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ANALYSIS OF THE EFFECTIVENESS OF THE USE OF ADAPTIVE TRAINING PLATFORMS IN SECONDARY VOCATIONAL EDUCATION

Abstract. The article considers the tasks and features of mathematics training for students of secondary vocational education. Special attention is paid to the need to solve the problem of adaptation of students to the conditions of study in college and the organization of independent work. In this regard, the authors propose to make wider use of the practice of adaptive learning as innovative pedagogical tools. The article considers the concept of the effectiveness of adaptive personalized learning and suggests the directions by which it can be evaluated. As an example, the experience of implementing an adaptive educational course "Mathematics", designed in the Articulate Storyline platform, is analyzed. The module is designed to organize and support adaptive learning of students of the Department of Information Systems by means of adaptive educational technologies. The results of the training are analyzed, and the possibilities of the Articulate Storyline platform in ensuring the independent work of students are presented. The main part of the article is devoted to evaluating the effectiveness of e-learning using an adaptive educational platform. With the help of questionnaires and tools of the Articulate Storyline platform, an assessment of the educational result achieved was made, the degree of motivation of students to master the discipline of mathematics was analyzed, and the attitude of students to the process of e-learning using an adaptive educational platform was investigated.

Keywords: mathematics, engineering specialties, student, results of training, adaptive learning platforms, educational process.

Introduction

The importance of mathematics is determined by the dominant role of science and technology in modern society. In this regard, the course of mathematics, which is the basis for the formation of natural science knowledge, on the one hand, should be ideological, and on the other - reflect the current state of this science. It is the combination of fundamental

and applied knowledge, as well as the achievements of the triad: theoretical, experimental, and computational mathematics, that makes it possible to achieve significant progress in the development of natural sciences in general, determine the current state of technology and technologies, and train qualified specialists in various fields [1]. Mathematics is included in the basic part of the natural science cycle of disciplines in the structure of Compulsory disciplines in college. The purpose of studying this discipline is to master the basic laws of mathematics and the possibilities of their application in solving problems arising in the subsequent professional activities of students, i.e. the basis for continuity and continuity of training in IT and other engineering specialties [2].

The difficulties of teaching mathematics

Achieving the goals of engineering education requires improving the efficiency of the learning process and organizing the joint work of the teacher and the student. However, the situation is complicated by the fact that the level of training of school graduates in mathematics has been steadily falling in recent years. At the same time, scientists have concluded that it is the study of mathematics that forms a child's ability to think logically or, as programmers say, "formats the brain" in its way. And also, mathematics classes contribute to the formation of the future scientific worldview to the greatest extent. Not to mention the fact that mathematical sciences serve as the basis of scientific and technological progress, including within the framework of the sixth technological order [3].

The situation at the Department of "Information Systems" of Aktobe Higher Polytechnic College is consistent with the overall picture of the country. Upon admission, applicants take a choice of 2 entrance exams: computer science, and mathematics. The average score for the entrance exam in mathematics for first-year students in 2020 was 54, which is less than the average score in all disciplines equal to 64 points. Figure 1 shows the average grade of the entrance exam in mathematics. The results of training in the first semester show that yesterday's applicants have significant gaps in basic training in mathematics, which have to be eliminated mainly in junior courses [4].
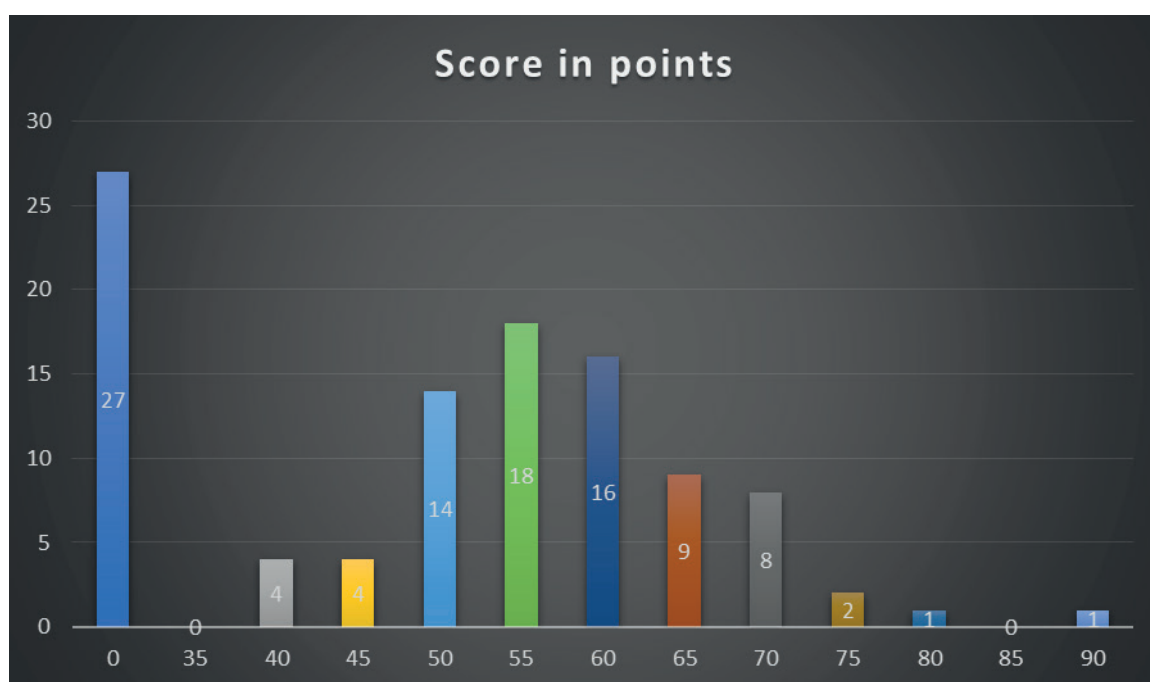

Figure 1. Histogram of the average grade of the entrance exam in mathematics
("0" – did not pass mathematics)

Moreover, the situation is aggravated by the reduction in the number of credits allocated to the development of mathematics conducted at the college. At the same time, the proportion of classroom classes has been reduced for most engineering areas. It should be taken into account that we teach yesterday's schoolchildren, most of whom have weak skills in conducting independent work.

In this regard, it is necessary to organize the independent work of students, with the possibility of implementing indispensable control over its results and monitoring how the student conducts this work, and how much time he spends on it. In today's situation, when the workload per teacher increases significantly, it becomes physically impossible to organize and control the educational activities of each student by traditional methods. It is necessary to optimize the learning process without losing its quality [5].

The possibilities of adaptive learning platforms as a means of learning

To better support, the development of adaptive learning environments, the science of learning has been attracting the attention of computer scientists for more than a decade. Researchers from the fields of education and computer science have tried to optimize the complex and time-consuming design of adaptive learning environments using advanced methods of data mining, machine learning, and deep learning. They aim to provide facilities for Intelligent Learning Systems (ITS) to help students more effectively. Several attempts have been made to develop ITS for the study of mathematics (Koedinger & Anderson, 1998 [6]; Razzaq et al., 2005 [7]), programming (Anderson & Reiser, 1985 [8]; Figueiredo & García-Peñalvo, 2020 [9] ; Mitrovic, 2003 [10]; Sykes and Franek, 2003 [11]; Weragama & Reye, 2013 [12]), languages (Evens et al., 1997 [13]; Ferreira & Atkinson, 2008 [14]; Slavuj, Kovačić, & Jugo, 2015 [15]; Swartz & Yazdani, 2012 [16]) and so on. Effective and efficient guidance of students in the learning process is a constant topic of research in the field of education in the 21st century.

The relevance of developments to ensure the quality of the college learning process is due to the need to integrate the educational process implemented in various educational institutions and search for effective methods and means to ensure the mobility of students. Another group of tasks includes monitoring the educational activities of students, and supporting interactive learning, which is enshrined in the requirements of the SES [17]. Consideration of students' preferences in obtaining and working with information, increasingly presented in electronic form, also requires attention.

The socio-psychological process of adaptation of a first-year student in college is also important. In the junior courses, students are faced with unfamiliar forms of organization of educational activities and types of control, as well as qualitatively new content of educational tasks. Compared to school, students are forced to work more independently, knowledge assessment does not take place at every lesson, and there is no total control on the part of parents. Few students adapt quickly and successfully to college conditions, especially when studying traditionally difficult mathematics for them. Often, students, having met with difficult material, do not have time to master educational information, do not complete tasks on time, and "drop out" of the learning process, which eventually leads to a large number of debts already in the first session [18].

With the help of modern means and technologies for organizing and supporting the educational process, it is possible to try to make the stage of adaptation of a first-year student to a new environment and a different learning style less difficult and lengthy. Educational programs implemented by various educational technologies, including distance learning technologies, e-learning, and adaptive learning platforms, come to the rescue.

Of course, technical means alone are not enough to ensure the effectiveness of the educational process. It requires the introduction of adaptive e-courses, their constant modernization and regular maintenance, quality control of the educational process, and much more.

Evaluation of the effectiveness of training using adaptive learning platforms

When developing an adaptive course, we conducted a comparative analysis of the following software tools (IPS): Articulate Storyline, Adobe Captivate, Course Lab, and MOS Solo. It is shown in Table 1. For this purpose, generalized evaluation criteria were chosen:
– intuitive interface;
– functionality;
– multimedia features;
– network capabilities;
– hardware and software independence.
Let's take a closer look at each of the criteria.

The intuitiveness of the interface implies the ability of the user to quickly understand the interface without a detailed study of its description in the user manual or the help system.

Functionality is a set of built-in IPS functions that implement the established or intended needs of the developer.

Multimedia capabilities are a set of built-in IPS functions that ensure the implementation, creation, processing, and reproduction of multimedia components.

Network capabilities imply ubiquitous and convenient network access for the developer to the IPS, for example, working in the cloud via a web interface.

Hardware and software independence implies the possibility of using adaptive courses created with the help of this toolkit on computers of other types, generations, and using an operating system different from the original one.

Table 1. Analysis of software tools for creating an adaptive training course

The name of the tool	Intuitive interface	Functionality	Multimedia features	Network Capabilities	Hardware and software independence	Total score
Articulate Storyline 2 (USA)	3	3	3	3	2	14
Adobe Captivate 8 (USA)	2	2	3	3	3	13
CourseLab 2.7 (Russia)	2	3	2	3	2	12
MOS Solo (Switzerland)	2	2	1	3	3	11

After processing the analysis data, we received an overall score, according to which we can conclude that the Articulate Storyline software product really corresponds to a combination of ease of learning and rich opportunities for professional development of an adaptive training course. The results obtained confirm that we made the right choice in favor of this toolkit.

As the best model of effective teaching, the authors selected and implemented an adaptive educational course "Mathematics", designed on the Articulate Storyline (AS) platform. The degree of achievement of the educational result was determined by evaluation implemented within the framework of the point-rating system (BRS). According to the BRS, the types of students' activities were established, which were evaluated in points, taking into account the

complexity of the intended actions of students and the importance of the result obtained in mastering the discipline.

Table 2 shows the results of passing the final exam and completing the entrance test for the above groups of students. The relatively low performance of the entrance test among students of groups № 2-4 is probably explained by extended summer vacations and superficial knowledge of mathematics. On the contrary, higher grades for the entrance test compared to the results observed for "strong" students is because the entrance test lacked the complex tasks of part "C", and the level of residual knowledge in this group of students turned out to be high.

Table 2. Results of initial training of students by groups of students

Group №	Input test, %	Output test, %	BO, %	Assessment for the exam
1	72,5	69,9	58,1	3,9
2	52,7	66,9	50,9	3,3
3	32,9	61,5	48,4	3,0
4	48,7	58,0	44,2	3,2

It follows from Table 2 that the score for completing the final test for "strong" students has practically not changed. Thus, working with an adaptive platform for this group did not affect the ability to perform test tasks in any way. Although at the same time, the average score for completing the final test turned out to be quite high, and the level of knowledge corresponded to the requirements of secondary vocational education.

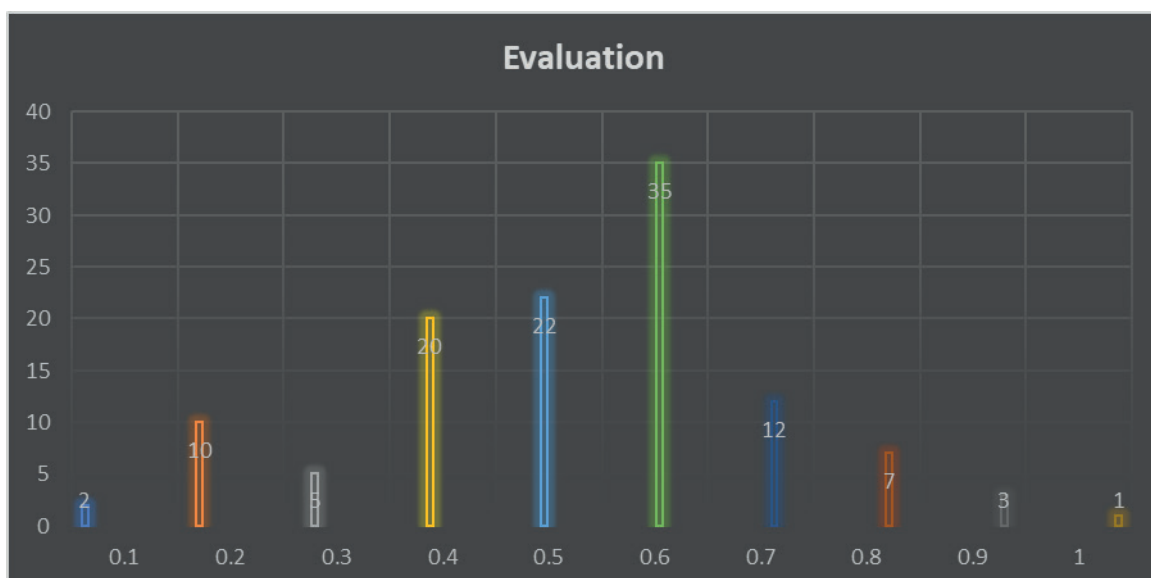The results of the test and homework are shown in Figures 2 and 3.

Figure 2. The histogram of the results of the test tasks

Figure 3. Histogram of homework results

The results of the course are presented in Figures 4, 5, and Table 3. As a result of the introduction of an adaptive learning platform, the weighted assessment of students was in the range of 15-85% with an average value of 51%.

Table 3. Learning outcomes

BO	Number of students	Assessment for the exam and the number of students who received this assessment
100 ÷ 80	7	«5» – 7
80 ÷ 65	24	«5» – 2, «4» – 22
65 ÷ 50	44	«5» – 2, «4» – 17, «3» – 22, «2» – 3
50 ÷ 40	24	«5» – not, «4» – 1, «3» – 23, «2» – 1
40 ÷ 30	10	Were not admitted to the exam – 5; received admission and passed the exam later – 5
< 30	8	Were not admitted to the exam

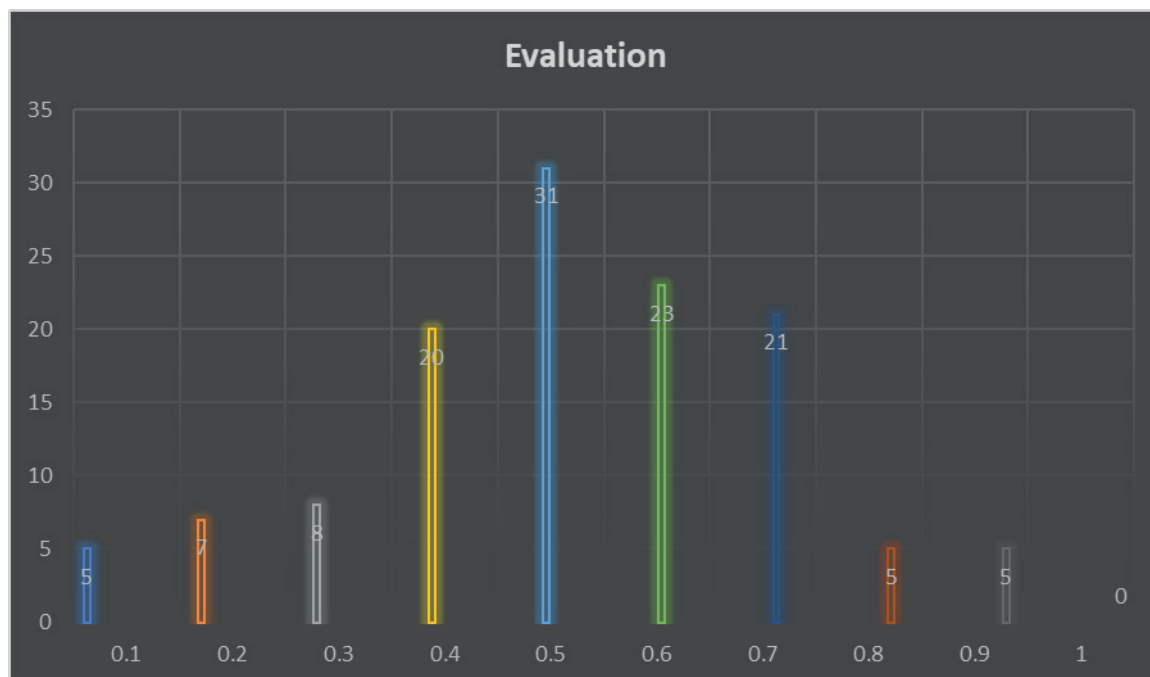Figure 4. Histogram of the results of the control work

Figure 5. The histogram of the weighted assessment for the course

The step in the weighted assessment, observed near 50%, is due to the fact that this indicator value, according to the BRS, was a threshold, i.e., a student could get a "good" grade on the exam if it was ⩾ 50%.

Table 4. Final results of the course development (average grades by groups of students)

Group №	Entrance exam in mathematics, points	BO, %	Assessment for the course exam	Average grade for the exam in all disciplines
1	59,2	58,1	3,9	4,1
2	53,7	50,9	3,5	3,5
3	53,0	48,4	3,2	3,4
4	-	44,2	3,4	3,3

The results of the entrance exam correlate quite well with the weighted and examination grades for the course. It is shown in Tables 3, 4. By the accepted BRS, a "good" grade was given to a student if his weighted score exceeded 65%, and he could receive a "satisfactory" grade only after successfully passing the exam. In 22 cases out of 35, if the student's VO was in the range of 55-65%, then he passed an oral exam for a grade of "good" or "excellent". If IN <55%, then, as a rule, the exam score was "satisfactory". It should be noted that the rather low VO among the students of the 4th group is explained by their weak motivation to systematically master mathematics. During the session, this disparity was eliminated, which may be due to the great abilities or diligence of this group of students.

The effectiveness of using an adaptive learning platform is evidenced by the fact that the difference in grades for the entrance exam in mathematics and other subjects was eliminated during the training. This can be seen by comparing the average grades for the entrance exam and the average grades of the session presented in Tables 2, and 4.

The second direction in assessing the effectiveness of training involves identifying students' perceptions of an adaptive learning platform. The most convenient means of evaluating the

effectiveness of training at this level is a questionnaire conducted at the end of the semester. 118 people answered the questions in the questionnaire developed by the authors of the article.

- The questionnaires offered to students using the AS "survey" tool contained 44 questions on all aspects of learning, including:
- how do students evaluate the quality of the adaptive platform and teaching methods;
- how effective are the training tools used;
- there is a need to improve the organization of work with an adaptive learning platform and forms of presentation of educational material;
- satisfaction with the score gained as a result of studying the discipline;
- the efficiency of using BRS;
- the efficiency of network interaction;
- labor costs for completing the proposed tasks;
- the nature of the technical and software tools used, etc.

The majority of students are satisfied with the quality and form of presentation of educational material in the adaptive learning platform (57% rated "good" and 28% – "excellent"). From the point of view of usability, the proposed adaptive course was quite effective. The organization of students' access to their results caused the greatest comments (25% of students scored "satisfactory" and "unsatisfactory" for the same indicator). As for the low activity of network communication, the majority of students noted that they could not identify topics for substantive communication for themselves, and some of the students indicated that they preferred to find out the available questions from the teacher at face-to-face consultations. Network communication in AS was conducted through mail and a forum. The diagram reflecting students' who need to use network communication in AS is shown in Figure 6.
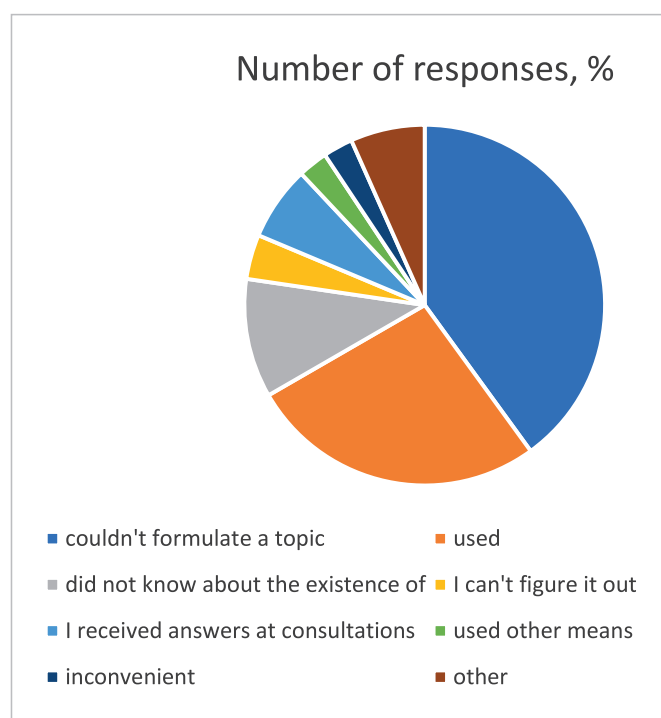

Figure 6. Diagram reflecting students' need to use network communication in AS

More than 90% of students rated the effectiveness of lectures, practical, and laboratory classes as "good" and "excellent". The effectiveness of independent work with an adaptive

learning platform, according to students, turned out to be somewhat lower: two-thirds of students rated it "good" and "excellent". Here, both the lack of independent work skills and insufficiently clear instructions on the order of students' actions are affected. Nevertheless, the majority of students (74%) considered the proposed technology of adaptive education effective. Only 12% of the respondents noted that the traditional form of education is preferable for them. As for the technical means available to students and the possibility of learning online, they turned out to be quite modern. A significant majority of students used laptops in their work – 61% of the answers and PCs – 36%, in other cases, tablets and smartphones were used.

Conclusion

The organization of the educational process using an adaptive learning platform made it possible to eliminate the difference in the relatively weak preparation of students in mathematics compared to other academic disciplines. With the help of the BRS integrated into the adaptive platform, it was possible to ensure a uniform course of independent work and motivate students to study mathematics. E-learning using an adaptive learning platform made it possible to adapt most of the first-year students to college, to build individual learning trajectories. Based on the monitoring implemented by Articulate Storyline, it became possible to justify and regulate the time required for both individual tasks. The vast majority of students considered e-learning technology using an adaptive learning platform effective. The use of the analysis tools included in the AS platform provided statistical data on the results of various tasks, which made it possible to make adjustments to the evaluation tools.

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