Эффект внедрения модульной системы обучения на факультете безопасности

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АННОТАЦИЯ

Введение. Один из возможных подходов к повышению конкурентных преимуществ в сфере образования может заключаться в переходе к модульной структуре учебного процесса. Учитывая растущую популярность образовательных платформ в последнее время, есть смысл изучить возможность применения схожего принципа к университетскому образованию с учетом психологических предпочтений студентов в обработке информации. В рамках эксперимента была изменена структура учебного процесса и оценено влияние модульной системы организации учебного процесса на успеваемость учащихся.

Цель исследования – научно обосновать полезность разбиения семестров на отдельные модули с точки зрения повышения оценки успеваемости студентов.

Материалы и методы исследования. В качестве материала исследования выступили результаты итоговой аттестации студентов по дисциплинам образовательной программы. В эксперименте приняли участие 498 студентов и 18 преподавателей, задействованных в реализации модульного формата проведения занятий на факультете безопасности Томского государственного университета систем управления и радиоэлектроники (Российская Федерация). Данные были проанализированы с применением критериального метода оценки. Оценка по каждому сформулированному критерию проводилась независимо.

Результаты исследования. В рамках настоящего исследования удалось выявить положительный эффект применения модульной системы организации учебного процесса: повышение сохранности контингента учащихся, повышение абсолютной и качественной успеваемости. Анализ междисциплинарных связей в процессе реализации образовательных программ позволил оптимизировать последовательность изучения дисциплин и повысить процентное соотношение студентов, сдавших дисциплину в период сессий. Абсолютная успеваемость студентов после внедрения модульной системы обучения в среднем по факультету выросла на 14%, а качественная успеваемость возросла на 19%. Кроме того, был снижен процент отчисляемых студентов по специальностям от 5 до 23%. Проведенный опрос среди участников эксперимента показал, что большая часть студентов (75%) и преподавателей (83%) оценила достоинства новой модели и готовы продолжать работать по ней.

Заключение. Изменение психологических особенностей восприятия информации представителями разных поколений требует постоянной работы по совершенствованию подходов к реализации образовательных программ. Направленность современного общества на микрообучение приводит к необходимости изменения графика учебного процесса, в рамках которого дисциплины изучаются в более сжатые сроки. Применение такого подхода позволяет повысить качество образовательного процесса.

КЛЮЧЕВЫЕ СЛОВА

график учебного процесса, модульное обучение, повышение качества образования

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The effect of introducing a modular training system at the Faculty of Security

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ABSTRACT

Introduction. One potential approach to enhancing competitive advantage in education may involve shifting the way the learning process is structured to a modular framework. This approach is analogous to the way courses are structured on educational platforms. Considering the rising popularity of such courses in recent times, there is merit in exploring the possibility of applying this principle to university education, considering students' psychological preferences for information processing. As part of the experiment, the structure of the educational process was changed and the impact of the modular system of organizing the educational process on student performance was assessed.

Purpose of the study: scientifically substantiate the usefulness of dividing semesters into separate modules in terms of increasing student performance assessment.

Materials and research methods. The research material was based on the results of final certification for students in the various subjects of the educational program. The experiment involved 498 students and 18 teachers involved in the implementation of the modular format of conducting classes at the Faculty of Security of Tomsk State University of Control Systems and Radioelectronics (Russian Federation). The data were analyzed using a criteria-based assessment approach. The assessment of each formulated criterion was conducted independently.

Research results. Within the scope of this research, we have been able to identify a positive impact from implementing a modular system in the educational process. This led to increased safety for students and improved academic performance. Analysis of interdisciplinary links within educational programs allowed for optimization of subject sequences and an increase in student passing rates. As a result, there has been an increase in the percentage of students completing courses on time. The number of students passing courses has increased by up to 14%, and quality performance has improved by up to 19%. Additionally, the rate of student dropouts has decreased. The introduction of a modular system has led to a 5-23% improvement in student safety.

A survey of participants in the experiment showed that the majority (75% of students and 83% of teachers) appreciate the benefits and are willing to continue using the new approach.

Conclusion. Changing the psychological characteristics of information perception among different generations requires ongoing efforts to improve educational approaches. In today's society, which focuses on micro-learning, there is a need for a shift in the structure of the educational process. This involves covering subjects in shorter periods, which allows for a more efficient learning experience.

KEYWORDS

education, educational process schedule, modular training, improving the quality of education

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INTRODUCTION

The United Nations (UN) plays a significant role in promoting initiatives to improve the international competitiveness of education through collaboration, innovation, and reform of educational systems. The organization has launched several programs to enhance the competitiveness of educational institutions globally, focusing on providing quality education, promoting digitalization, and ensuring inclusivity. These initiatives aim to transform education systems to meet the demands of the 21st century and increase the demand for internationally recognized higher education.

The UN promotes academic mobility for students and teachers by recognizing qualifications and facilitating access to educational opportunities through its programs. One notable example is its development strategy for technical and vocational education (2022-2029), which aims to improve the quality, relevance, and appeal of these programs to contribute to a successful and equitable societal transformation. Many studies in the field of education focus on addressing the specific needs of UNESCO programs. McGrath [1] has been given significant attention to investigating the positive impacts of implementing these initiatives in various countries. For example, an evaluation of a particular program has been conducted, ranging from examining the connections between various sustainable development objectives to planning for future phases of implementation. One of the fundamental principles underlying the development of society, as outlined in this article, is the interdependence of all sustainable development objectives. For instance, the authors emphasize the clear correlation between SDG 4 (Quality education) and SDG 8 (Decent work and economic growth). Therefore, it can be inferred that by working towards improving the quality of education, society may directly or indirectly contribute to achieving other SDGs.

The relevance of research in the field of educational technology lies in its potential to improve the quality of education, which is a priority for state policy in this area. This emphasis on the importance of accessibility and effectiveness at all levels of education highlights the need for regular monitoring and assessment of learning outcomes. In today's rapidly changing society and economy, education must constantly adapt and innovate. Modernization and innovation in educational institutions is essential for improving the teaching process and ensuring that students are equipped with the knowledge and skills they need to succeed in the job market. This includes not only providing them with the necessary knowledge but also developing their ability to think critically and solve problems. By focusing on these aspects, educational institutions can ensure that students are well-prepared for the challenges of a rapidly changing world and contribute to their individual success and overall well-being.

The importance of information security education in Russia is driven by several factors. One significant factor is the increase in cyber-attacks and data breaches in recent years, which have highlighted the need to protect personal and organizational information from unauthorized access and theft. These events emphasize the importance of having information security professionals who can prevent these incidents and ensure the safety of institutions and businesses. Another factor contributing to the significance of information security training is the growing demand for skilled professionals in this field. Organizations recognize the importance of data protection and seek to hire qualified individuals who can implement and maintain robust security measures. This makes information security a promising career path for those with an interest in technology and problem-solving.

The arguments presented above demonstrate that information security training has an advantage over other educational programs for potential students. However, it should be noted that creating a positive image of the profession also plays a role in attracting more educational institutions to offer these programs. To ensure the success of these programs and continue attracting interested students, it is crucial to develop personal competitive advantages.

The key characteristics of any educational program are the quality of its implementation and the attractiveness of the program for applicants. These indicators work in close conjunction with each other. Attracting applicants to any field of study without quality development of competencies will lead to a decrease in the attractiveness of the educational institution, and therefore to a decrease in its competitiveness in comparison with similar offers from other universities. Many research works are devoted to the issue of competitive advantage of educational institutions. The study presented by Huriya [2] discusses the issue of students' choice of educational institutions as a source of competition between them. The paper examines various prerequisites for creating competition

when choosing an educational institution. Including political, economic, social living conditions of applicants. The analysis revealed a slight positive effect of such competition on student performance.

Miotto [3] considers the influence of the reputation of an educational institution on its legitimacy in the eyes of employees of educational organizations and, therefore, on its competitive advantage. It is worth noting that the work does not consider the impact on students studying at the educational institution, or applicants choosing this university for admission. However, this allows us to build a chain of conclusions Aledo-Ruiz [4], leading to the conclusion about the high quality of work of employees who are legitimate in their place of employment. And high-quality teaching of academic disciplines, in turn, should have a positive impact on the quality of development of students' competencies. Research is devoted to the issue of student loyalty based on the quality and implementation policy of educational programs. Hoa [5] noted that the quality of graduate training is closely linked to the policy of implementing educational programs. Borishade [6] have concluded that the loyalty of students and graduates to the educational institution increases. Aledo-Ruiz [4] also emphasizes the importance of creating an emotional connection between the educational institution and the student. Emotional appeal involves creating pleasant emotional responses that can be associated with a good impression of the organization. This in turn leads to a positive attitude and dedication to the university and, as a result, his inspiration to participate in the educational and scientific activities of the organization. These indicators are an important criterion when assessing university rankings.

The issue of competitive advantage is also addressed Dian [7]. The study specifically notes the importance of attracting specialists in the professional field of implementing educational programs. Monteiro [8] also notes the importance of attracting talented specialists. This is a significant investment in the organization's reputation. In turn, attracting qualified personnel requires appropriate policies to retain talented specialists.

The study presented Komljenovic [9] aims to assess the impact of the development of digital platforms and their application on competition in the field of education. It is noted that a particularly large surge in the development of educational platforms occurred during the 2020 pandemic, which led to the need to transfer educational processes to a remote format. The development of such courses has led to the formation of short-term training programs in various areas, which has become an attractive alternative to the classical form of education in terms of obtaining specific results for inclusion in the work process. Networked Learning Editorial Collective [10] provides an analysis of the impact of the pandemic on the development of online learning, within which the opinions of 40 authors from 6 continents who are directly related to the implementation of educational programs are assessed. Both positive and negative aspects of this direction of technology development are considered. However, the general conclusion of the study is more likely to favor the usefulness of this innovation in educational activities, considering a qualified approach to its implementation.

Summarizing the main ideas presented in the articles, we can come to the following thought. The competitiveness of a university is determined by several indicators, the main of which are quality, forms and methods of teaching. The following factors influence the improvement of the quality of training:

- quality and efficiency of educational services;
- research activities of teachers;
- qualification level of teaching staff.

The listed factors relate specifically to the work of an educational organization. It is obvious that for continuous development of each item, measures must be systematically implemented to improve indicators. It is worth noting that students' interest in education is not directly affected by the factors, but is a consequence of high-quality work in the listed areas.

However, in the implementation of educational programs there is a factor that remains practically unchanged throughout the entire period of implementation of the educational program. This is due to the drawing up of a clear schedule of the educational process at the stage of coordinating curricula. In this regard, the issue of the possibility of changing the model of implementation of the educational process and the impact of this change on the quality of education was considered.

The issue of constructing an educational trajectory when drawing up curricula or in the process of planning the next academic year is also given attention in research works. Some of the works are devoted to a review of modern methods for solving the scheduling problem. Therefore, Tan [11] provides a detailed discussion on the issue of categorizing scheduling approaches. Ceschia in his research [12], noted that the area of scheduling is divided into three components of the main problems. Two of these, course scheduling and exam scheduling, are key for higher education institutions. Bashab [13] also pays attention to these problems and even describes the restrictive parameters for building the system. At the same time, these works do not pay attention to assessing the impact of the schedule on the quality of mastering disciplines.

One of the challenges that is addressed in the process of creating a class schedule is the efficient allocation of educational resources (classrooms and teachers) to assigned classes, as described by Ibrahim [14]. Another example of such studies is Arratia-Martinez [15], which examines the scheduling of classes, taking into account teachers who work full-time and part-time.

No direct studies have been found on the preparation of schedules that consider the quality of students' mastery of the educational program. However, it is possible to highlight studies that evaluate the process of memorizing information from the point of view of a psychological analysis of the principles of the human brain. Separately, it is worth noting research concerning the "forgetting curve" phenomenon. Research into the amount of information stored in the brain after different periods of time began more than 100 years ago and is still ongoing today, led by scientists like Averell [16].

Most of the research in this direction is related to the organization of programs for individual disciplines. They provide guidelines for reviewing key points at specific intervals. Thus, Averell in [16], a model of forgetting material is analyzed considering regular prompts and reproduction of previous material. The research presented Radvansky [17] approaches the issue of forgetting material from an alternative point of view and proposes a division into phases that considers the characteristics of neurological memory. For example, knowledge obtained because of experimental knowledge has a more linear nature of forgetting. This allows us to conclude that there are differences in the behavior of the forgetting curve for theoretical and practical knowledge and skills. At the same time, Rivera-Lares [18] addresses the issue of the influence of students' initial training on their rate of forgetting. The experiment carried out by the authors showed that there is no effect on speed.

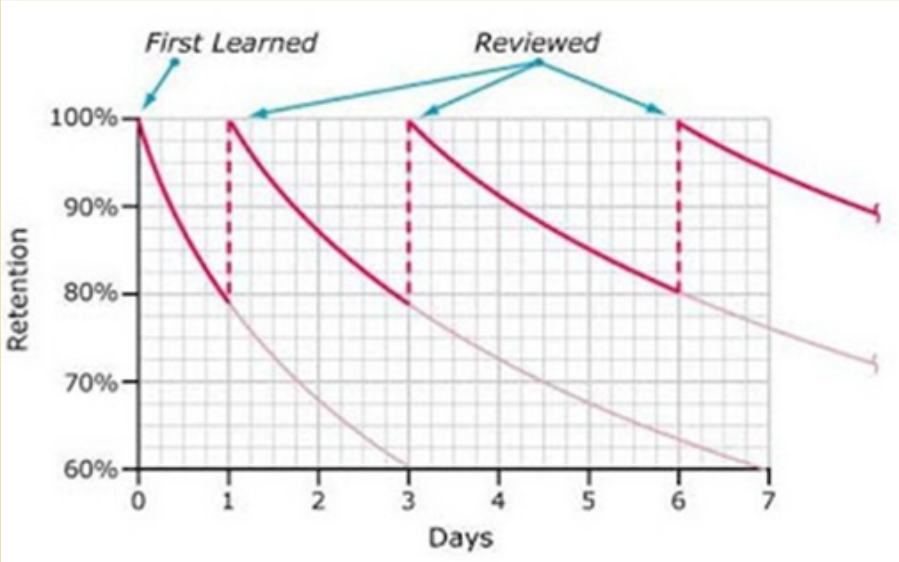

Figure 1 Forgetting curve

It is also worth noting the approach to learning used in educational courses on online platforms. The presentation of course materials takes into account the psychological characteristics of learners, as exemplified through the implementation of microlearning principles by scholars such as Dolasinski [19]. According to this approach, the material is given in small

portions (lasting less than 20 minutes), which reduces student fatigue and increases their involvement in learning Taylor's research [20] focuses on the differences in the way material is perceived by people from different generations, leading to a need for a change in the learning model. Fitria [21] also notes the importance of teachers' readiness to include digital technologies in educational courses. The general idea of all research leans toward the need to break the material into smaller parts, which will allow the teacher to more easily hold students' attention and simplify the procedure for updating the content of classes, and students will have a deeper understanding of the subject. In addition, the microlearning model addresses the need for more concentrated study of individual disciplines. Taylor [20] also hypothesizes that, from the learner's perspective, shorter and more targeted presentations of information, tailored to their specific needs, make it easier for them to assimilate the material.

Therefore, as previously mentioned by Konev [22], the following aspects should be identified and addressed in the planning process for the educational programme:

- intervals between classes in one discipline exceeding 1 week in duration lead to the need to allocate a period within classes to review material from previously covered topics;
- the involvement of practicing specialists as teachers is significantly limited by the amount of free time such employees have from their main jobs;
- the presentation of the material should be in a more concise form.

Let us note that the classic format of the educational process schedule with the parallel study of all disciplines during the semester does have a number of disadvantages that hinder the increase in competitiveness. These points were noted by teachers:

- weekly frequency of classes in 8–10 disciplines over four months leading up to the session leads to students "forgetting" the material from the beginning of the semester;
- delay by many students in completing laboratory and practical work until the end of the semester leads to overload of teachers in the pre-session week (especially if he teaches more than one discipline);
- the need to accept debts (for current and intermediate certification) in parallel with teaching disciplines in the next semester reduces the quality of teacher preparation for classes;
- classes falling on holidays, teacher business trips, conferences, etc. disrupt the rhythm of learning for both students and teachers, which also negatively affects the quality of the educational process.

Changing the duration of classes is not possible in this situation due to the strict regulation of organizational documents. In this regard, the issue of implementing microlearning within disciplines can only be resolved in the conditions of organizing their implementation by the teacher and requires a separate study. As part of further work, microlearning ideas will be considered only from the point of view of short-term training on specific topics.

Elimination of the above shortcomings and improvement of the quality of education was realized by changing the curriculum (in particular, the schedule of the educational process aimed at modular study of disciplines. In publications, modular training is understood as the division of an overall large training program into smaller components devoted to individual topics. Publications in this area primarily focus on the process of developing a separate discipline by breaking it down into individual topics, as in the case of Minamatov's study [23], or by incorporating pre-existing implementations of individual topics within the taught curriculum, as described in Castroverde's work [24]. Also, part of the research is aimed at building correct interdisciplinary connections between individual subjects included in a single module. Busta [25] acknowledges that interdisciplinary learning fosters the development of skills and thought processes from diverse perspectives. Turner [26], in turn, also acknowledges the usefulness and benefits of interdisciplinary learning. However, he also recognizes that implementing it in practice can be challenging. There are also studies aimed at modules of specific forms of training and evaluation of their effectiveness. For example, Bacomo conducts an assessment for self-learning modules in [27]. This study of the effectiveness of modular distance

learning during the COVID-19 pandemic combines descriptive and correlational methods. It focuses on the relationship between students' profiles, attitudes, and performance, as well as on the relationship between attitudes and performance within self-study modules.

In the framework of this work, modularity means the most time-concentrated study of disciplines. With this approach, it becomes impractical to study the discipline within the entire semester. In this case, there is a need to divide the semester into smaller components, which is similar to the ideas raised in the concept of microlearning.

When developing the modular system, Konev [22] were identified the following key advantages for students, teachers and departments in comparison with the classical model of planning the educational process.

For students:

- comprehensive study of the discipline within a month and delivery "without delay", which should lead to an increase in the quality of learning the material and academic performance;
- distributed passing of intermediate certification, which allows you to purposefully prepare for each exam.

It is important to understand that the distribution of subjects across weeks in a modular format does not constitute a change to the overall academic program for the semester. Rather, it represents a shift from a traditional model in which all subjects are taught simultaneously. Despite this shift, the benefits of the modular approach remain the same. However, if a student were to move a subject to another module for any reason, the advantages of this approach would naturally decrease.

For teachers:

- the emergence of the opportunity to "free up" time from students (for example, half a semester without teaching at all) for scientific work, internships, advanced training, development of teaching materials, online courses, etc.;
- separation of flows submitting current reports when different disciplines/specialties are distributed across quarters, the teacher receives a more even load throughout the semester;
- it becomes possible to schedule debt collection during quarters free from classes;
- it becomes possible to create a sequence of different types of classes in any order - lectures, practices, etc.;
- classes are not lost due to holidays, which allows you to completely read the discipline in the original rhythm set by the teacher.

For departments:

- the number of transfers and "cancellations" of classes decreases (for example, if classes fall on holidays), as a result, work programs and workload become more objective;
- it becomes possible to attract qualified professionals from organizations that correspond to the profile of our educational programs, who are unable to work in an educational setting on a full-time basis, to teach classes;
- it becomes possible to manage the sequence of disciplines more flexibly, practically without loss of quality (disciplines of the same semester that depend on each other will not run in parallel, but sequentially);
- it becomes more realistic to use unique equipment in the educational process, for example, within the framework of collective use centers, because it is possible to exclude this equipment from the scientific or production process for a short period, and not for the entire semester; the flexibility of distributing the teacher's workload increases when he is involved in the educational process of branches or when conducting classes as part of additional education;

- there is variability in the response to force majeure events; in particular, it is possible to transfer the discipline to another quarter in the event of a teacher's illness, because changing a teacher is not possible for all disciplines.

Thus, the research of scientific sources and the analysis of the experience of other educational institutions allowed us to formulate a hypothesis about possible improvements in the quality of student learning. We decided to conduct an experiment by changing the schedule of the educational process to a modular format to test this hypothesis.

The purpose of this study was to evaluate the effectiveness of switching to a modular curriculum in terms of enhancing students' ability to master the educational program. To achieve the stated goal, we completed the following tasks:

1. Collected data on students' academic performance over the evaluation period.

2. Formulated criteria for evaluating the performance of students from different educational programs.

3. Analyzed the results based on the formulated criteria.

MATERIALS AND METHODS

The data on students' academic performance served as the foundation for the study. The evaluation was based on information from traditional education and modular programs, which only differed in how the learning process was structured. The study allowed for a comparison between specific years, as students in those years had identical requirements and educational standards.

At the Faculty of Security starting from the 2020-21 academic year. year, an experiment is being conducted based on a modular approach to the schedule of the educational process. The essence of the changes is to divide each semester of study into quarters and teach the main part of the disciplines concentrated within one quarter (3-5 weeks of training and 1 week of the control stage). That is, the curriculum identifies a number of disciplines that are studied with full immersion during the module and then these disciplines are accepted. Disciplines and types of classes such as foreign language, physical education and sports, group project learning, coursework and research work are taught throughout the semester, and the rest are concentrated.

Figures 2–3 show the timing of the stages of intermediate certification with a modular training system. The boundaries of individual modules are highlighted in different colors. The first weeks of the module are devoted to studying the discipline, and the last week is scheduled for certification in the form of an exam or test.

Month	September					October					November				December					January					February	
Date	01-07	08-14	15-21	22-28	29-30	01-05	06-12	13-19	20-26	27-31	01-02	03-09	10-16	17-23	24-30	01-07	08-14	15-21	22-28	29-31	01-04	05-11	12-18	19-25	26-31	01	02-08
Week	1	2	3	4	5		6	7	8	9		10	11	12	13	14	15	16	17	18		19	20	21	22		23
Type	Education						Exam	Education						Exam	Education				Exam	Vacation		*	Education				Exam

Figure 2 Academic process schedule for the autumn semester

Month	February			March				April					May				June					July
Date	09-15	16-22	23-28	01	02-08	09-15	16-22	23-29	30-31	01-05	06-12	13-19	20-26	27-30	01-03	04-10	11-17	18-24	25-31	01-07	08-14	15-21	22-28	29-30	01-05
Week	24	25	26		27	28	29	30	31		32	33	34	35	36	37	38	39	40	41	42	43	44		
Type	Education						Exam	Education						Exam	Education					Exam	Education		Exam		

Figure 3 Academic process schedule in the spring semester

Figures 4–5 show an example of the distribution of disciplines in semesters 1 and 2 for the 2020 enrollment year. In subsequent years of enrollment, the division of the semester into separate periods of teaching disciplines remained unchanged. Disciplines that are studied modularly were painted in the same colors as in figures 2-3. The difference arose only in the list of disciplines implemented in the modular system format. A number of experiments were conducted to change the duration of studying individual disciplines, which showed the need to implement them in more than 1 module.

1 half-year			
1 quarter (1.09 - 12.10)	2 quarter (13.10 - 23.11)	3 quarter (24.11 - 28.12)	4 quarter (12.01 - 08.02)
Physical culture and sport			
Foreign language			
Fundamentals of project activities			-
Computer science	Organization of computers and computing systems	Mathematical analysis	-
Introduction to the specialty	Algebra	System analysis	Russian history

Figure 4 Distribution of disciplines in the first semester

2 half-year			
1 quarter (09.02 - 22.03)	2 quarter (23.03 - 03.05)	3 quarter (04.05 - 14.06)	4 quarter (15.06 - 05.07)
Physical culture and sport			
Foreign language			
Educational and laboratory workshop			
Fundamentals of project activities			-
Mathematical analysis	Information Security Basics	Physics	-
Business communications	Mathematical logic and theory of algorithms	Basics of programming	Introduction to Artificial Intelligence Techniques

Figure 5 Distribution of disciplines in the second semester

The Faculty of Security implements the following areas of training and specialties from an enlarged group of specialties and areas 10.00.00 Information security:

- Bachelor's degree in the field of study 10.03.01 "Information Security;
- Specialist program 10.05.02 "Information security of telecommunication systems»;
- Specialist program 10.05.03 "Information security of automated systems";
- Specialist program 10.05.04 "Information and analytical security systems."

Table 1 provides brief information on the admission of students in different areas of training and specialties 4 years before the start of the modular training program and 4 years after the transition to the experimental format. The data is provided for students enrolled in a budget-funded form of study and with full reimbursement of costs for each area.

Figure 6 shows the dynamics of the overall change in the number of students studying in different areas of training and specialties of enlarged group of specialties and areas 10.00.00 Information Security. The difference in the number of students depends on many factors. These include changes in tuition fees, changes in the requirements of educational standards, changes in passing scores for admission to each area, etc.

Table 1

Data on the number of students admitted to different specialties

Year of recruitment	10.03.01		10.05.02		10.05.03		10.05.04	
	Budget training	Paid training	Budget training	Paid training	Budget training	Paid training	Budget training	Paid training
2016	25	10	25	16	25	15	25	6
2017	30	7	25	12	25	14	25	6
2018	30	7	25	17	25	27	25	5
2019	33	12	29	9	29	15	25	9
2020	30	20	30	4	30	18	25	6
2021	40	7	44	3	42	4	24	6
2022	35	4	34	0	24	1	32	1
2023	37	5	25	1	35	3	35	2

Each program has a different set of disciplines, considering the focus of the program for preparing future graduates. However, these differences mainly arise in senior years, which necessitates the formation of basic competencies that are similar for different specialties. For this reason, it was decided to select the first courses for analysis to analyze the generalized results for the entire faculty and separately make comparisons for each of the areas of training for different years.

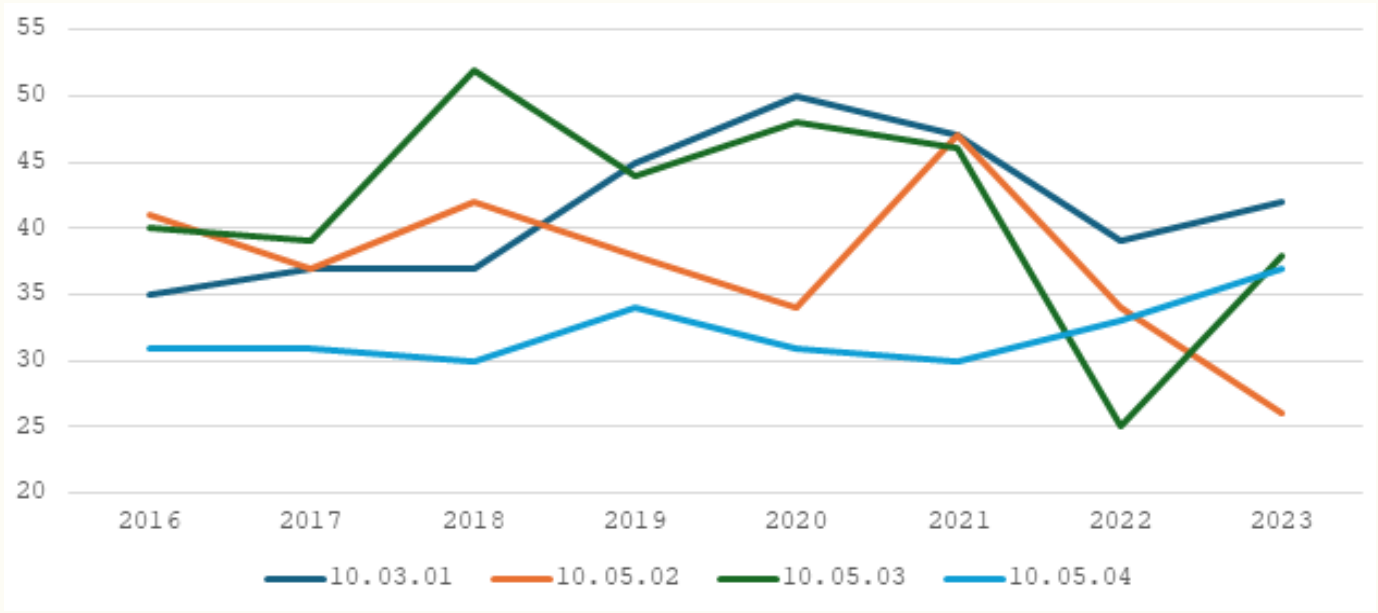

Figure 6 Dynamics of changes in the number of applicants by specialty

For comparison, the learning results of students enrolled in 2019, 2020, and 2021 were selected. It should be noted that these recruitment years were affected by the COVID-19 pandemic. The pandemic began in March 2020 and ended in December 2021. During the pandemic, training was conducted in periods in a mixed format, namely lectures in an electronic information educational environment, practical training in a face-to-face format, and periods only in an electronic information educational environment.

Students admitted in 2019 They study using traditional technology and by the beginning of the pandemic they had completed 1 semester full-time. Semesters 2, 3, 4, 5 were affected by the pandemic, but they gained experience of student "life" and managed to get to know each other.

Students admitted in 2020 and 2021 study using a modular system; at the initial stage of their studies, they had no experience of studying at a university. For the 2020 intake, 1, 2, 3 semesters passed during the pandemic, and for the 2021 intake, 1 semester, it should be noted that these students studied in the 11th grade during the pandemic.

In the course of the work, new criteria for assessing the quality of training were formed for analysis. They differ from existing ones in that the calculations do not consider students on academic leave, transferred from other specialties, universities, who have returned from academic leave and are calculated based on the number of admitted students in the corresponding year.

1. ***Safety of the number of students (percentage)***. It is calculated as follows: In each semester, the number of students Z remaining after expulsions (the corresponding year of enrollment) is determined. That is, if X students entered a specialty, and Y students were expelled by the third semester, then to calculate the safety of the contingent in the third semester, we take Z = X-Y students. Next, we take the ratio of the remaining students to the number of applicants and calculate the percentage of safety Z*100/X.

2. ***Proportion of students who passed the course on time (percentage)***. The number of students in each semester remaining after expulsions of the corresponding enrollment year (Z) is determined. From these, we determine the number of those who passed the session at the end of the semester (Q) and take the ratio Q*100/X, where X is the number of applicants in the corresponding enrollment year.

3. ***Quality academic performance (percentage).*** The number of students (G) who passed the session with grades 4 and 5 is determined. It is calculated from the number of those who passed on time. The ratio G*100/X is taken, where X is the number of applicants in the corresponding enrollment year.

Similar assessments of teaching quality are considered in many studies. Estimating the percentage of students who have completed a training program is most often associated with research on the social status of students. For instance, Wells [18] conducted a study to evaluate the impact of social and cultural capital, race, ethnicity, and student retention on college outcomes. Additionally, Oni [29] has also examined social and cultural factors within the learning experience of African American students. Another significant factor is the current global situation, which has a psycho-emotional impact on students. For instance, Pare's dissertation [30] examines the issue of implementing global teacher support programs and their effect on the quality of education. Many studies also address the impact of the pandemic, including the study by Contreras [31]. Individual ideas were formulated into scales for further assessment of changes in the educational program.

RESULTS

In accordance with the criteria outlined in the previous section, we have assessed educational programs from different recruitment years. The result for 2019 represents an example of a traditional format for organizing the educational process, while the other two programs use a modular format.

Figures 7-9 show the results of assessing the above indicators for bachelor's degree 10.03.01 "Information Security". As you can see, the indicators for the modular system are predominantly higher than for the classical model for constructing a graph of the educational process. The difference from the general trend in the retention of the contingent is observed only for the 2020 enrollment groups, which experienced a sharp decline in the 4th semester, provoked by a deterioration in academic performance in the 2-3 semesters. Similar results were obtained for other training programs.

The results obtained for the 2022 and 2023 enrollment years for the specialty turned out to be close to the 2021 data. In this regard, it was decided not to consider them in this diagram. In

addition, additional training disciplines were introduced for subsequent years of enrollment, which does not allow unambiguous comparison of students in different conditions. A study with groups from later years of recruitment is planned for publication in future articles.

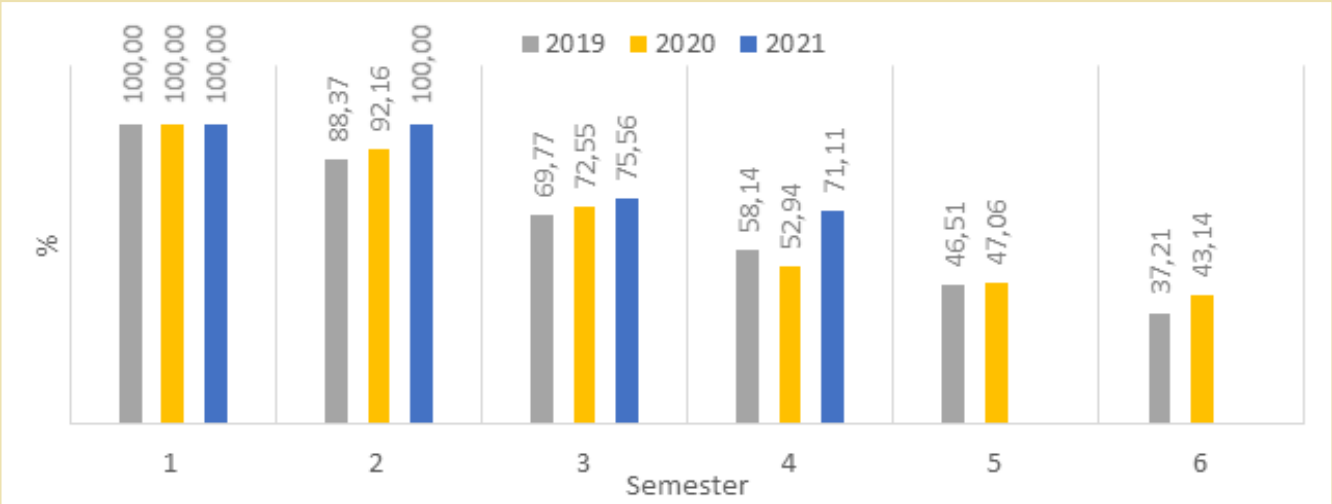

Figure 7 Safety of the number of students

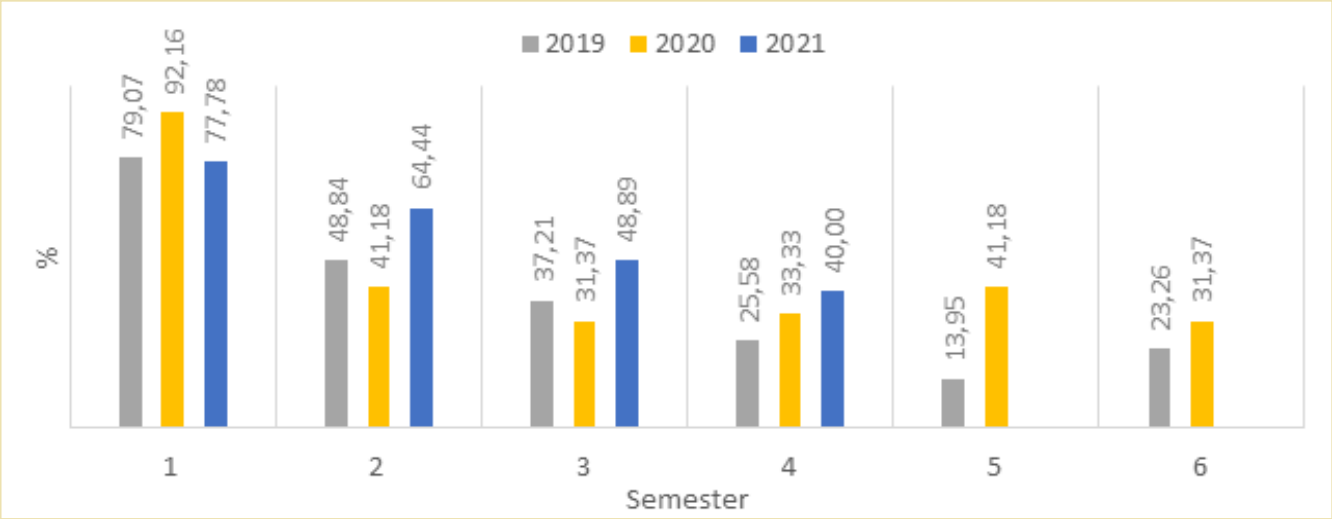

Figure 8 Proportion of students who passed the course on time

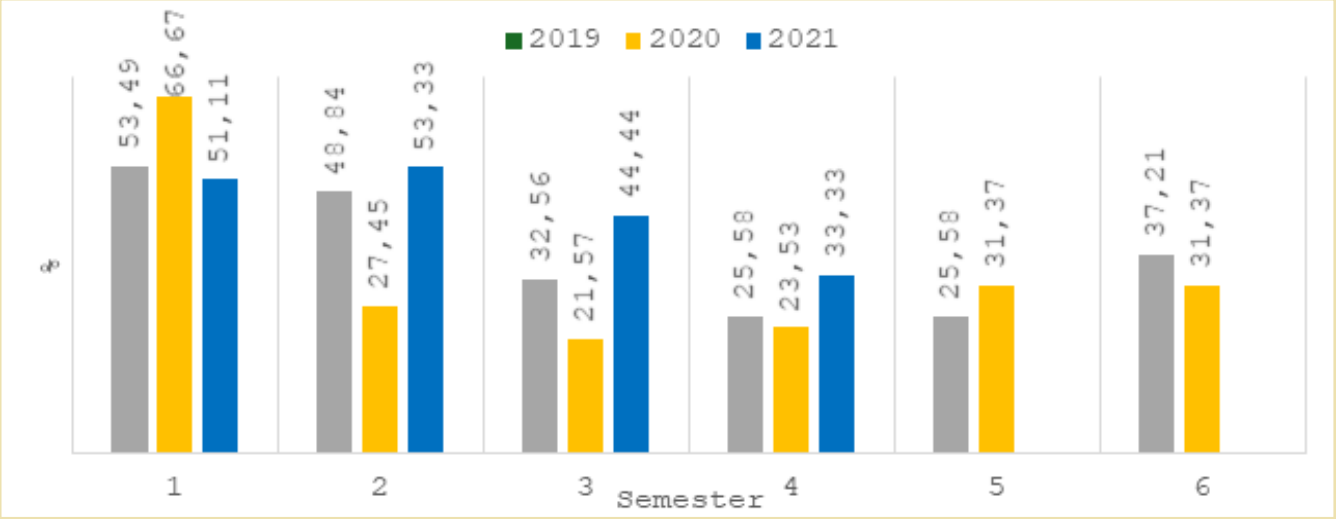

Figure 9 Quality academic performance

Please note that the results of the 2021 intake for all specialties according to the criteria: retention of the contingent, timely completion and quality in most cases are higher than the results of the 2019 intake.

In addition, the results of each semester were analyzed during the experiment. It has been observed that for the 2020 intake, the number of students passing on time in the second and third semester is less than those passing in 2019. The reason has been found. Two labor-intensive disciplines (physics and programming basics) with a lot of laboratory work were included in one module. This issue has been resolved for students in 2021 and subsequent enrollment years. The distribution of disciplines by modules in the semester has been changed (fig. 10). Disciplines are highlighted in orange, the format of which has been changed from covering all the material in 1 module before the semester.

2 half-year			
1 quarter (09.02 - 22.03)	2 quarter (23.03 - 03.05)	3 quarter (04.05 - 14.06)	4 quarter (15.06 - 05.07)
Physical culture and sport			
Foreign language			
Educational and laboratory workshop			
Fundamentals of project activities			-
Business communications			
	Physics		
Mathematical analysis	Information Security Basics	Mathematical logic and theory of algorithms	Introduction to Artificial Intelligence Techniques
Basics of programming	Function series theory	-	-

Figure 10 Updated distribution of disciplines by modules in the 2nd semester in the 2021 enrollment curriculum

The figure shows that the disciplines “Fundamentals of Programming” and “Physics” are distributed across different modules. The discipline “Physics”, in agreement with the supporting department, was divided into three modules. This is primarily due to the high workload of laboratory equipment during the period of modular training for individual specialties.

Unlike traditional technology, intermediate certification of students studying under the modular system is carried out throughout the semester, and not concentrated in the last weeks of the semester. Students who have not passed disciplines 1, 2, 3 modules can take them during teacher consultations until the end of the fourth module. However, they will not be considered debtors, since the semester ends at the end of the last module. With this approach to the educational process, it becomes relevant to conduct tutoring sessions with underachieving students in the disciplines of the current semester. In this regard, the faculty has eliminated the practice that leads to annual debt among students. Students studying at the Faculty of Security must liquidate all debts no later than the second week of the second module of each semester.

The distribution of disciplines by modules is changed annually when planning the load for the next academic year. This procedure is carried out on the basis of analysis of learning results in the previous semester, wishes of teachers, contingent of teachers and other identified needs.

Generalized assessments of indicators for the enlarged group of specialties and areas of training 10.00.00 "Information Security" are shown in Figures 11-13.

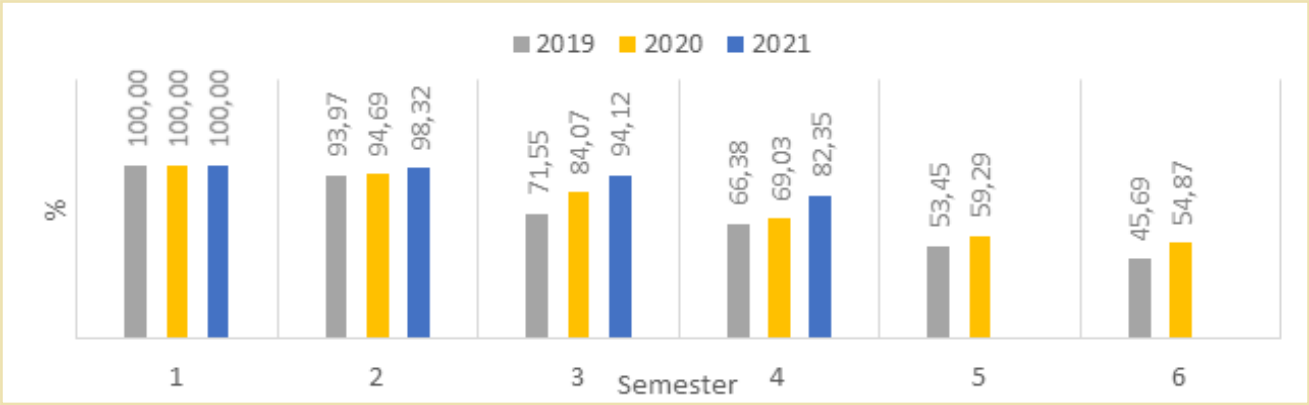

Figure 11 Generalized result of the indicator of safety of the number of students relative to the number of applicants

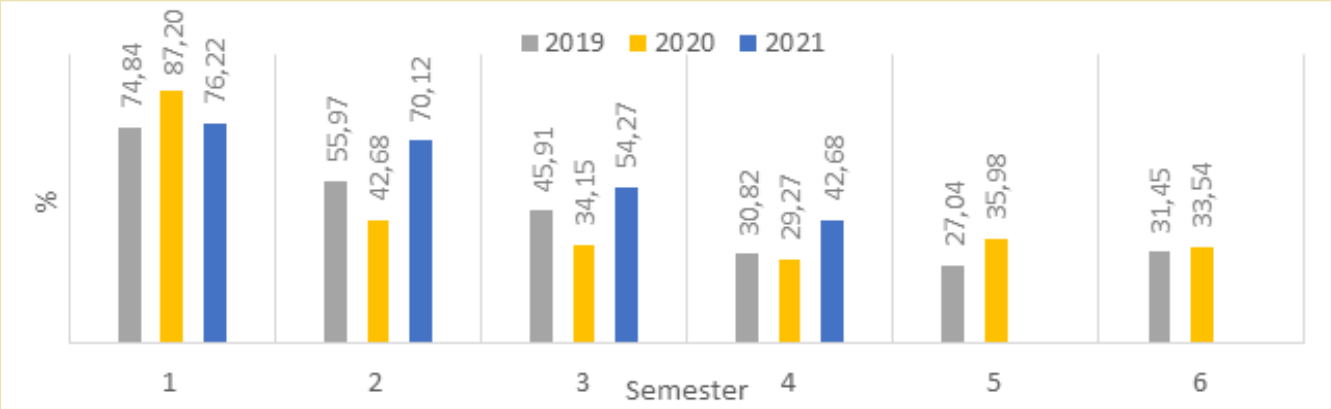

Figure 12 Generalized result of assessing the share of students who passed on time depending on the total number of applicants

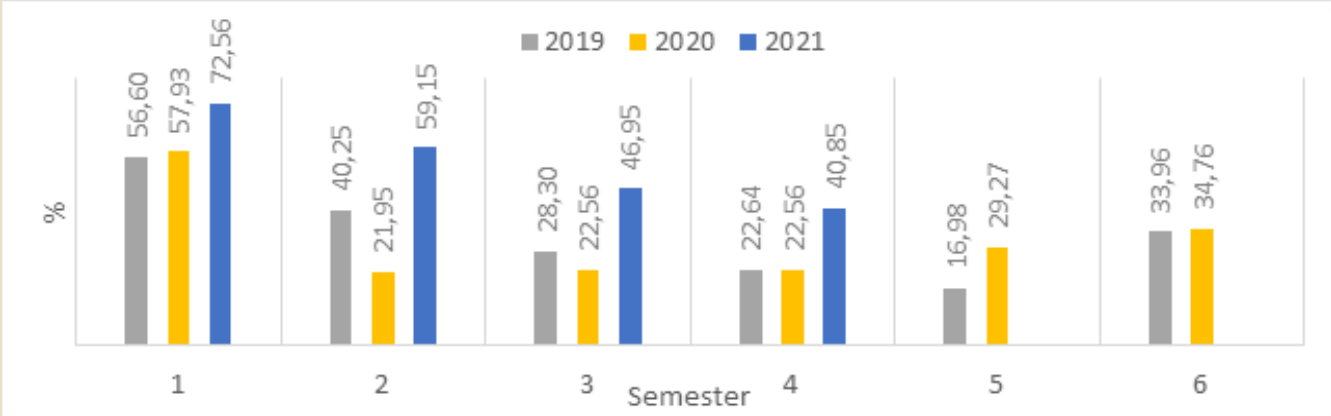

Figure 13 Generalized assessment of quality academic performance

An analysis of the results in the Information Security direction was carried out for the 2019, 2020, 2021 admissions. in all specialties and bachelor's degrees. The calculation was carried out similarly to the previous ones according to the criteria: safety of the contingent, timely delivery and quality. The value of the number of "entrants" was determined as the sum of all students admitted to the Information Security major, including bachelor's degrees in the corresponding year. All other values were determined similarly: the number of people passing on time and quality. Calculations were carried out and diagrams were drawn.

It should be noted that the number of students enrolled in these years differ slightly from each other. The difference is no more than 0.03, so you can compare the results as a percentage. From the diagrams you can see that:

- the indicator of "safety of the number of students" with a modular system is higher than with a traditional one. The difference by semester is from 5% to 23%;
- the indicator of "proportion of students who passed the course on time" after correction of the educational process schedule is higher than with the traditional education system. If we compare the 2019 recruitment year and 2021. then the difference is from 1% to 14%;
- the "quality academic performance" indicator after adjusting the educational process schedule is higher than with the traditional education system. If we compare the 2019 recruitment year and 2021. then the difference is from 16% to 19%.

It is worth noting the graphs depicting the evolution of quality indicators in the fourth semester (Figures 14–16). Across all quality metrics and specializations, we can see that the values of these metrics are gradually increasing. This indicates the beneficial impact of the modular approach on the overall quality of the project.

Timely correction of the approach to selecting disciplines when determining their order for study allowed us to avoid a negative impact on the curriculum in subsequent years. The initial trajectory of the sequence of disciplines was determined by the need for interdisciplinary connections in materials. This ensured that the material covered in each discipline was not forgotten as useless but was actively used in another subject later that month. Not all disciplines are equally important in relation to each other, so no connection was found between «Physics» and «Fundamentals of Programming» in this experiment. However, due to a random coincidence in the position of modules, this influence was discovered and considered in the new curriculum.

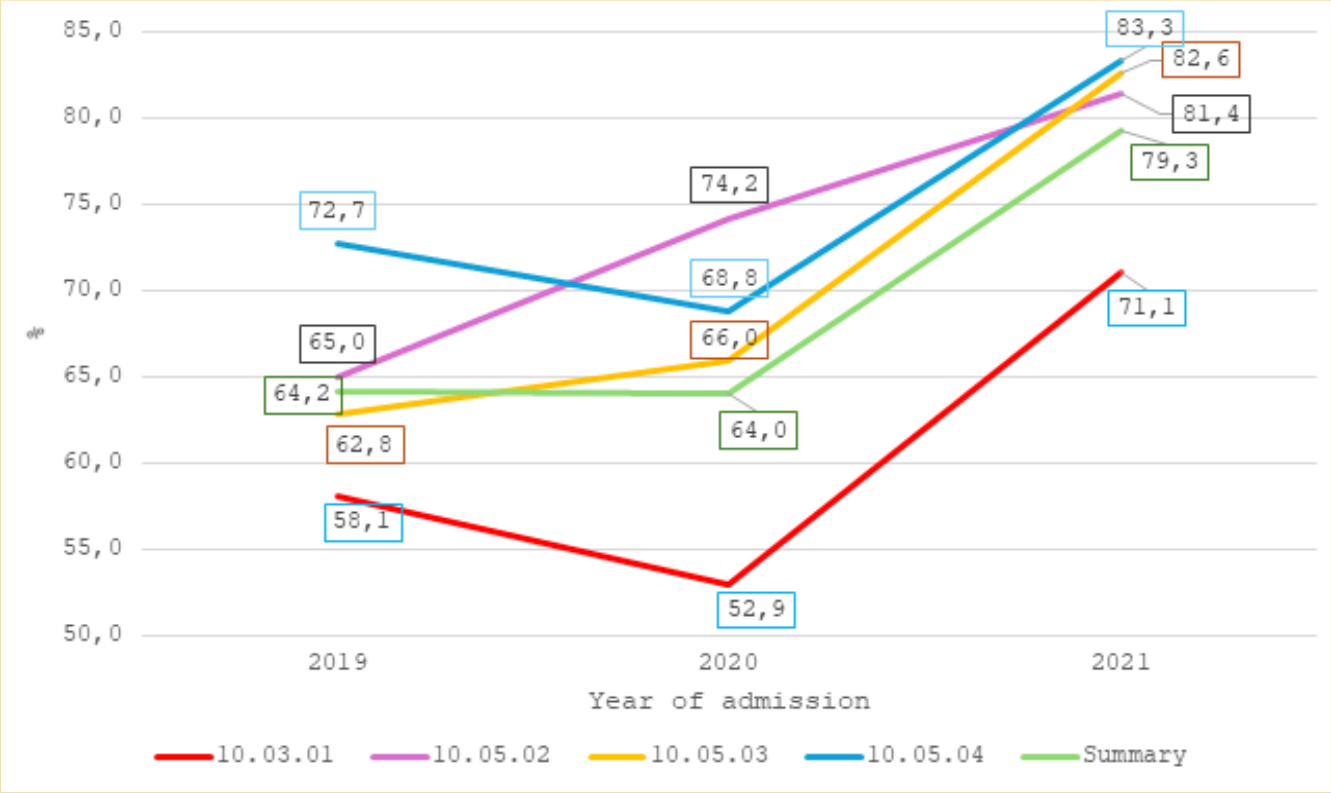

Figure 14 Safety of the contingent by year of admission

The results were presented to the faculty members for discussion during meetings, shared with students, and discussed in the university's academic council. To objectively analyze the attitude of students and teachers to the modular system, an anonymous survey of students and teachers was

conducted. The survey involved 498 students, and 18 teachers involved in the implementation of the modular form of teaching.

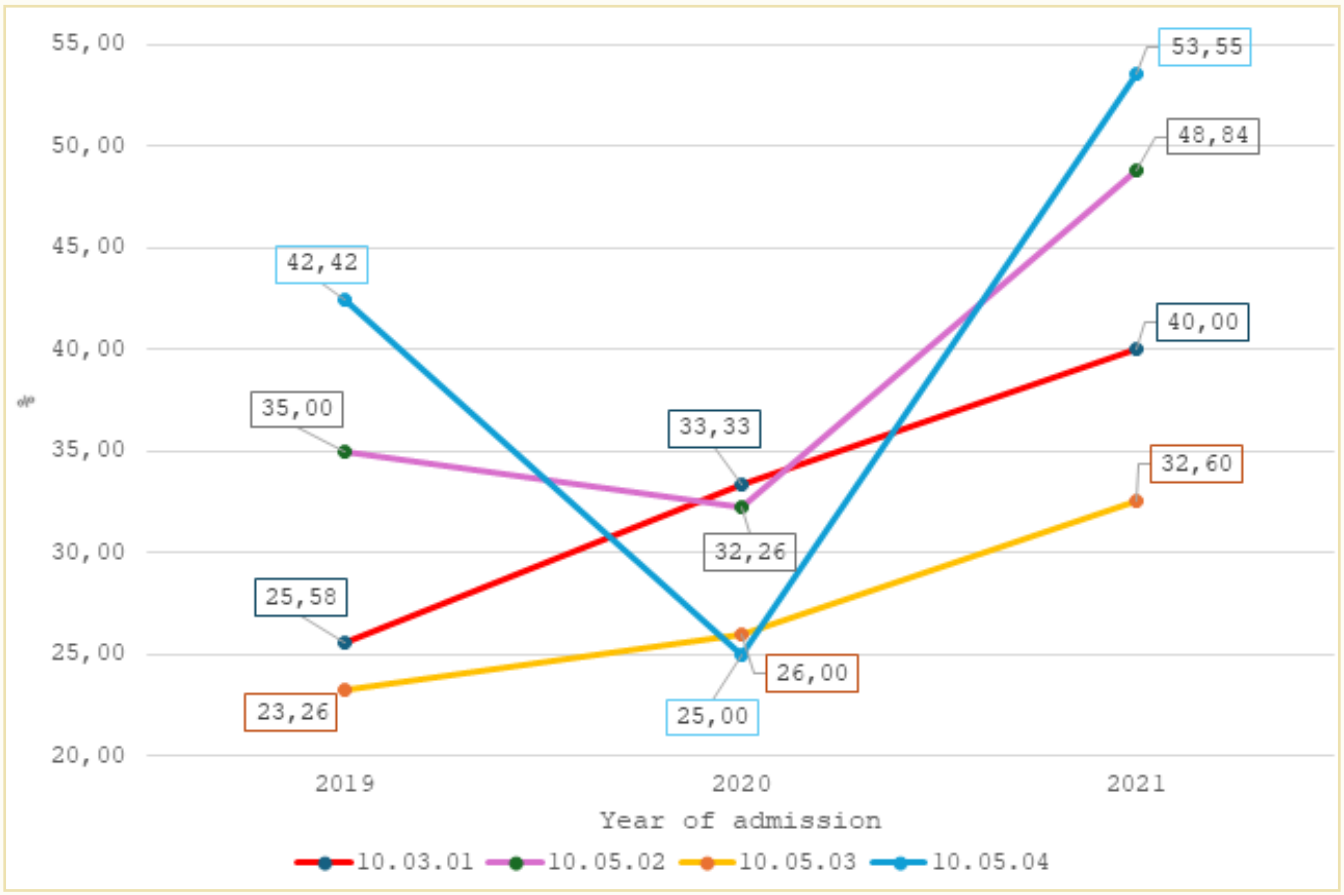

Figure 15 Proportion of students who passed the course on time, for different years of enrollment

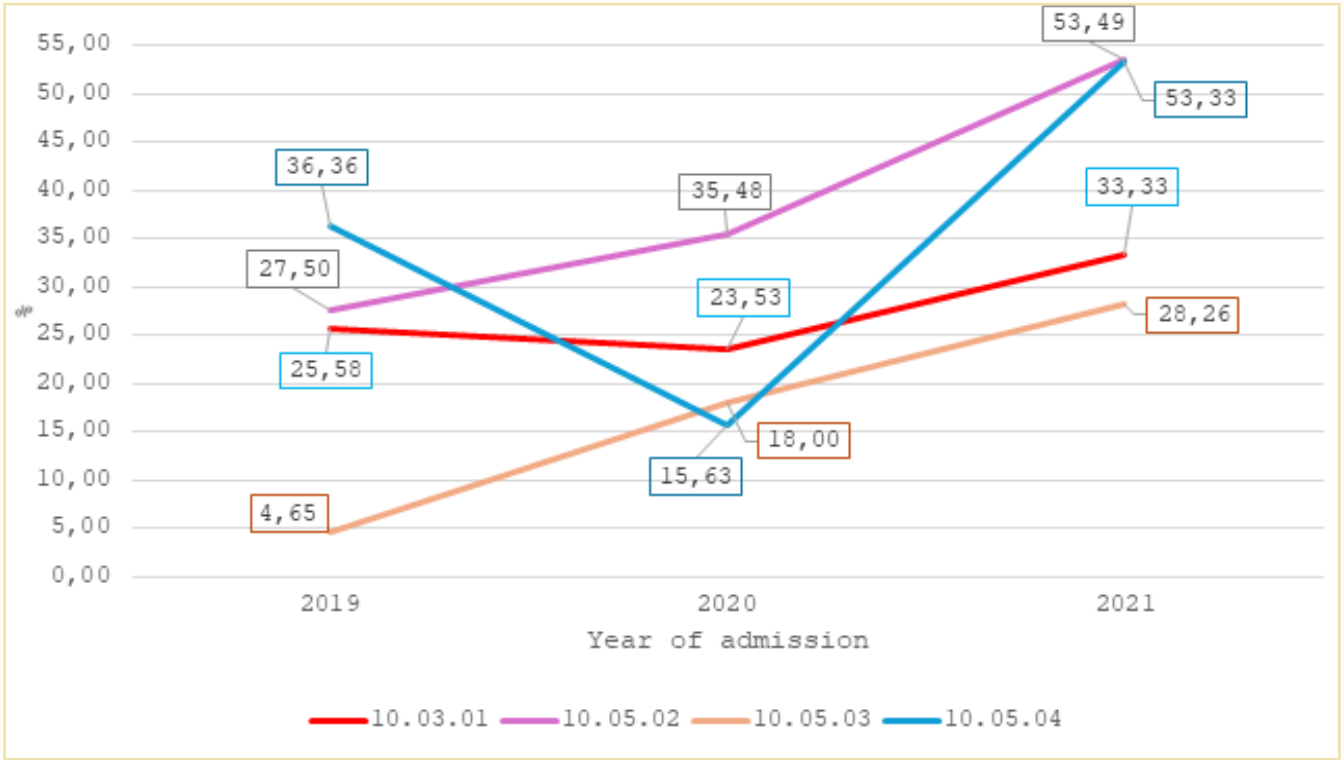

Figure 16 Qualitative student performance for different years of enrollment

First, students were asked the question: "Which training format do you prefer?" with the following answer options:

- studying and passing the discipline within a month (modular format);
- semester format.

The survey result is shown in figure 17. As can be seen from the diagram, 75% of students chose the modular format.

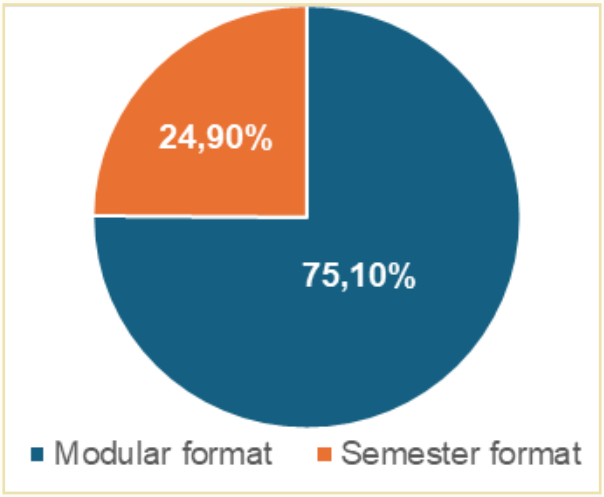

Figure 17 The result of a survey of students regarding the choice of a scheme for constructing a schedule for the educational process

To the question "Are you able to teach the discipline with high quality in a modular format of the educational process?" 15 teachers responded positively, representing 83% of the staff. The result is shown in figure 18.

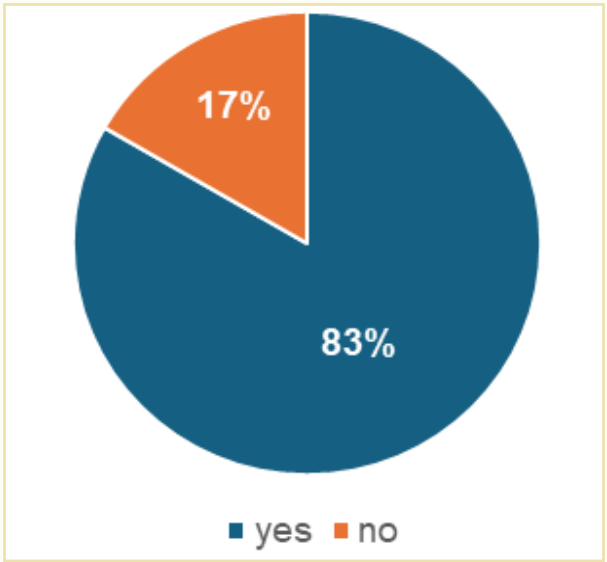

Figure 18 The result of a survey of employees about the possibility of high-quality teaching of disciplines in a modular format

18 teachers answered the question "Are you satisfied with the modular format of the educational process (score from 0 to 10)?" The result is shown in Figure 19. The diagram shows that the majority of teachers preferred the modular teaching system to the classical one.

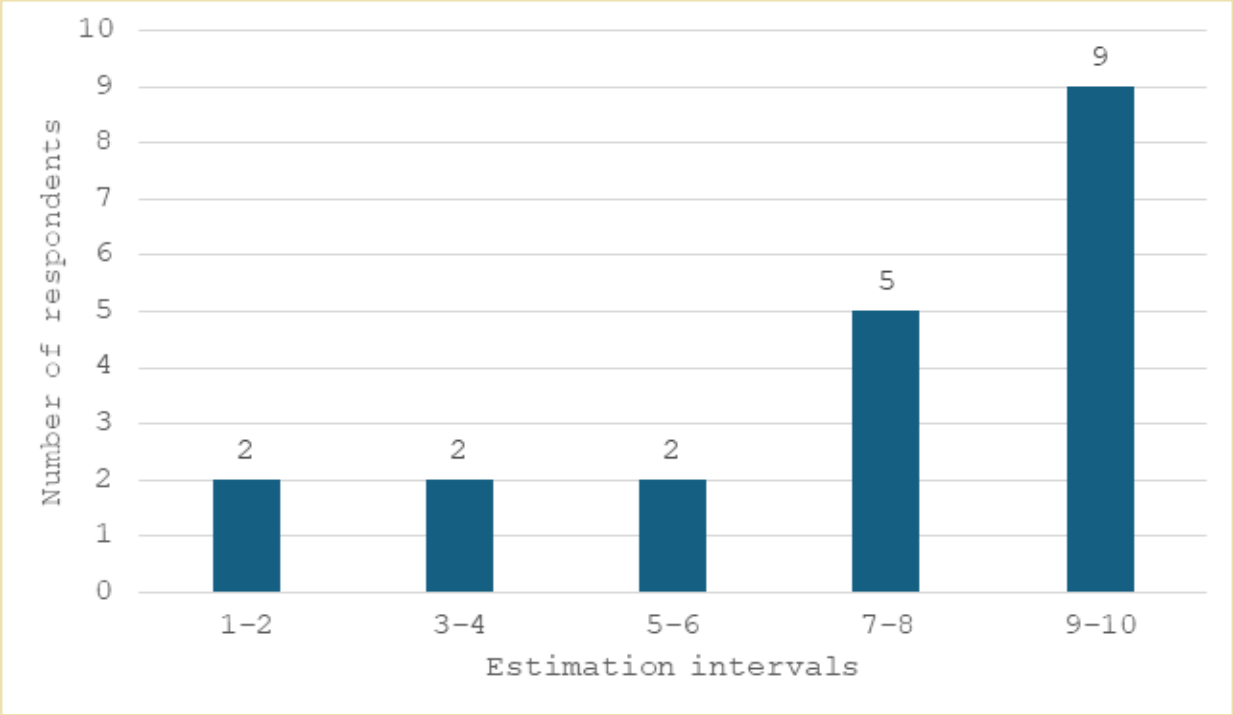

Figure 19 Assessment of teachers' attitudes towards the modular system

DISCUSSION

The results of the experiment support the initial hypothesis about the positive impact of a modular system for organizing the educational process. As expected, a more condensed training format led to an increase in all of the mentioned indicators. This finding is in line with the results presented in studies on microlearning by Dolasinski [19] and the forgetting curve by Radvansky [17]. The impact of reducing the length of study for individual subjects on students' engagement in the learning process leads us to the conclusion that this area of research holds promise. Such findings may suggest a decrease in the beneficial impact of the physics modular system on the academic achievement of the initial group of students. It is noteworthy that, in the context of the experiments conducted by colleagues at other educational institutions, there were no identified negative consequences from the implementation of a modular system for certain subjects.

However, this negative experience has allowed us to evaluate the possibility of making flexible changes to the educational program during its implementation. The experiment has shown its potential for the transition to a more modular educational system, but it is important to note that a modular approach may not be appropriate for all subjects within an educational program. Nevertheless, we believe the experiment should continue to explore this approach and expand it to other groups of specialties in order to better understand interdisciplinary connections and identify areas for improvement in the curriculum. In today's rapidly changing world, it is crucial to continuously update training methods to ensure the success of future professionals. By continuing the experiment and exploring the modular approach, we can better prepare students for the demands of a dynamic job market and help them develop the skills they need to succeed.

The main theses of teachers regarding their attitude to the modular system for constructing a schedule for the educational process are presented below:

- studying a subject for a month is more effective from the point of view of assimilation and memorization, since the material is repeated in different forms at short intervals several times;
- the modular system has a positive effect in terms of load distribution - it is possible to allocate periods of time for other activities;

- not all students cope with the high pace of studying the discipline within the module;
- students who are ready to learn will be more responsible about their studies and will not put off completing assignments until the end of the semester, which allows us to weed out those who are not interested in getting an education at the early stages;
- more flexible scheduling required;
- modular system for creating graphics for the educational process is not suitable for all disciplines;
- the modular system allows to reveal non-obvious interdisciplinary connections.

CONCLUSIONS

During the work, an analysis of the educational process was carried out using a modular system. Based on the work performed, conclusions can be drawn:

- The introduction of modular technology has made it possible to increase the following indicators compared to the traditional educational process planning system:
- the indicator "safety of the contingent" is from 5% to 23% for different areas of training and specialties;
- the indicator "the share of students from the total number who passed the disciplines studied in the semester on time" by an amount from 1% to 14% for different areas of training and specialties compared to the 2019 enrollment year;
- the indicator "quality of students' mastery of educational programs" by 16% to 19%.
- The majority of students and teachers support the modular organization of the educational process.

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