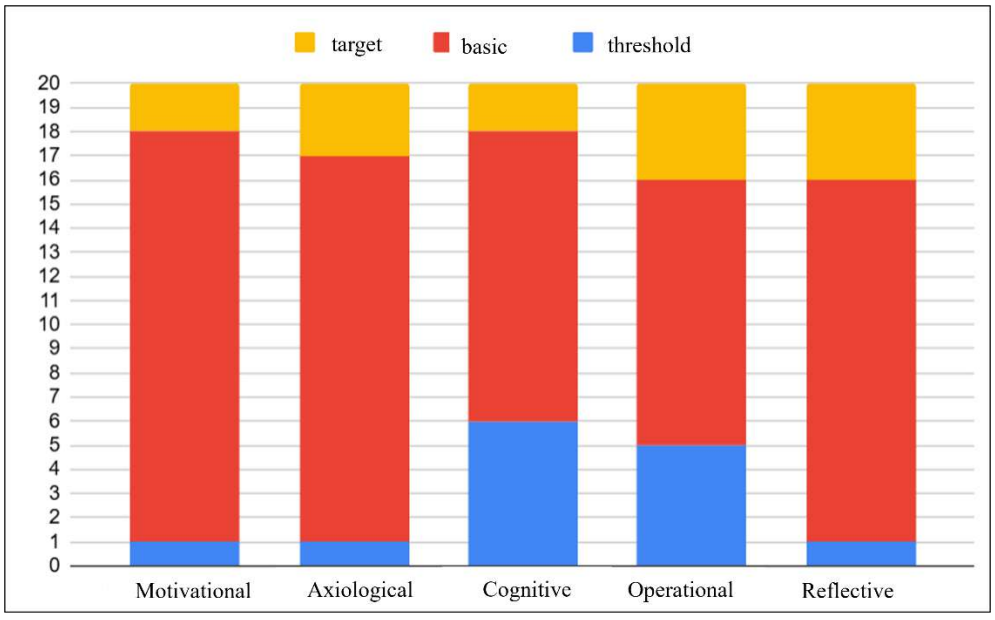


Figure O.2. – Profile of TW competence development in students of the control group based on the results of the final assessment

APPENDIX P

Examples of Methodological Recommendations for University Instructors on Organizing Student Teamwork in the University's Electronic Information and Educational Environment

Contents

The purpose of the recommendations is to outline the stages, pedagogical conditions, and tools for developing the students' TW competence in the EIEE.
Below are the methodological foundations underlying each part of the methodological recommendations.

1. TW Competence Structure	In the context of the digitalization of education, we have combined the characteristics of traditional and online teams to form a complete component composition of the competence.
2. Stages of Development	The stages presented below are based on the psychological structure of activity and its systemogenesis. At each stage, the predominant development of a specific component of the competence takes place.
3. Pedagogical Conditions	The pedagogical conditions for the development of each component of TW competence are based on the systematization of the psychological and pedagogical characteristics of students' remote team activities.
4. ICTs	The recommendations for each stage of the development of students' TW competence in the university's EIEE include a set of online resources.

TW Competence Components

01

Motivational

Personal motivation for teamwork

02

Axiological

Value-based attitude toward each team member

03

Cognitive

Knowledge of teamwork, as well as cognitive processes underlying peer learning

04

Operational

Experience in teamwork, abilities, and readiness for competence implementation

05

Reflective

Skills of self- and peer assessment, mastery of team reflection techniques

Modifications of TW Competence

Component	Modification
Motivational	Motivation for online teamwork Willingness to resume interaction in case of technical issues Quick and active engagement in online team communication
Axiological	Perseverance in mastering ICT for remote team interaction Awareness of the value of using ICT in teamwork Utilization of digital footprints to provide partners with well-reasoned developmental feedback
Cognitive	Knowledge of the specifics of distributed teamwork at each of its stages Knowledge of key online teamwork trackers and their interface features Knowledge of conflict resolution strategies in online teams Knowledge of information visualization specifics considering cognitive load factors Knowledge of methods for structuring information in digital knowledge bases
Operational	Skills in using virtual interactive whiteboard tools Ability to monitor team activities using online trackers Skill in preparing and conducting online voting Ability to use digital nonverbal reaction tools Ability to conduct and participate in team online reflection Skill in presenting teamwork results in a digital environment
Reflective	Ability to search for and analyze digital footprints of online team members Ability to forecast future work based on reflection in a digital environment Development of team-significant personal qualities through reflection in a digital environment

Factors for the Effective Development of Students' Teamwork Competence in the University's EIEE

Stages

The systemogenesis of the psychological structure of teamwork activity goes through a series of universal stages

Conditions

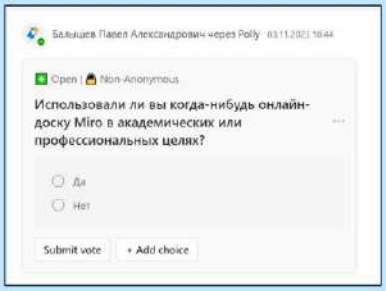
At each stage of competence component development, it is important to adhere to a set of pedagogical conditions

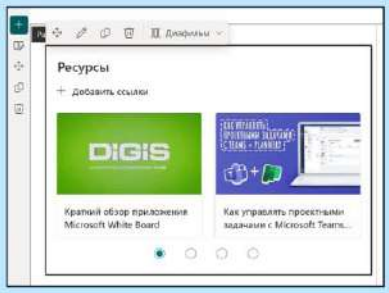
EIEE

For the effective implementation of pedagogical conditions, a didactic selection of ICT is required to design the EIEE for the development of teamwork competence

Individual-Motivational Stage

Before the start of the course, determine the students' level of digital skills development using an online survey or interactive assessment tasks. Provide instructions on working with team ICT tools in the EIEE





ICT Tools:
- Polly
- Google Forms
- Yandex Forms
- Google Drive
- EIEE File Storage

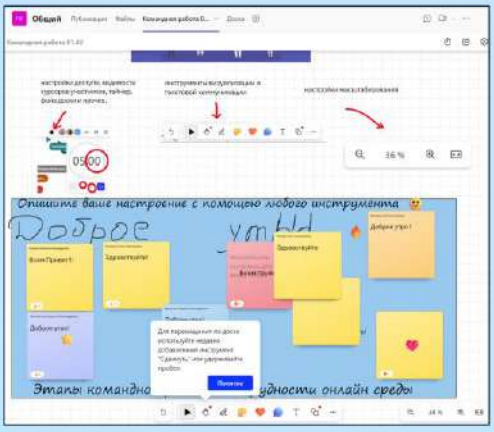
Individual-Motivational Stage

Create a dedicated training space for students with low digital skills proficiency.

For example, use an interactive online whiteboard such as Miro, MS Whiteboard, or Google Jamboard.

Using pre-prepared instructions, guide students through a series of actions and operations with various resources.

ICT Tools:
- Learning Apps
- HTML5
- Quizlet
- Miro



Individual-Motivational Stage

To reduce students' anxiety during communication in the EIEE, use problem-based questions with multiple pre-prepared answer options that students can respond to using digital reactions. For example, they can drag and drop emojis onto a digital sticky note to indicate their choice.

To create personal significance for teamwork in the EIEE, invite students to digitally record their ideas on how the project assignment related to the lesson topic will help them in their professional activities. Later, organize a group discussion to reflect on and share their insights.

ICT Tools:
- MS Teams
- Skype, Zoom
- Yandex.Telemost
- Miro
- MS Whiteboard

Key Conditions

Digital Skills

Ensuring a unified level of students' digital skills in online tools before team interaction begins

Virtual Sandbox

Creating an additional virtual space to provide training exercises for students with low digital skills proficiency

Virtual Space

Organizing a digital environment with the ability for students to move between team zones (sections of an interactive whiteboard, breakout rooms)