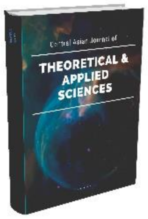

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The Teaching of the Course "Discrete Structures" in the Direction of Computer Engineering Using Innovative Technologies

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Abstract: *The effectiveness of using discmath.uz software in the educational process of the "Discrete Structures" course taught to bachelors of computer engineering was mentioned in the article, along with scientific-methodological recommendations on the introduction of Agile technology into educational practice.*

Keywords: *Computer engineering, discrete structures, methodological support, innovative technologies, Agile, information and educational resource.*

Students' creative abilities, creative and cognitive thinking, general competences related to the foundation and science, and modeling creative activities in the USA, England, Canada, Korea, and Russia are increasing. Scientific and practical research is being done on these topics as well as the introduction of innovative technologies to the educational process around the world, studying their didactic foundations, improving the technology and methodological foundations of developing innovative methods, and increasing students' creative abilities.

A person should be prepared by today's contemporary education to participate fully in a free society and assume his role. An educated person is a person as well as an expert. Therefore, education must educate a person for life, for living in a world of production, for passing numerous exams, for adapting to changing living situations, for understanding and respecting others' ideas, as well as for realizing one's own responsibility. Therefore, the objective of contemporary education is to acquaint pupils with cultural and spiritual values in addition to imparting information and intellectual activity experience.

The training of highly skilled, competitive experts using contemporary computer technologies was given much attention in the Republic of Uzbekistan's higher education system, and the normative-legal and material-technical foundation were modernized. The key task of enhancing the state's youth policy is described as "Ensuring open and high-quality education for young people, ensuring that young people obtain outstanding education at all stages of schooling"[1] in the new Uzbekistan's development strategy. As a result of these tasks, it is necessary to organize the future personnel training process in an electronic education system, teach the "Discrete Structures" course in the field of computer engineering, and create

[1] Decree No. 60 of the President of the Republic of Uzbekistan dated January 28, 2022 "On the Development Strategy of New Uzbekistan for 2022-2026". https://lex.uz/docs/5841063

and use interactive electronic educational resources based on information and communication technologies. The teaching of the course "Discrete Structures" is crucial to the advancement of students' knowledge, credentials, abilities, and professional and fundamental competencies in the field of computer engineering.

In the preparation of bachelor's degrees in computer engineering, scientific-methodical recommendations have been developed in this article to enhance the teaching of the "Discrete Structures" course based on cutting-edge technologies, specifically to introduce Agile technology into educational practice through the discmath.uz (author's program) mobile application.

K. Toraev, S. Sadaddinova, Yu. Abdurakhmanova, and F. Rakhimova on the issues of preparing computer engineering specialists in Uzbekistan for professional activities, the issues of fostering in them the necessary professional qualities and skills, and advanced methods of effective teaching of programming and mathematics, based on the contemporary "Discrete Structures" course The creation of theoretical and methodological guidelines for the application of interdisciplinary relationships between mathematics and informatics, assuring the content, structure, and coherence of the discrete structure course, as well as issues of theoretical justification and methodological provision to increase the effectiveness of teaching O. Allamov, N. Kasimov, R. Dadajanov, F. The Ibragimovs' research on the subject expressed it.

Scientists from the Commonwealth of Independent States (CIS) include O. Yarygin, M. Kondurar, N. Prusova, A. Alfimova, E. Firsova, E. Perminov, I. Zmurova, E. Musinova, E. Ananeva, M. Cave, and E. (CIS). The issues of enhancing the caliber of training of information technology specialists through the practical application of a novel approach to the formation of intellectual competence through the course "Discrete Structures," the theoretical justification for the formation of professional competence, the development of methodological support, and its application in practice are highlighted in the scientific works of Musinova, S.Surikova, and others.

Software development, Discrete Mathematics, Arithmetic and Computer Science Interrelationship in Higher Education by Cécile Ouvrier-Buffet, Antoine Meyer, Simon Modeste, Technological and Technological in Teaching Discrete Mathematics Course to Computer Science Students by Adam Blank and Da, Application of Innovative Methods in Teaching Discrete Structures by Foreign Scientists such as M. Durcheva, E. Varbanova, Shuai L, Fu W, Qiang L, Zhang X., The study focused on pedagogical improvements and fresh methods for instructing "Discrete Mathematics."

The aforementioned studies are scientific research works focused on the theory and application of information technology introduction in the teaching of the discrete structures course as well as the methodology of developing students' competence in using information; they did not specifically conduct research on the subject of improving the teaching methodology of the "Discrete Structures" course based on cutting-edge technologies in the training of bachelors in the field.

The teaching of mathematical sciences is necessary in order to shape the scientific and technological viewpoint of undergraduate students majoring in computer engineering, introduce them to contemporary technical tools, and provide the groundwork for their application. The mathematical language of computer science is discrete mathematics, which was developed some decades ago. Because the mathematics taught in colleges is insufficient for learning a programming language, scientists incorporate extra mathematical disciplines into one course. **Discrete Structures** is the new name for this course.

In the curriculum for computer engineering, relevant courses can only be taken during scheduled class times. The Discrete Structures course has a total of 180 hours allotted to it: 60 hours of lectures, 30 hours of hands-on instruction, and 90 hours of individual study[2]. The number of hours allotted is insufficient to

[2] *5330500 – Компьютер инжиниринги* (Компьютер инжиниринги) таълим йўналиши ишчи ўқув режаси. Тошкент ахборот

completely learn the subject's material. As a result, it is essential to employ cutting-edge pedagogical devices and additional methodological help while setting up sessions. Based on this need, research was done on the utilization of a number of techniques, tools, and cutting-edge technologies that help to improve the efficacy of hands-on training and boost student enthusiasm for learning in order to improve the "Discrete Structures" course.

High efficiency in the teaching process is ensured by the use of contemporary teaching techniques. Based on the didactic objective of each lesson in the Discrete Structures course, it is advisable to use these strategies. The level of learning of students rises when the regular format of the class is enhanced by a variety of techniques that spur student involvement. With the help of a variety of technologies, computer engineers may solve any problems that may emerge in the course of their work, learn how to build cohesive teams for shared objectives, and keep up with the latest trends in a world that is changing quickly. We may use Agile technology as an illustration. This technology provides several methodology and approaches to learning management, including person-centered methods, active use of feedback, collaborative objectives, and developing strategies and tactics. In the creative framework of Agile technology, "the process and the outcome are crucial!" whereas the primary objective of many new technologies is "the result, not the process."

Agile technology is typically thought of as a technique, or collection of practices, for flexible project management. However, this idea has much more to it than that. Agile is the capacity to function in today's environment of evolving culture, behavior, and unpredictability.

The implementation of Agile principles has the effect of arranging students' high levels of activity during the learning process to create a more appealing educational model. They develop a love of learning, increase their self-confidence, and realize how much they can learn if they have the correct beliefs and principles thanks to technology.

All HEIs in our nation currently structure their instruction around the credit system, and the 100-point rating system—which corresponds to the Agile technology evaluation system—is used to evaluate student understanding.

It is deemed reasonable to provide students group tasks so that they can master several subjects in the Discrete Structures course. Checking the completeness and closure of the system of logical functions, bringing logical functions to disjunctive and conjunctive normal forms (DNF, CNF), as well as perfect disjunctive and perfect conjunctive normal forms (PDNF, PCNF), using binary logic elements, problem-solving with analysis and synthesis in logical schemes, simplifying relay contact circuits, solving problems with reduced DNF, deadlock DNF, and minimal DNF creation methods call for Students will master the aforementioned subjects in a fun and engaging manner by putting the teamwork and learning ideas into an Agile technology game. To achieve this, rigorous advice on the use of Agile technology in the planning of practical training, in the development of students' critical thinking, creativity, communication, and collaboration abilities, was established.

The adoption of Agile technology in the educational process is suggested below.

1. *Sprint instead of semester*. Quarters or semesters are the standard time units in conventional schooling. The findings of the training are often made known to both students and teachers after a few months, by which point it is usually too late to make any changes.

With the introduction of agile sprints, the feedback loop is shortened, enabling instructors to immediately see issues and take the necessary action. The learning process should be broken down into cycles of two

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to three weeks each, and each Sprint should begin with planning, discussion of upcoming tasks, analysis of completed work, and identification of areas for improvement.

In other words, running multiple short distances is preferable to running a marathon.

2. *The formation of academic teams*. Agile refers to cooperation and teamwork. Each student is given a goal to master, and grouping them into small groups that get along well together fosters cohesiveness. Students prioritize their colleagues' growth in addition to accomplishing their own goals. For this, it is important to form groups of 6–8 kids, with a coach or instructor in charge of each group. In an Agile team, a teacher is required to perform the role of Scrum Master. Its goal is to remove barriers that prevent pupils from learning new information and to foster group collaboration and teamwork.

At the conclusion of each sprint, the team makeup can be altered. In this approach, adaptable abilities are developed, aiding in the maintenance of team spirit at both the team and group levels.

3. *Using creativity or playing games to learn*. Agile's basic tenet is that projects should be designed around motivated people. Grades are a common incentive and success indicator in education. They can be replaced by points and prizes by rethinking the learning process. Students begin with no points and build them up as they learn. Points may be given to students for effort, academic achievement, conduct, and teamwork contributions.

Additional advantages that don't directly advance learning but foster teamwork among the team and the entire group are also beneficial. As an incentive, they can plan a field trip or movie night if all the pupils meet the sprint objective.

4. *Comprehension and natural conversation*. Continuous evaluation of what is happening to increase work efficiency is a key Agile concept.

Three stages of analysis should be fostered in students: individual, group, and study group. To do this, students should independently get familiar with the new content before the start of the class. This will help them to build independent learning abilities and improve the effectiveness of their lessons. Following the completion of the initial task, students are interviewed and given feedback. Representatives from each team should share their experiences in problem-solving at the conclusion of the assignment so that other students may apply these suggestions in subsequent sprints and increase the efficacy of the group as a whole.

5. *Self-evaluation*. Students are motivated to strive even harder by critical thinking, recognizing mistakes, and achievement. This is a result of ongoing inquiry, a need for fresh information, and personal development.

6. *Fostering the inventiveness of teachers*. One of the most crucial elements of Agile technology is that the instructor should be able to identify problems and activities within his subject that are appropriate for it, and creatively build projects tailored to small groups that can be finished quickly. This offers the instructor fresh assignments and motivates him to look for information and collaborate with pupils.

We used discmath.uz copyright software as a methodical tool for applying Agile technology in teaching the course "Discrete Structures". discmath.uz software contains theoretical materials, lecture texts, assignments for practical exercises, frequently asked questions by students and their answers, questionnaires, interpretive programs for performing practical exercises, thematic and interim control tests, as well as links to literature recommended for mastering the subject.

The practical activities in the discmath.uz program are made for small teams and are intended to foster respect among the students as well as collaboration between the team and the entire group when the tasks are being completed. The program's "Questions and Answers" part has been enhanced with questions and responses that encourage pupils to reflect. In addition to assessing students' knowledge, questionnaires, theme assessments, and midterm control examinations provide natural contact with students. With the use of interpretative software, students may review the examples they have performed for practical exercises and comprehend their accomplishments and faults. It is possible to show detection algorithms by creating adjacency and joint (incidence) matrices of graphs, computing the shortest distance in a graph, converting formulas into perfect disjunctive and perfect conjunctive normal forms, checking the completeness of the class of logical functions, and determining finite covers when finding minimal and dead-end disjunctive normal forms.

A pedagogical experiment was conducted to ascertain the efficacy of utilizing the discmath.uz software tool in the educational process, which is provided as an improved methodological support of the "Discrete Structures" course. Students from the Tashkent University of Information Technologies' Samarkand, Fergana, and Karshi branches, as well as professors and lecturers of "Discrete Structures," participated in experimental work from 2019 to 2022. 25 professors and 396 students (see Table 1) participated.

Table 1. Number of students involved in experimental work

т/р	Higher education institutions selected as experimental objects	Number of students		
		Total	Experimental group	Control group
1	Samarkand branch of Tashkent University of Information Technologies	**174**	86	88
2	Fergana branch Tashkent University of Information Technologies	**140**	70	70
3	Karshi branch of Tashkent University of Information Technologies	**82**	42	40
	Total:	**396**	**198**	**198**

Three levels of pedagogical experimentation were conducted: fundamental, instructional, and clarifying.

1. The initial stage (2019-2020 academic year). The aims and objectives of the research, the object and its indicators, as well as the criteria related to it, were all analyzed, as well as the scientific-theoretical and scientific-methodological underpinnings of the research process. Working hypotheses were developed because it was decided that the course "Discrete Structures" needed more methodological support. To improve training effectiveness, a bank of theoretical and practical assignments and exam questions that gauge efficiency has been created.

2. Academic level (2020-2021 academic year). The research's aims and objectives, as well as its working hypothesis, have all been met. For the "Discrete Structures" course, Discmath.uz software was created, and training materials were organized. In order to strengthen the current methodical support, emphasis was placed on the development of the professional competency of computer engineering professionals in the creation of lecture texts, practical assignments, and laboratory projects. The relevance of the research effort and the methodological rationale of using the enhanced principles were both supported by experiments.

3. Identifying experience level (2021-2022 academic year). An expert poll was used to assess the viability of discmath.uz software for the "Discrete Structures" course. The training technique created with the aid of the discmath.uz software was put to the test when instructing the "Discrete Structures" course in an effort to improve educational efficacy. The results of instructing the "Discrete Structures" course using the discmath.uz software were compiled during the experimental work, the conclusions were tested in

real-world settings, and these results were then analyzed using the Student-Fisher T-criterion mathematical-statistical method (see Table 2).

The Discrete Structures course's new, better methodological assistance was used to teach the lessons in the experimental groups, whereas the standard approach was used in the control group.

Table 2. Statistical analysis of student achievement indicators

	Experience class					**Control class**				
	X_i	"5"	"4"	"3"	"2"	Y_j	"5"	"4"	"3"	"2"
Before the experiment	n_i=198	27	57	91	23	n_j=198	27	55	93	23
After the experiment	n_i=198	56	103	39	0	n_j=198	33	63	83	19

The following graphic (see Figure 1) shows the learning dynamics of the 396 students who took part in the experiment at the start and conclusion of the trial:

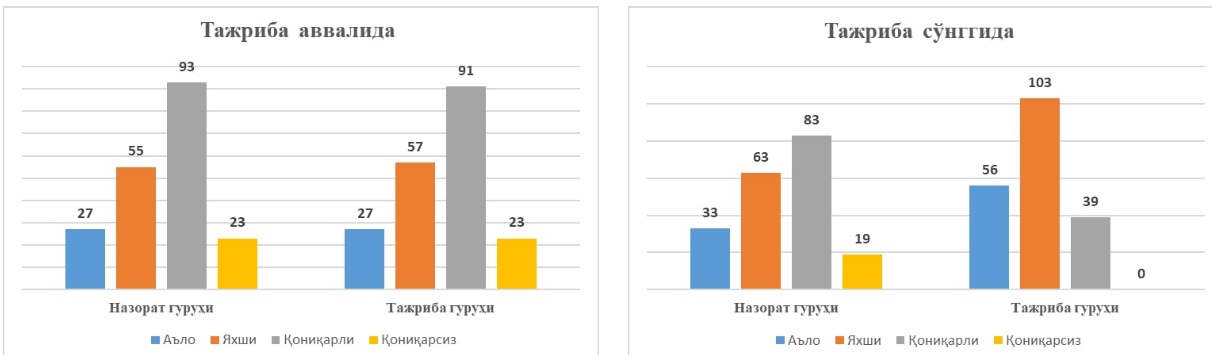

Figure 1. Diagrammatic view of experimental results

In conclusion, it can be claimed that utilizing mathematical and statistical techniques, the effectiveness of training conducted on the basis of novel improved methodological support of the course "Discrete Structures" is 1.15 times (14%) greater. The efficient application of Discmath.uz software in the educational process has been demonstrated to enhance students' logical thinking, knowledge, skills, and talents, as well as their interest in digital technology.

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