

# Application of Adaptive Learning Technologies in Modern Polytechnic Education

V V Kukartsev<sup>1,2</sup>, E A Chzhan<sup>3</sup>, V S Tynchenko<sup>4,5</sup>

<sup>1</sup>Department of Informatics, Siberian Federal University, 79, Svobodny pr., Krasnoyarsk 660041, Russia

<sup>2</sup>Department of Information Economic Systems, Reshetnev Siberian State University of Science and Technology, 31, Krasnoyarsky Rabo-chy Av., Krasnoyarsk 660037, Russia

<sup>3</sup>Department of Intellectual Control Systems, Siberian Federal University, 79, Svobodny pr., Krasnoyarsk 660041, Russia

<sup>4</sup>Department of Technological Machines and Equipment for the Oil and Gas Complex, Siberian Federal University, 79, Svobodny pr., Krasnoyarsk 660041, Russia

<sup>5</sup>Department of Information Management Systems, Reshetnev Siberian State University of Science and Technology, 31, Krasnoyarsky Rabo-chy Av., Krasnoyarsk 660037, Russia

E-mail: vlad\_saa\_2000@mail.ru

**Abstract.** In modern society, special requirements are imposed on education and pedagogical methods. Education can be obtained remotely using various means and capabilities. These include interactive e-courses. This article is devoted to the problem of development of electronic courses based on the Moodle platform. The main feature of the courses under consideration is the use of different learning pathways. These pathways help to make e-course adaptive. Students have the possibility to control the learning process and its progress. The article presents the results of testing an adaptive course for students.

## 1. Introduction

Currently, there is a generation change, future students are representatives of generation Z, who are actively involved in the online world and chatting, entertainment occurs in an interactive form using various devices. The learning process should also be interactive, with elements of gamification. In this regard, in learning process it is considerable to use open online courses, electronic educational courses, etc. [3, 6]. One of the key points in the implementation of electronic courses is feedback from the teacher. Modern platforms where electronic courses are presented allow to give feedback through various tools [1, 13].

Feedback allows teachers to manage the learning process in e-learning courses (ELC). However, the main problem is a different level of preparation and progress of students who take one or another course. Difficulty in providing materials for various students arises because the courses are massive. In this way, it is advisable to realize the opportunity to provide material on various learning pathways depending on the complexity of the presentation [2, 4, 7]. Thus, students can choose, in accordance

with their preferences, the particular learning pathway [9, 10, 12]. This will simplify the learning process and help students to complete adaptive courses successfully [8, 11].

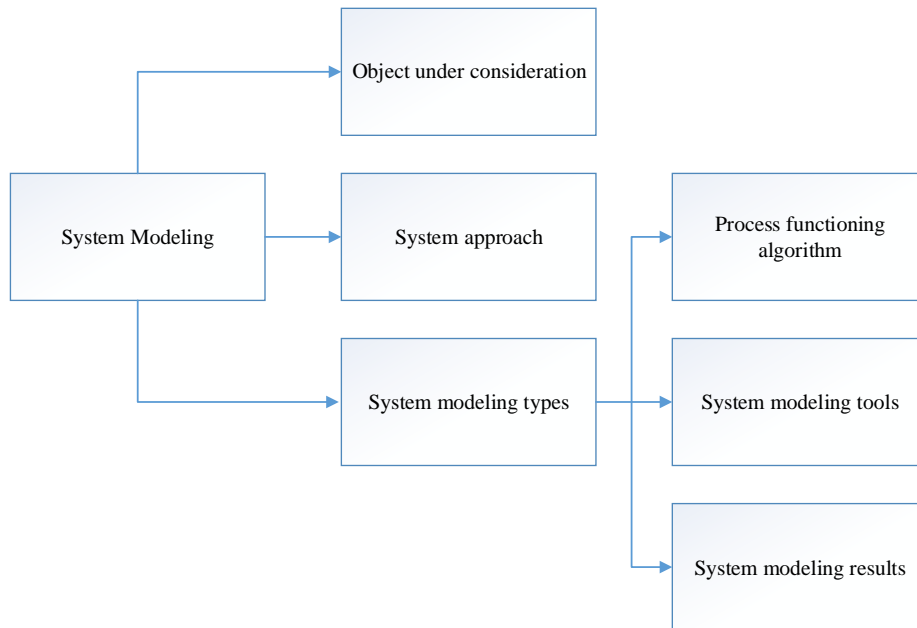
The implementation of the adaptability of ELC using different pathways was proposed earlier and the results are presented in the work of the authors [5]. As a part of this study, it is proposed to provide students with independent control over the course, assess their success and be able to improve their performance.

This article is devoted to the study of the implementation and introduction of an e-learning adaptive course, where adaptability is realized through the use of several learning pathways.

**2. Problem statement**

In the framework of this study, the main criterion for the quality assessment of the learning process is the student academic performance. By academic performance we mean the results of the final control of the discipline. To improve student performance, it is proposed to develop an adaptive e-course. Student have the opportunity to study the material in their own mode of study, dwelling in detail on the necessary sections. The use of ELC in the full-time learning process allows to implement a mixed learning model, which is one of the most effective learning models.

The e-course is based on theoretical material and practical tasks necessary for obtaining knowledge and skills. For tasks development it is proposed to use a tree of operations. The tree of operations for the discipline “System Modeling” is presented in the following figure. Also, this tree is necessary to divide the course into sections. In the adaptive e-course of “System Modeling” only learning success of theoretical material is estimated automatically with tests. The practical tasks for every path in one section is the same.



**Figure 1.** The concept tree of the adaptive course.

**3. The use of learning paths in adaptive courses implementation**

The most common by far is a five-point scale estimation. In this case, the discipline is mastered, if a student receive a rating of "satisfactory", "good" or "excellent". Thus, we shall accept the hypothesis that the three learning pathways that correspond to these estimates are best suited for the adopted assessment system. The initial definition of a learning pathway can be implemented using two methods: the first is based on students' personal preferences, the second is based on the results of input testing, which allows automatically identify the initial level of training level of students.

The high learning pathway corresponds to the rating of "excellent". In this case, the material is presented most concisely, abstractly, without a large number of explanatory examples. We assume that for training along this pathway, students are well prepared, have the necessary amount of basic knowledge and learn the material more quickly.

The average pathway corresponds to the rating of "good". In the presentation of material on this pathway it is used a small amount of samples and explanatory information blocks.

The low pathway corresponds to a satisfactory assessment. The material is presented in more detail with a large number of examples.

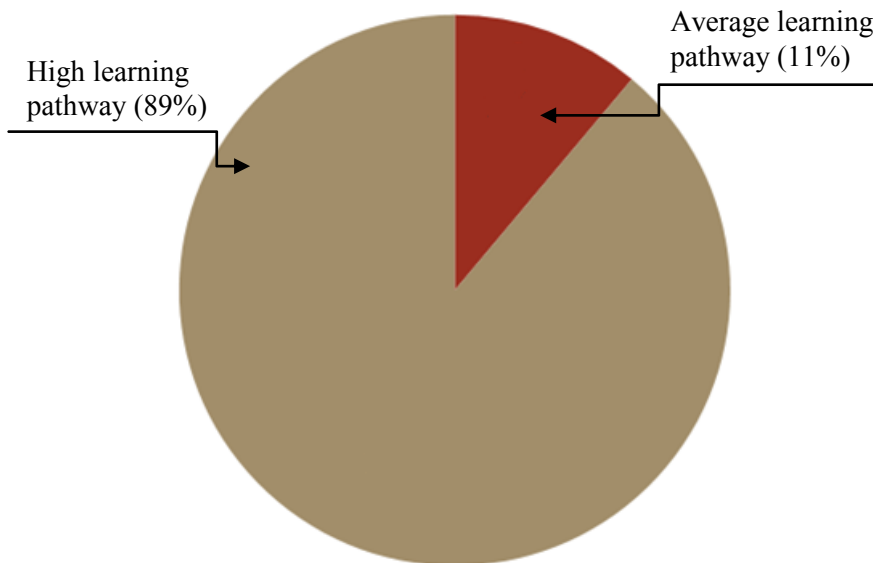
If students have not mastered the material after passing through all the sections, they are offered an on-site consultation with the teacher.

To assess the success of the passage of the section testing is used. If a student has completed the test (percentage of completion of 85 for a limited time), then he or she can proceed to the next section. Each learning pathway corresponds to a specific assessment ("satisfactory", "good" or "excellent"), i.e. to improve the assessment within one section, it is necessary to study the material of a higher pathway. If the student has not mastered the material, i.e. has not passed the test, then he or she has the opportunity to choose a lower pathway.

Finally, to get the final grade for the course in automatic mode, not only the results of the final control are taken into account, but also intermediate control results, i.e. estimates for the material of each section in accordance with the type of learning pathway. The peculiarity of the adaptive course is that the student is able to not only plan his or her studies, study the material and carry out practical exercises, but also estimate the results of the final control. It is excluded the factor of subjective attitude when grading. Thus, a student can independently achieve an increase in assessment within one section by passing through different pathways.

**4. The results of the implementation of the adaptive e-course**

Consider the results of using an adaptive course on the discipline "Systems Modeling". The material presented in the ELC consisted of 5 sections. In each section, the material was presented in three different forms along three pathways. De-pending on the pathway, the volume and complexity of the material differ.



**Figure 2.** The initial distributions of students.

The distribution of students was carried out automatically according to the results of input testing. Within the framework of the training, the disciplines are related residual and basic knowledge from related subjects are necessary for studying subsequent disciplines. Therefore, input testing is based on the theoretical material of related disciplines. The results of student allocation are shown in Figure 2. As we can see, the majority of students studied the material of the first section in a “high” pathway, which corresponds to the “excellent” grade.

Below the figure 3 shows the transitions along the pathways. As it can be seen from the histogram, in the learning process students moved both to a higher pathway and to a lower one.

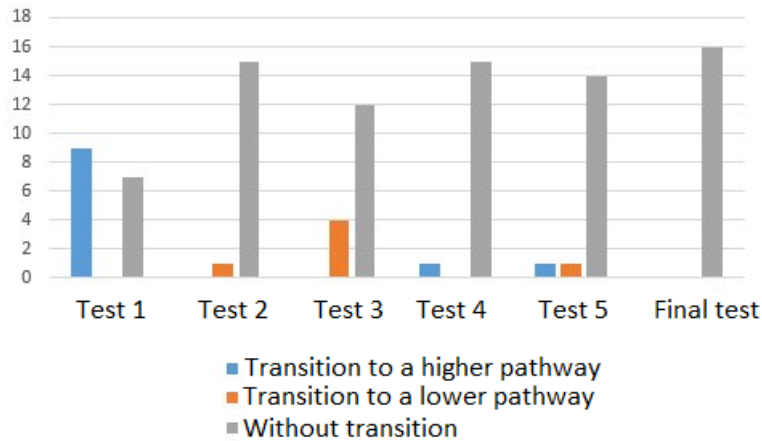


Figure 3. The histogram of transitions along learning pathways.

Students have several attempts to compete the tests. If the results are not satisfactory, the student have to change the learning pathway to a lower one or to attend on-site consultation with the teacher. The number of attempts and unique attempts are shown in Figure 4. The first test was the most complicated as student needed to make several attempts to complete it.

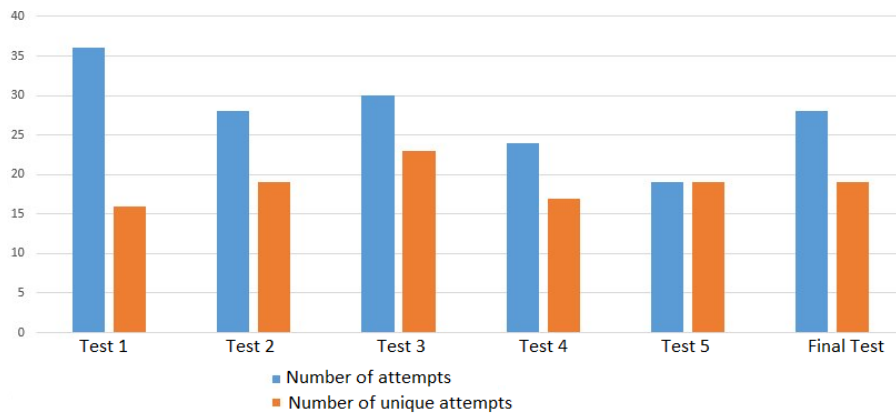


Figure 4. The histogram of tests attempts number.

The analysis was conducted on the basis of the retrospective data on the results of the final certification for the discipline "System Modeling" from 2015 to 2018 academic years. The results are shown in the histogram in Figure 5. In 2018, an experiment was conducted on the use of the adaptive ELC for learning this discipline. It can be concluded that the use of the adaptive e-course course allows to reduce the number of untested students and improve the performance in general.

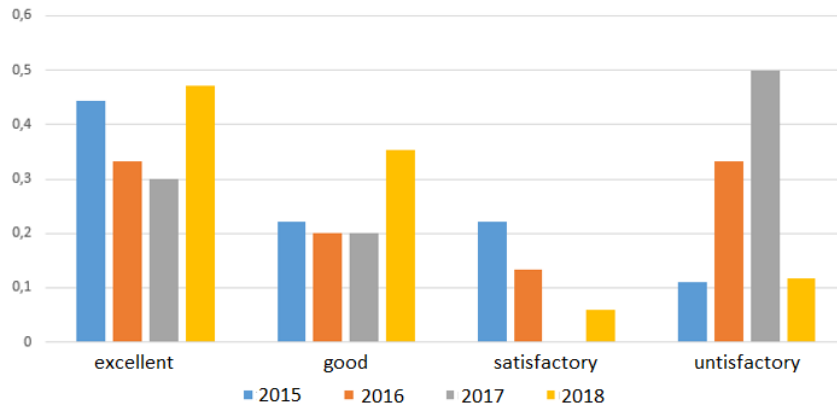


Figure 5. The histogram of final grades.

### 5. Conclusion

In the framework of this study, the results of the development and testing of an adaptive e-learning course are presented. Different learning paths were implemented which corresponds to different assessments. The results of a retrospective analysis showed the effectiveness of the use of adaptive ELC. In the future, it is supposed to automate the process of checking not only theoretical material, but also practical tasks on the discipline.

### References

- [1] Birjali M, Beni-Hssane A and Erritali M 2018 A novel adaptive e-learning model based on Big Data by using competence-based knowledge and social learner activities *App. Soft Comp. J.* **69** 14-32
- [2] Brusilovsky P 2003 Adaptive navigation support in educational hypermedia: the role of student knowledge level and the case for meta- adaptation *British J. of Educ. Technol.* **34(4)** 487-497
- [3] Clark R C and Mayer R E 2016 E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning *John Wiley & Sons*
- [4] Kardan A A, Aziz M and Shahpasand M 2015 Adaptive systems: a content analysis on technical side for e-learning environments *Artif. intel. rev.* **44(3)** 365-391
- [5] Kukartsev V, Chzhan E, Tynchenko V, Antamoshkin O and Stupina A 2018 Development of Adaptive E-Learning Course in Moodle System *EDP Science* **50** 01091
- [6] Margaryan A, Bianco M and Littlejohn A 2015 Instructional quality of massive open online courses (MOOCs) *Comput. & Educ.* **80** 77-83
- [7] Mavroudi A, Hadzilacos T and Angeli C 2016 An adaptive e-Learning strategy to overcome the inherent difficulties of the learning content *European Conference on Technology Enhanced Learning. Cham.* 440-445
- [8] Premlatha K R and Geetha T V 2015 Learning content design and learner adaptation for adaptive e-learning environment: a survey *Artif. Intell. Rev.* **44(4)** 443-65
- [9] Sysoev P V 2013 Training on an individual trajectory *Lang. and Cult.* **4(24)** 211-19
- [10] Sztajn P, Confrey J, Wilson P H and Edgington C 2012 Learning trajectory based instruction: *Toward a theory of teaching Educ. Res.* **41(5)** 147-156
- [11] Terzieva T and Rahnev A 2018 Basic Stages in Developing an Adaptive E-Learning Scenario *IJISSET-International J.ournal of Innov. S., Engineering & Technology* **5(10)** 50-54
- [12] Zaslavskaya O Yu and Kravets O Ya 2010 Features of the construction of an individual trajectory of learning computer science on the basis of a dynamic integral assessment of the level of knowledge *Bulletin of the Russian University of Peoples' Friendship. Series: Informatization of education* **4** 78-92
- [13] Zaytseva L V 2008 Technology for developing adaptive e-learning courses for computer-based learning systems *Educ. techn. and soc.* **11(1)** 135-142