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## Impact of the Combination of Natural Sciences and the Humanities on the Quality of Modern Education

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**Abstract.** The paper relates to the relevance of the implementation of the integrated approach to building the higher education system. The research aimed to investigate the features of the combination of natural sciences and the humanities and consequences on the quality of higher education. One-hundred and twenty-four (124) students in their first and second years of study (bachelor's degree) from a Faculty of Natural Sciences and Geography, 29 teachers, and 15 independent experts took part in the experiment. The study was designed as a semi-experimental study that included both quantitative and qualitative methods. This included the method of self-reflective notes and expert evaluations, online questionnaires (Google Forms, Likert scale), and statistical data processing. Descriptive, content, and qualitative analysis was used for data interpretation. In general, the parties involved evaluated the concept, course, and results of the experiment positively. According to the evaluation results, the students (the focus group) evaluated the

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prospects of the integrated model positively. The teachers were the most optimistic in their predictions about the potential of integrated teaching to influence the quality of education, and the experts gave a medium score. The main difficulties were related to the establishment of appropriate conditions for cooperation in the context of distance learning and the need to work more intensively than under the traditional autonomous teaching of disciplines. Therefore, the combination of natural sciences and the humanities positively affects the quality of modern higher education during high-quality implementation of the innovative educational model. The study contributes to the present discussions about approaches of reforming and developing the HEI educational paradigm.

**Keywords:** humanitarianization of higher education; innovative teaching methods; natural sciences; quality of education; sustainable development

## 1. Introduction

Quality is one of the central concepts in modern discourses on the problems of higher education in Ukraine and the world in general (Jamoliddinovich, 2022; Seyfried & Pohlenz, 2018). The Law of Ukraine on Higher Education (Verkhovna Rada of Ukraine, 2021) defined quality in higher education as:

*“compliance of the conditions of educational activities and learning outcomes with the legislation and standards of higher education, professional and/or international standards (if available), as well as the needs of interested parties and society, which is ensured by implementing internal and external quality assurance procedures.”* (Chapter I, Article 1, Paragraph 23)

In the current law, the concept of quality is comprehensive and occurs more than 100 times in different word-formation variations. This indicates the importance of higher education in producing a high-quality educational product according to numerous parameters ensured by a whole mechanism for quality control of higher education (Vovk & Hryshchenko, 2018). For example, the section on the rights of academic, research, and teaching staff explains their right *“to choose methods and means of education that ensure high quality of the educational process”* (Verkhovna Rada of Ukraine, 2021: Chapter X, Article 57, Paragraph 5). In view of the topic of this research, the decision to intentionally combine natural sciences and the humanities to improve the quality of higher education is reasonable provided it is guided by the imperative of quality (Stukalo & Simakhova, 2020).

As for the activities of the central body on education quality issues – the National Agency for Higher Education Quality Assurance – its tasks include the development of regulations on accreditation of educational programs, as well as the analysis of the quality of educational activities of higher education institutions (HEIs). It is worth noting that the combination of natural sciences and the humanities as investigated in this paper does not occur within the scope of the presented research at the level of changing educational programs. Instead, it focuses on the level of the experimental pedagogical trend, which may result in a more comprehensive strategy for the organization of higher education in general,

or at least in the teaching of several subjects where the integration of natural sciences and the humanities is most appropriate.

According to current law, the National Agency for Higher Education Quality Assurance involves international experts, representatives of leading foreign HEIs, and/or experts from institutions that ensure the quality of higher education in other countries (Verkhovna Rada of Ukraine, 2021). This implies the openness of the quality assurance system and its synchronization with global trends in the interpretation and implementation of approaches to ensuring quality higher education.

With the global-scale transition from elite to mass higher education, the emphasis in evaluating the quality of higher education shifts towards meeting the students' needs (Alzafari & Ursin, 2019; Ruben, 2018). However, it is also important to consider the needs of the state and the labor market because of the socially determined nature of the education. This is a question of how accurately (that is, "qualitatively") a graduate of an HEI will be able to fulfil social requirements for the professional qualities of a specialist in a specific field. The standards established by the state for evaluating the professional competence of graduates must be accompanied by the state's obligation to employ graduates in accordance with the professional competence that they obtained in compliance with these standards. In this case, employers, professional public institutions, etc. should be involved in determining the indicators of the quality of education. For this purpose, university departments usually conduct questionnaire surveys among employers during the accreditation process regarding the suitability of graduates of their HEI for the position they hold and their qualifications in terms of professional duties. This is one of the most important focal points of the implementation of the integrated model of higher education, but it is quite difficult to fully investigate it within the scope of a time-limited experiment. The thesis that the modern employer prefers a versatile and harmoniously developed employee with balanced soft and hard skills and broadened competence is taken as an axiom (de Vos et al., 2021; Jelonek & Urbaniec, 2019).

The available studies deal with the direct impact of the integrated approach on the quality of the offered higher education (Leal Filho et al., 2016). HEIs around the world are increasingly paying attention to building a wider range of student competencies provided by the curriculum, which should increase students' chances of academic success and competitiveness in the labor market. In addition, an integrated approach to teaching is linked to ideas of sustainable development; integrative approaches have the potential to help embrace sustainability in a transformative way. However, existing works indicate a lack of applying the favorable potential of the integrated approach to building the higher education system. It is therefore necessary to develop new approaches and methods that can eliminate this gap, as well as to investigate how the integration of subjects of different scientific cycles affects not only students' performance but also the broader concept of the quality of education.

The aim of this research was to study the impact of the combination of natural sciences and the humanities on the quality of modern higher education. The aim involved a number of research objectives, in particular to:

1. Monitor the connection between the integrative approach and issues of the quality of higher education in current literature.
2. Determine the main indicators of the quality of higher education.
3. Organize an empirical study to determine the influence of the combination of natural sciences and the humanities on individual indicators of the quality of modern higher education.
4. Identify the features of the integration of the subjects that belong to the natural sciences and the humanities based on the criteria of contiguity, compatibility, and further research potential.

## 2. Literature Review

Natural sciences are those scientific fields that study the phenomena of the surrounding world in living and non-living nature. Therefore, natural sciences traditionally do not include research into the way of life of human society, languages, and culture, which are part of the humanities. Exact sciences such as mathematics and informatics are also a branch of knowledge separate from natural sciences or the humanities, but natural and exact sciences are closely related, while the methods and results of mathematical research are widely used in the natural science niche. This is because the natural sciences seek to explain the rules that govern the natural world through scientific methods, the cornerstone of which is quantitative data (Guo, 2018). Astronomy, biology, chemistry, earth sciences (geology, geosciences), and physics are the most important of the natural sciences. Researchers have agreed that over the past five centuries, the natural sciences have changed the way we live and think much faster than in any previous period of human civilization. The outlined paradigm of scientific directions enables discussion around the potential matrix of integration of natural and humanitarian components.

The principle of integration is one of the end-to-end notions (Dollinger et al., 2018; Kwon & Ahn, 2012). It assumes that the content of educational material and the form in which it is offered to students should be such as to form a holistic vision of the world. It understands that everything is interconnected, all distinctions are conditional and dynamic (Budwig & Alexander, 2021; Gal & Gan, 2020). That is, the principle of integration in education is based on a deep philosophical vision of world dialectics (Terepyshchyi & Khomenko, 2019).

There are various reasons for the growing interest in the integration of disciplines in higher education (Mahmud et al., 2021; van den Berg et al., 2020). First, the process of integration of the economy and labor markets stimulates the demand for competent workers with knowledge of foreign languages and social and intercultural skills. As world economies, in particular the labor and business markets, are becoming increasingly interconnected, multilingualism and intercultural skills (the component of the humanities in specialist training) are becoming increasingly important on a global scale. Furthermore, the role of the export of educational services is growing. It has become one of the sources of

income for HEIs in the 21st century and is an indicator of the success of higher education in the country in many respects. This stimulates the demand for compliance of national education systems with a single global standard. One of the trends of such a theoretically existing standard of higher education in the world is the integration of training, breadth of outlook, complex analytical thinking, and expanded competence (Prokopenko et al., 2020). These factors ensure the plasticity of professional training, that is the ability to quickly acquire new knowledge and skills necessary for the performance of specific duties. It is possible to realize this trend directly in the form of the results of the provision of an educational service through the search for ways of combining subjects of different cycles, forming and applying a model of their interpenetration. Each educational subject within the integrative approach during professional training is considered as a model of a “window” to the real world. This appeals to the reality that surrounds each individual and includes the student themselves. The principle of integration is not a set of formal schemes with functionality according to certain rigid rules. Instead, the combination of various components in the teaching process is an organic, well-thought-out combination of many dialectically interconnected processes that develop and fade according to probabilistic laws and serve as mutual stimuli for each other.

Higher education administration and, directly, HEIs are interested in integration activities, but it demands clear understanding of the rationale and motivation for the effort (Kwon, 2012). An integrative approach to curriculum development is proposed as a source of appropriate, timely, and comprehensive knowledge management in HEIs (Khan & Law, 2015).

UNICEF (2016) defined the quality of education as outcomes that encompass knowledge, skills, and attitudes and are linked to national goals for education and positive participation in society. The quality of higher education is characterized by indicators of educational contribution, the process of providing education, educational results, and context. Education indicators provide information about the state of the education system. There are a number of indicators of the quality of higher education (Florida & Quinto, 2015; Loukkola et al., 2020; Times Higher Education, 2022), although not all of them can be considered within the scope of this paper. The *teaching methodology and environment* indicator was chosen to establish a connection between the changes of the integrative nature between the subjects belonging to the natural sciences and the humanities and the quality of higher education. In their compilation of the annual world rankings of HEIs, Times Higher Education (2022) interpreted this indicator as one of the indicators that has the greatest weight of the coefficient. UNICEF (2016) defined the process as “*measuring learning, teaching and education*”.

Analysis of several of the above-mentioned works and official documents from international educational organizations has clearly shown that the education quality assessment system lacks a single algorithm that would determine the quality of learning and the quality of teaching within the scope of activities of HEIs. This statement was made by the European University Association (Loukkola et al., 2020). However, based on the generalization of the analyzed

works, we have determined the basic algorithms that are relevant for the current study:

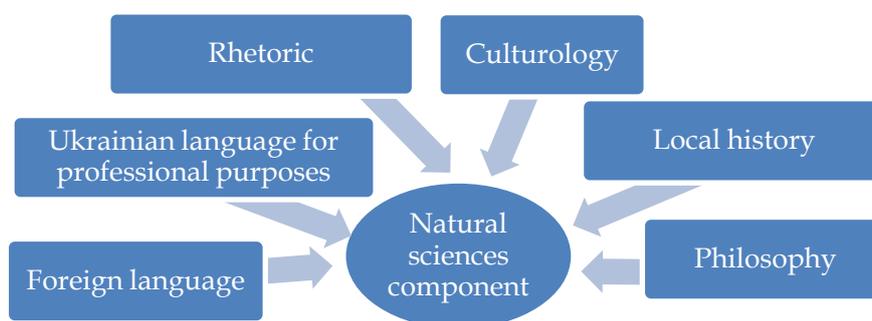
- Independent assessment of educational programs and the scheme of integration of the components of natural sciences and the humanities, observation of open classes by a committee of experts from other HEIs.
- The level of students' satisfaction with the quality of teaching material, evaluation of their own development trajectory within the framework of the integration paradigm of education, and impact on employment opportunities.
- The level of teachers' satisfaction with the students' work in classes, their individual academic growth, the development of hard and soft skills, and the quality of the integrative presentation of the material.

### 3. Methods

#### 3.1 Research Design and Procedures

The study adopted characteristics of both explanatory design and exploratory design. First, quantitative data were collected and analyzed, followed by qualitative data collection and analysis. The qualitative data helped explain the quantitative results. In addition, characteristics of exploratory design study were employed. That is, qualitative data and analysis regarding multiple sides of the integrated approach of education and quality of education were conducted before exploring the research questions using quantitative methods.

The first stage of the research involved the development of a paradigm of projected integrative connections (between the subjects belonging to natural sciences and the humanities) (Figure 1). Even for the purpose of the experiment, it was not possible to change the set of studied subjects because of the fixed educational and professional programs for specialists in a certain field. Therefore, the model was designed to integrate the humanities component as much as possible into the subjects available in the schedule of classes and to study the impact of this integration on the indicators of the quality of education determined in the literature review.



**Figure 1: Integrative model of education within the scope of the experiment**

Teaching and learning methods optimal for the implementation of integrative connections were also determined. In particular, these were: project learning, business game method, essay method, research proposal, jigsaw methods, etc. The

teachers of the natural sciences and the humanities jointly developed a combination algorithm, namely the teaching of the natural sciences component with a broad integration of humanitarian knowledge, skills, and abilities in order to shape students' holistic, dialectical vision of the world and themselves in it. A broad integration of the humanitarian component was ensured for the teaching of subjects belonging to the natural sciences, such as Physics, Biophysics, Introduction to the Profession, Anatomy and Morphology of Plants, Invertebrate Zoology, Meteorology and Climatology (1st year); and Soil Science, Basics of Herbarium Work, Histology with the Basics of Cytology and Embryology, and Methodology of Cytological Research (2nd year).

Integration took place at all levels of teaching. For example:

- 1) A number of classes were conducted in a foreign language (lecture, practical, laboratory).
- 2) Specialists from abroad were involved, with whom scientific conferences, symposia, and meetings were held (for this purpose, partnership cooperation with teachers from Poland, Romania, and Austria was established).
- 3) During classes held in Ukraine, experts in the humanities taught students to express their opinions in compliance with current language norms, as well as in accordance with the tools of practical rhetoric.
- 4) Humanitarians actively worked with students when they learned the scientific style required for preparing project and scientific works, specifically in essay-writing (scientific journalistic style).
- 5) The connection with philosophy was implemented in the direction of developing issues of the material or ideal as the primary basis of all existence, issues of the cognoscibility of the world, ontology, metaphysical or dialectical order of the world, and the birth of natural sciences from philosophy as the cradle of all sciences.
- 6) Furthermore, local history expeditions were held within the scope of studying the specified subjects.
- 7) Lastly, the connection between the achievements of humanity in the natural sciences and in cultural studies was established. Attention was paid to how the world of living and non-living nature was reflected in the cultural situation in the region, in particular how this was reflected in the folklore heritage of the region.

The first stage of integration lasted from January 2019 to March 2020. The preparation for the integration of the experiment required a lot of organizational planning and conceptualization of the research idea, as well as the possibilities of its implementation in view of the need to fulfil the traditional scope of the program load.

The second stage (March 2020 – September 2022) involved the implementation of the idea of integrated teaching of subjects belonging to natural sciences and the humanities. The course of experimental training was recorded by all teachers involved in the experiment in the form of reflective notes. At the same time, the planned learning algorithm was adapted to the distance and mixed learning,

which was connected first with quarantine measures and then with the introduction of martial law in the country.

In the third stage (September 2020 – October 2022), a survey was conducted among a group of independent experts, students, and teachers. The survey regarded the consequences of the integration of the components of natural sciences and the humanities. Special electronic questionnaires were previously developed for this purpose.

### **3.2 Data Analysis**

The results of the experiment were summarized in November 2022 after all three stages had been completed. In the final stage, the notes in the diaries from the experiment were analyzed (diaries were kept by both students and teachers). A joint summarizing conference-meeting of teachers and independent experts was held.

### **3.3 Sampling**

The empirical study was conducted at the Faculty of Natural Sciences and Geography of Pavlo Tychyna Uman State Pedagogical University. The experiment involved 124 students in their first and second years of study (bachelor's degree), 29 teachers, and 15 independent experts. The group of independent experts consisted of representatives of four other HEIs in Ukraine and one HEI in Poland (three representatives from each HEI). All participants provided their voluntary written consent to participate in the experiment.

### **3.4 Methods**

In addition to traditional research methods (general scientific methods), the methods of self-reflective notes and independent expert evaluations were employed. Furthermore, the author questionnaires were developed (data collection was organized through Google Forms). A five-point Likert scale was used in the questionnaires (1 - *strongly disagree*, 2 - *disagree/do not support*, 3 - *neither agree nor disagree*, 4 - *agree/support*, 5 - *strongly agree*). Statistical data processing was carried out using Microsoft Excel.

Regarding the validation of the data collection tools (questionnaires), they were tested for validity and reliability before the study commenced. This included an analysis of their construct validity and internal consistency. During data collection, the trustworthiness of the questionnaires was verified (the correctness of completing the questionnaires was checked, the absence of random or systematic errors was checked). In addition, peer-reviewing was also employed by involving experts, who helped to verify the logic, discuss the conclusions, and ensure an independent evaluation of the results. Descriptive, content, and qualitative analysis was used for data analysis.

## **4. Results**

### **4.1 Independent Assessment by the Expert Committee**

The group of independent experts worked with students and teachers within the scope of the experiment and had access to all research program materials, teaching

materials, and classes. Even before the experiment, the research project was approved by the expert group. According to the results of the final questionnaire survey, evaluations were received from the experts on several questions posed to them (Table 1).

**Table 1: Indicators of expert questionnaire survey regarding research results**

No.	Questionnaire item	Statistical average answer
1.	The combination of the components of natural sciences and the humanities has a positive effect on the quality of higher education	4.1
2.	The integration of the components of natural sciences and the humanities corresponds to world trends in education	4.3
3.	The combination of the components of natural sciences and the humanities increases students' motivation to study	4.0
4.	Evaluate the developed integration algorithm	4.2
5.	Evaluate methods of working with students within the scope of the experiment	4.3
6.	Evaluate the completeness of the implementation of the experimental design	3.6
7.	Evaluate the impact of the integration of the components of natural sciences and the humanities on the development of students' hard skills	3.6
8.	Evaluate the impact of the integration of the components of natural sciences and the humanities on the development of students' soft skills	3.8
9.	Evaluate the completeness of the integration of the components of natural sciences and the humanities within the scope of the experiment	3.7
10.	The integration model of higher education increases students' chances of employment after obtaining a diploma	3.8
<b>Average score = total coefficient of positive evaluation</b>		<b>4.1</b>

The standard deviation scores concerning responses to each of the listed questions (Table 1) ranged from 0.276 – 0.713. In this case, a small value of the standard deviation indicates that the values hardly deviate from the mean value. This can be the case when the data in a study or data set have low variation or when it is very close to the mean. This validates the obtained results. Table 1 shows how the experts rated the questions that related to the design of the experiment and the conceptual model of the integrated study of the components of natural sciences and the humanities. As for the consequences of its implementation, the lowest scores were obtained for the evaluation of the real results of the experiment. Medium scores were obtained for the development of students' hard and soft skills within the framework of the implementation of the experimental model of education. At the final conference, the representatives of the expert group discussed the inconsistency of the originally designed model of the experiment in the limited learning tools that could be used during distance learning, especially after the introduction of martial law, when distance education was mostly asynchronous. According to the experts, the potential of the combination of the components of natural sciences and the humanities to increase the chances of

employment has been poorly studied. Therefore, this aspect requires an additional mechanism for establishing an objective connection between the two mentioned factors. Moreover, it requires an expansion of the temporal coverage of the experiment (at least 10 years).

#### 4.2 Level of Students' Satisfaction

The opinion of students as the main participants of the experiment is paramount, as related to them being its target audience in particular and to the goal of all pedagogical intentions in general. According to modern concepts of education, the student is an active subject of education and can therefore influence the educational process directly or through influencing the transformation of pedagogical approaches in a way that corresponds to the modern generation of learners. The student evaluations of the experiment on the combination of components of natural sciences and the humanities are presented in Table 2.

**Table 2: Indicators of student questionnaire survey regarding research results**

No.	Questionnaire item	Statistical average answer
1.	The combination of the components of natural sciences and the humanities has a positive effect on the quality of higher education	3.7
2.	I consider the humanitarian component important in training me as a natural science specialist	4.1
3.	The subjects belonging to the humanities contributed to the development of soft skills	3.9
4.	The integration model of learning stimulated my motivation to acquire new knowledge	3.9
5.	The integration model of education did not stand in the way of fully mastering hard skills on the subjects belonging to the natural sciences	4.0
6.	It was not difficult for me to learn within the scope of the experiment	3.4
7.	I received enough support from the teachers of the subjects belonging to the natural sciences and the humanities who worked with us	3.3
8.	The integration model of higher education increases my chances of employment after graduation	3.7
9.	I would like to adhere to the integration model of education in the future, upon completion of the official part of the experiment:	3.9
	9.1. Under any further learning format.	3.5
	9.2. I consider integration expedient only under the context of full-time education.	4.6
10.	I think that the study of the subjects belonging to the natural sciences independently from others does not meet the current requirements	4.5
<b>Average score = total coefficient of positive evaluation</b>		<b>3.9</b>

The standard deviation scores concerning responses to each of the listed questions (Table 2) ranged from 0.477 – 0.857. The data values in the set are moderately scattered around the mean. This may indicate that the data or data set have

moderate variation. The results of evaluation by the students testify, first, to the factor of remote educational interaction as the most negative in influencing the potential of achieving good results with the experiment. Question 9 (9.1 and 9.2) is significant in this regard, where students considered it appropriate to conduct such an experiment during offline learning. Question 7 is also related: As a result of remote, and even more, forced asynchronous interaction, students experienced a lack of support from the teachers of the subjects belonging to natural sciences and the humanities who worked with them (3.3 out of 5). The result for Question 6 also indicates that students faced difficulties with the work. However, Question 10 is ideologically significant and decisive in this case. The majority of students involved in the experiment admitted that the study of the subjects belonging to natural sciences independently from others does not meet the current requirements (4.5 out of 5).

#### 4.3 Level of Teachers' Satisfaction

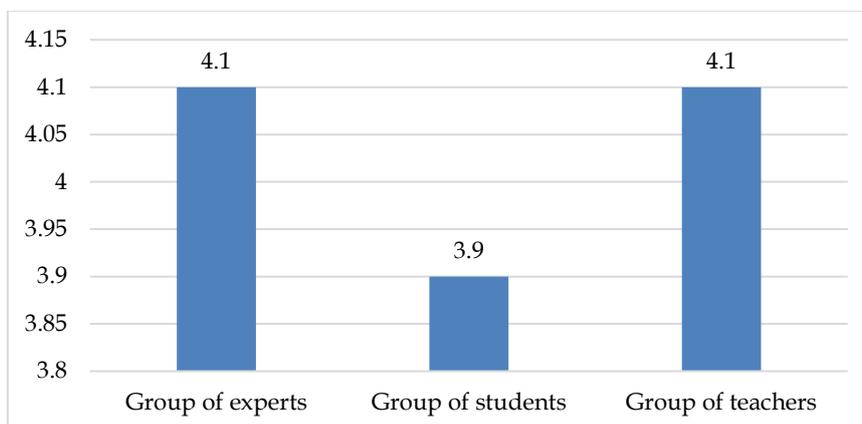
The teachers were specially selected for the integration of the experiment to produce a team of like-minded professionals. Therefore, all the teachers expressed a positive attitude towards the idea of the experiment and its potential to influence the quality of education in the conditions of the modern social space. Table 3 presents the results of the teacher survey.

**Table 3: Indicators of teacher questionnaire survey regarding research results**

No.	Questionnaire item	Statistical average answer
1.	The combination of the components of natural sciences and the humanities has a positive effect on the quality of higher education	4.8
2.	It was not difficult for me to teach according to the integrated model of education	3.3
3.	The combination of the components of natural sciences and the humanities did not negatively affect the results of teaching my subject	4.3
4.	The integration model of higher education creates a springboard for the widespread use of innovative teaching methods	4.8
5.	I was sufficiently prepared to implement the experiment	3.8
6.	I did not experience insurmountable difficulties during the implementation of the integration model of education	3.7
7.	I positively evaluate my work as a teacher	4.0
8.	I positively evaluate the dynamics of building professional competences by students majoring in natural sciences in the context of a combination of the components of natural sciences and the humanities	3.9
9.	The integration model of higher education increases students' chances of employment after obtaining a diploma	3.9
10.	The combination of the components of natural sciences and the humanities has the potential to positively affect the popularity of natural sciences	4.5
<b>Average score = total coefficient of positive evaluation</b>		<b>4.1</b>

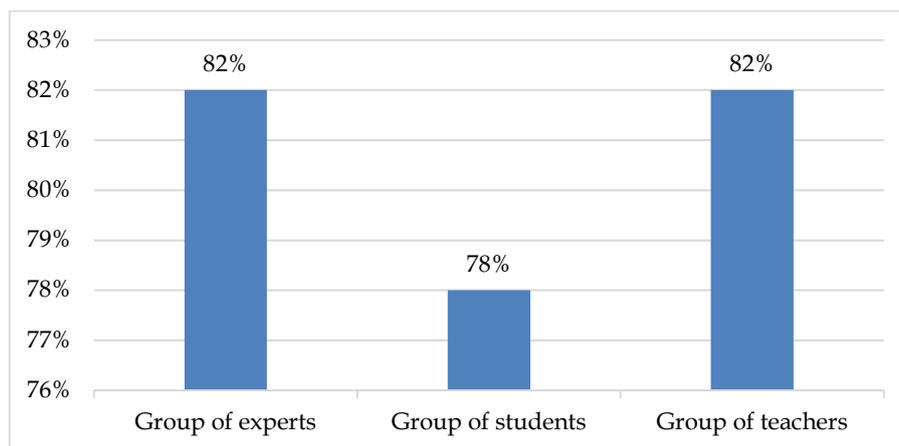
The standard deviation scores concerning responses to each of the listed questions (Table 3) ranged from 0.316 – 0.584. Questions 5, 6, 7, and 10 obtained the most significant results. The results show that the teachers were not adequately ready for the experiment. The final conference clarified the unwillingness to implement the experimental model in the context of distance learning, as well as a number of other difficulties that traditionally arise at the stage of implementing a pedagogical plan. The difficulties were easier to deal with. This meant the need for additional consultations with students, the development of a larger number of methodological materials, close interaction with teachers of the subjects belonging to the humanities, and the need for spontaneous correction of the initial pedagogical ideas regarding the experiment. A quarter (26%) of the teachers reported that they experienced insurmountable difficulties during the implementation of the integration model of education. This may indicate, first, lack of experience in pedagogical experiments of this type. Second, it may indicate the complexity of the experiment itself, which requires extremely careful preparation and is at risk in case of significant changes in the circumstances of its implementation. However, in the end, the majority of the teachers indicated that they were mostly satisfied with the results of their teaching. The plans to improve the experimental model of education were drawn up at the final conference. A positive assessment of the impact of the integration model of higher education on increasing the popularity of natural sciences (4.5 out of 5) is important.

It is important to compare the indicators of the assessment of this impact by different parties of the experiment (independent experts, teachers, students), as the topic of the study relates to the impact of the combination of the components of natural sciences and the humanities on the quality of higher education. Figure 2 shows the comparative chart in this regard.



**Figure 2: Comparative chart on the combination of the components of natural sciences and the humanities, indicating a positive effect on the quality of higher education**

The overall coefficients of the positive evaluation obtained from the different parties of the experiment (experts – 4.1, students – 3.9, teachers – 4.1) must also be compared. Figure 3 illustrates the results as a percentage.



**Figure 3: Comparative coefficients of the positive evaluation of the concept and consequences of the experiment**

## 5. Discussion

In many developed countries, particularly the United States, a broad study across a range of subjects, as well as in-depth study within a specific area of interest, has long been a defining feature of higher education (Skorton & Bear, 2018). Researchers have criticized the existing opposite trend, which is defined as an approach heavily rooted in disciplinary silos – artificial separation of academic disciplines (Skorton & Bear, 2018). An example of the integration of different fields of knowledge in the pedagogical systems of developed countries can be a guarantee of successful transformation of the sphere of higher education for developing countries as well (Lim, 2017). The conducted theoretical and empirical research enabled the singling out of the main tasks of the integration process in higher education for the near future. The research concerned the theoretical study of the concepts of integrated teaching of subjects in high school, quality of higher education, and experimental verification of the influence of the combination of the components of natural sciences and the humanities on the quality of education. This was done at the level of immediate reflection of the consequences on such indicators of the quality of education as meeting the students' needs and requests, creating employment opportunities, and ensuring sustainable development in education.

The main tasks of the integration process in higher education in the near future are explained next. First, the scientific and practical orientation of the educational process must be enhanced based on the integration of subjects of various fields (in accordance with the principles of dialectics, based on the understanding of the world and reality as a constantly changing, interconnected, and mutually determined entity). Second, education must be adapted to the modern labor market, which requires a person with a higher education qualification to have an integrated outlook and comprehensive universal competences. Employment opportunities retain one of the important places in both the educational and general political agenda. Universities must demonstrate that their educational services produce more attractive employment opportunities for students; governments must ensure the development of sufficient human capital to compete in the global market (Gal & Gan, 2020). This is a condition necessitating

the development of education for sustainable development, which is based on an integrative approach where sustainability is considered as a context for achieving the goals of education. Third, the spiritual and humanitarian component in education must be strengthened – supporting the trend towards humanitarianization of education (Yevsovyh, 2021).

The data of the conducted research confirm the opinion that an integrated approach to teaching contributes to the improvement of students' oral and written communication, teamwork skills, decision-making, critical thinking, and ability to apply the acquired knowledge in real life (Gidley et al., 2010; Skorton & Bear, 2018). An important finding of this study is the participating students' support of the thesis that the study of subjects belonging to the natural sciences independently from others, as revealed as a result of the experiment, does not meet the requirements of modernity. Instead, the humanitarian context of education enriches the natural sciences background and creates a favorable basis for the development of soft skills, the role of which is growing rapidly in the European and global context and is sometimes even a prerequisite for hiring an employee (Kwan et al., 2018). A positive point is that the integrated teaching of subjects from various fields of science and practice creates a favorable paradigm for the introduction of the latest methods and technologies of education. Therefore, integration qualitatively renews the entire system of higher education (Seyfried & Pohlenz, 2018; Zidny & Eilks, 2020) and leads to positive transformations, the full scope of which remains to be clarified in further research on the topic.

The results of the conducted experiment revealed difficulties in the implementation of the initial idea regarding the combination of the components of natural sciences and the humanities. The difficulties that arose had an impact on the results of the experiment both on the part of the teachers and that of the students. However, the experiment conducted in crisis conditions enabled confirmation of an important thesis about the prospects of integrated teaching of subjects in universities: the correspondence of this trend to the modern educational context.

The experiment also revealed that integrated teaching, although being the best option for acquiring professional competencies (combined with soft and hard skills), requires additional efforts from both students and teachers. That is, it challenges the comfort zone of all parties in the pedagogical process as well as their readiness for intensified work. In addition, the combination of the components of natural sciences and the humanities requires close cooperation between all subjects of education, an appropriate level of communication, and readiness to provide additional help and consulting support on the part of teachers. Furthermore, teachers of the natural sciences and the humanities must also be ready to create optimal conditions for cooperation among themselves at the level of co-organization and a mutually beneficial combination of educational material.

Integrated teaching of subjects that combine the components of the natural sciences and the humanities requires close interaction and constant coordination of actions by the participants of the process. Therefore, offline education is the best method for implementing the ideas of interdisciplinary integration. The need for distance and blended learning had an impact on the course of the experiment, in particular on the opportunities to fully implement all ideas and on the psychological background of the participants. We assume that the results for the selected criteria could be higher in case of implementation of an already improved version of the organized experiment (considering the primary experience) under normal rather than crisis conditions.

The current work partially fills the gap on the lack of empirical and theoretical research on the practical application of the favorable potential of the integrated approach to improve the existing system of higher education. Research has been conducted on how the integration of disciplines of different scientific cycles (using the example of humanities and natural sciences components) has a positive effect not only on the success of students but also on the broader concept of the quality of education. The algorithm provided by us was tested only once and in the circumstances specifically described in this work. Consequently, more algorithms for the integration of disciplines of different cycles should be developed and implemented as well as empirically tested in the future at different levels and specialties of higher education.

## **6. Conclusion**

An integrated view of the phenomenon of human knowledge is reflected in the history of higher education – from the traditions of Socrates and Aristotle to current days. Einstein's opinion about science as a tree with different branches is well known. Therefore, the components of natural sciences and the humanities are not polar paradigms with limited points of contact that cannot be integrated. First, this applies to the method of identification of sciences of various fields and the method of pedagogical interpretation of knowledge. Multi-vector and interconnected higher education is important for preparing citizens for life, work, and participation in the social life of the community. The leading world educators are deliberating over overcoming the artificial technocratic tendency of the study of subjects independently and separated from others which are not the field of professional interests of students.

The participating students and teachers, as well as group of independent experts, generally positively evaluated the experimental primary implementation of integrated teaching of natural sciences and the humanities. The progressiveness of such an approach and its compliance with modern ontological models of the world, with students being active participants in the future and during their studies at HEIs, have been confirmed.

The results of the experiment can be used to conduct similar studies or to develop other integrative models of education for students of HEIs (for example, combining technical sciences and the humanities). The limitations that were discovered in the process of the experiment can serve as guidelines for

maximizing the positive effects of further experimental studies of integrated science teaching in HEIs.

## 7. Recommendations

In Ukraine, the issue of the unpopularity of natural sciences is acute. We consider it appropriate that a special career guidance survey be conducted among university entrants to determine the reasons. The options include offering a model of the integration of the components of natural sciences and the humanities in the form of presentations with a photo and video report prepared during the research. The explanatory work with potential university entrants will be followed by a survey on whether the integration of the components of natural sciences and the humanities in the educational process of students majoring in natural sciences will contribute to its popularization among young people. This will compensate for the lack of personnel, thereby fulfilling the social order for competent and comprehensively developed specialists in natural sciences.

## 8. Limitations

During the development of the research paradigm regarding the influence of integration relations in teaching subjects of various fields on the quality of education, we faced the issue that a very limited range of indicators can be taken into account in a time-limited empirical study. For example, the employability rate is one of the key indicators of the quality of education today. It was virtually impossible to determine the impact on this indicator in the context of this study. Potentially, the combination of the components of natural sciences and the humanities can affect other indicators of the quality of education. This is true especially if we take into account that this concept has not been standardized on a global scale, it is not unified, hence there being a terminological looseness.

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