Providing Adaptivity in Moodle LMS Courses

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Abstract—This study was aimed at investigating ways to ensure the adaptivity of Moodle courses to improve the efficiency of the educational process. As the main research method, the survey was used to study the issues of ensuring the adaptivity of eLearning in Moodle. Besides, within the current work, the method of achieving the course adaptivity was combined with a personalized approach proposed by Limongelli et al. It was revealed that most study participants have difficulties with self-learning and perceiving educational material through audio records (36.4% and 36.4%, respectively). The development of the model for adaptive eLearning in Moodle was based on the use of the personalization approach, which provides an automatic adjustment of educational content according to students' knowledge and way of learning. The adaptivity of eLearning courses is necessary for the successful implementation of online training in today's education system. Prospects for the practical use of the research results lie in the possibility of an international exchange of experience concerning Moodle courses' adaptivity.

Keywords—eLearning; model; personalization of learning; system

1 Introduction

Online education is receiving increased attention from researchers worldwide. Under the current conditions, if properly implemented and adapted to modern students' requirements, eLearning is expected to strengthen and develop traditional education [1]. Such a training mode allows removing time and space barriers, which are typical for traditional teaching since access to an educational course is possible through the connection to the Internet. At the same time, eLearning makes it possible to monitor the learning progress of the students better. It is crucial for teachers because they have the ability to make judgments on the state of students' knowledge [2].

1.1 LMS adaptivity theory

Online education mode significantly differs from that offered by the regular curriculum in universities. It is primarily provided through a Learning Management System (LMS), which should accept students with various academic performance and competence due to the impossibility of assuming their pre-knowledge levels. To maintain eLearning, instructors are to provide a constant update of the training content and make the learning course engaging to keep students motivated. Hence, the implementation of adaptive learning in online courses is essential [3].

Students' needs in the context of the learning content are individual for each subject. Students' capabilities relate to their ability to read, learn, and think critically. In the process of eLearning, learners are recommended to use different educational resources, including websites and educational applications, proposed by their teacher to improve the level of their knowledge and enhance professional skills [4].

The current educational market presents many eLearning systems; however, they provide only the same plain hypertext pages to all learners regardless of individual ability. In many web-based courses, educational material is still implicitly oriented for a traditional on-campus audience consisting of homogeneous, well-prepared, and well-motivated students. Notwithstanding this, web-based courses are used by a much wider variety of users than any campus-based ones. Usually, learners have different goals, experiences, knowledge levels, and learning capabilities. A web-based course designed for a specific group of users, like a traditional one, may not fit other learners. Therefore, the course material needs to be flexible so that different learners can receive personalized content and information in demand [5].

In an adaptive eLearning environment, students can virtually navigate traditional semester courses at an accelerated or extended pace. In most cases, learners must repeat, rewind, and replay options to achieve better training results.

1.2 Moodle LMS

It has been multiply proved that students are more convenient to study with LMSs due to the benefits they offer (the ability to access information anywhere and anytime). Today's educational system proposes various popular LMSs to be used. One of the most famous is Moodle – a modular object-oriented developmental learning environment designed especially for web-based education [6].

Moodle is used to create online educational courses and websites. It is an ongoing development project designed to support eLearning that is provided free of charge as open-source software under the GNU Public License.

Many educational organizations use an open-source Moodle framework to implement eLearning solutions due to the lack of required infrastructure and resources. Since Moodle is an open-source framework, it defines the structure of a software system and facilitates the development and integration of various components of a large project. Thus, its extension is possible by adding the desired functions in the form of plugins, packages, and modules [7].

Creating and adding new modules in Moodle is easy without interfering with the original system. For all these functions, portability and standardization are essential. In the meantime, LMS should be open and able, for example, to quickly integrate learning content created before its introduction in the training process [8].

The Moodle platform has proven to be a useful learning tool owing to its interactive multimedia content. It gives ample opportunities to collaborate, follow guidelines, provide and receive feedback, and reinforce prior learning material. Among the central principles of Moodle are storing, tracking, and measuring educational outcomes, as well as providing an eLearning environment for various learners [9].

1.3 Adaptivity system in Moodle LMS

Adaptation of eLearning in accordance with the learners' needs is the central question raised in this study. In order to better understand its essence and justify approaches to developing recommendations for its improvement, it is important to understand how an online LMS works.

Traditional eLearning practices deal with all students the same way, delivering identical content. When it comes to different people, this method has shown its limits in terms of efficiency and effectiveness. The slogan "everything for everyone" does not work here. Consequently, it becomes necessary to develop systems for adaptive eLearning management [10].

Over the past twenty years, smart educational systems have concentrated their personalization efforts on assisting learners in searching the best way through available training content to reach their learning goals. Nowadays, a wide range of personalization technologies, known as course sequencing, adaptive navigation support, and content recommendation, can propose the most appropriate content with regard to learning goals and the current state of student's knowledge [11].

The government and educational sector increasingly appreciate personalized education. The adaptive learning system provides suggestions for students through constant cooperation. Abundant and personalized learning resources, timely feedback, rapid communication systems, and real-time adaptive grading are more oriented toward learners' individual needs [12]. Adaptive learning technology, in conjunction with digital software, lies at the heart of personalized learning that shapes each student's profile and continually adjusts learning methodologies based on a person's progress.

In modern education, LMS (like Moodle, Blackboard, Sakai, and others) is an integrated system that supports eLearning and administration processes [13]. Moodle is responsible for monitoring an objectively module-based environment for distance education, taking into consideration the philosophy of "social constructivism." Moodle strives to ensure the simultaneous interaction between the educator and the study group at the synergy and group development level [14].

Today, Moodle is considered a promising software environment that allows teachers to organize and manage eLearning effectively. Moodle's multimedia tools enable the creation of interactive and engaging activities that facilitate the learning process from the students' perspective [15]. Moodle provides full-fledged learning with control systems, assessment of knowledge quality, and a wide range of learning content. Its tools

allow creating a complex professional training product that is required to ensure the integration of traditional and web-based learning in higher education institutions. Simultaneously, Moodle remains a resource base for joint external education.

1.4 Personalized learning in Moodle LMS

In the online environment of eLearning, adaptive education is possible through the identification of a student, personalization of course content, track of interests, and evaluation of learning outcomes. Against this background, adaptive learning presents a great learner-centered experience due to the individualization of the learning path with reference to a person's needs and contemporary educational trends [16].

Moodle LMS can design an individualized course based on the initial student model and the use of metadata by teachers to manage the learning content. The students' distance learning process is monitored during the assessment of their progress and actual usage of the training material, allowing the system to adapt the course to the learner's expectations [17].

Moodle LMS provides the opportunity to study at any time, both inside and outside the classroom. It fosters the ability to interact and exchange ideas with classmates and educators through electronic communication. In doing so, teachers can present the information, exercises, and tests, and update learning content via Moodle to make it more interesting, without the necessity for lecture-based teaching [18].

It is essential to design eLearning courses in an efficient way. Their curriculum must address students' demands and requests and be able to adapt to the learning process. The functionality of the eLearning platform and knowledge of its functions play a prominent role in creating an effective online course [19].

The concept of learning adaptation is generated from the adaptive hypermedia field and depends on complex conceptual models, usually based on sequencing rules developed in the courseware. In order to build a personal learning plan, the system uses students' knowledge elements. Their proper arrangement provides the automatic generation of a learning path that will satisfy a potential student [20].

To explore the possibilities of ensuring adaptivity in Moodle LMS courses, the present study reviews the following issues:

- World experience in the development of eLearning with the help of Moodle LMS
- Features of ensuring adaptivity in Moodle LMS courses
- Approaches to building a learning adaptivity model in Moodle LMS.

The work begins with an introduction that addresses the importance of adaptivity in eLearning courses and the need to use a personalized approach while developing training programs. After the introduction, attention is paid to the theory of courses' adaptivity in Moodle. The development of the adaptivity system in the Moodle LMS is considered separately. The next sections are the research methodology, study results, and their discussion and comparison. The final conclusions are given at the end of the article.

2 Materials and Methods

2.1 Research design

The central research method was a survey aimed at studying issues related to ensuring the adaptivity of eLearning in Moodle courses. This survey was based on a special questionnaire designed to investigate the level of students' understanding of eLearning possibilities and the most appropriate learning styles in Moodle. It included ten questions, formed in conformity with a mixed methods methodology. The day before the start of the examination, all those wishing to be engaged were proposed to participate in an anonymous survey. Each respondent was given, on average, 15-20 minutes to complete the given form. Out of 200 prepared paper questionnaires, only 172 were completed, 10 of which were rejected.

When developing a learning adaptivity model in the Moodle LMS, an approach based on the personalization of training experience was used. The proposed system combined Moodle with an adaptive module that provides automatic sequencing of learning material in accordance with students' knowledge and learning styles [17].

2.2 Sample

In the course of the study, the number of respondents amounted to 162 people – 71 males and 91 females (44% and 56%, respectively). The sampling was independent and random (Table 1).

Table 1. Sample population

Gender	Number	%
Male	71	44
Female	91	56
Total	162	100

The survey was conducted anonymously with the observance of all ethical principles. The involved students were acknowledged that the obtained data would be used only for scientific purposes and remain confidential.

2.3 Statistical analysis

Statistical analysis of data obtained was carried out in the Microsoft Excel spreadsheet through the Analysis ToolPak add-in.

2.4 Research limitations

The current research was performed by studying the opinions of the Kazan (Volga region) Federal University students on ensuring the adaptivity of eLearning in Moodle courses. Issues related to technical features of Moodle were not considered.

3 Results

According to the extensive scientific literature available as of July 2020, nowadays, Moodle continues to be among the most popular LMSs. The number of its users reaches 217 million people from 241 countries who can benefit from Moodle by virtue of 158 thousand educational sites (Table 2). Moodle provides access to more than 26.7 million courses in various fields of study. The platform's significant spread has become possible primarily due to its open-source code, accessibility, availability of multifunctional capabilities to develop training programs, and the global trend of digitalization of education.

Table 2. Moodle world statistics as of July 2020

Category	Number
Sites	157,801
Forum posts	483,287,416
Courses	26,747,189
Resources	226,492,579
Users	216,699,298
Quiz questions	2,737,569,651
Enrolments	1,119,536,485
Countries	241

Source: Moodle [21]

It should be separately noted that most of the registered Moodle-based websites have an audience of up to 1,000 users, and from 1,000 to 10,000 active visitors (Table 3). Only seven educational sites have more than one million learners.

Table 3. Registered Moodle sites by size as of July 2020

Users	Registered sites
0 - 1,000	140,182
1,000 - 10,000	13,729
10,000 - 20,000	1,835
20,000 - 50,000	1,266
50,000 - 100,000	442
100,000 - 200,000	209
200,000 - 300,000	49
300,000 - 400,000	18
400,000 - 500,000	7
500,000 - 1,000,000	12
> 1,000,000	7

Source: Moodle [22].

The Russian Federation is one of the top ten countries where the Moodle eLearning platform is used. As of July 2020, the number of Russian sites based on Moodle amounted to 5,076 (Fig. 1).

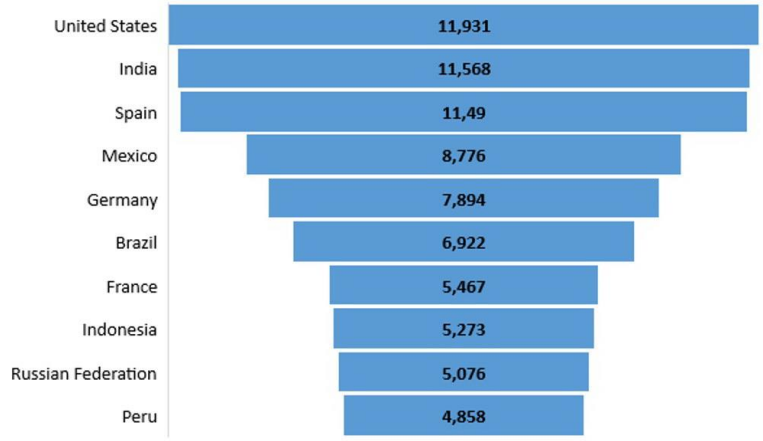

Fig. 1. Top 10 countries by Moodle registrations

Source: Moodle [23].

Moodle is used in many educational institutions of Russia as the basis for organizing distance learning courses. The worldwide spread of COVID-19 has accelerated the transition to distance education. As a result, this fact necessitated the development of a system for ensuring educational courses' adaptivity through the implementation of various learning models. The survey of 162 students was performed to substantiate the proposed model theoretically (Fig. 2).

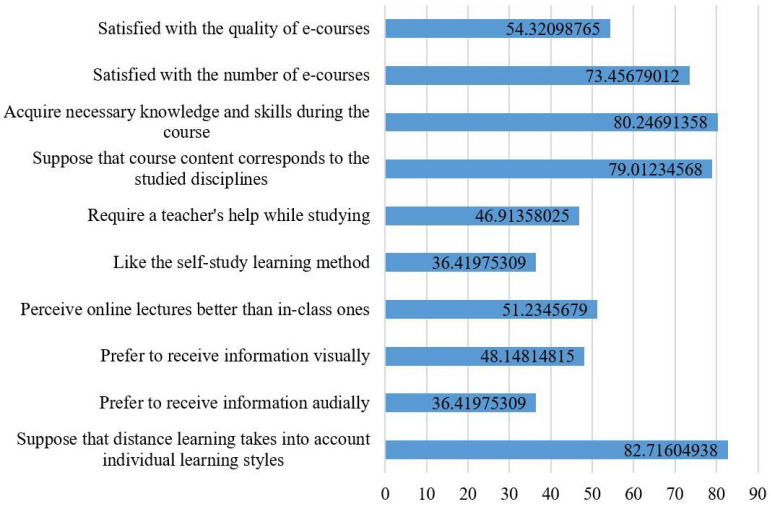

Fig. 2. Results of the students' survey concerning Moodle courses, %

According to the survey conducted to determine the capabilities of Moodle LMS for adaptive online education, it was uncovered that the majority of respondents are

satisfied with the quality of eLearning courses (54.3%). The question regarding whether the individual learning style is taken into account during a Moodle course received the most significant number of positive answers (82.7%). On the flip side, a comparatively small number of study participants responded positively to the questions about independent work and preferences in receiving audio information (36.4% and 36.4%, respectively).

The main task of adaptivity in Moodle is the selection of optimal educational content that will be effectively absorbed by learners. Based on this, it is important to develop the adaptive model of Moodle based on the interaction between a student, database of educational content, and a teacher applying a special module that will provide a personalized approach to the choice of training materials (Fig. 3).

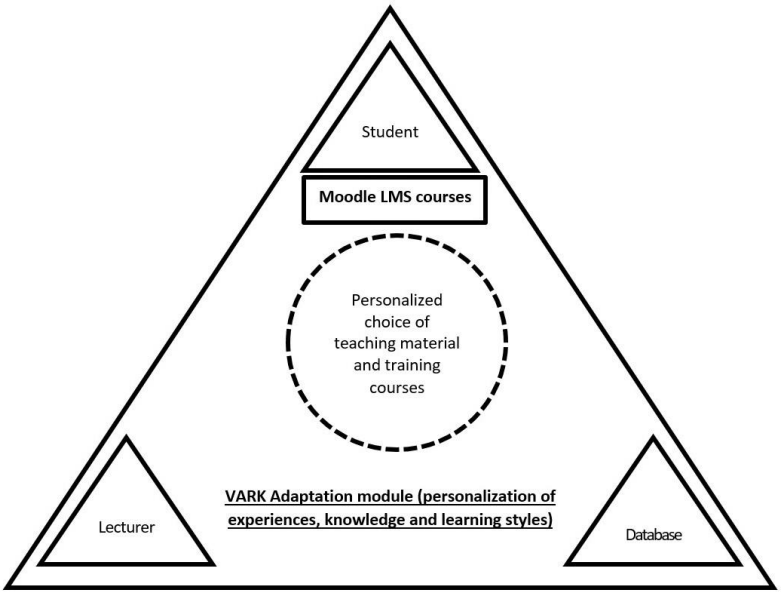

Fig. 3. Model of adaptive learning in Moodle

Source: developed by the authors based on Limongelli et al. [17].

The practical application of the proposed model is expected to contribute to the effective adaptation of eLearning in compliance with students' needs and expectations. Besides, depending on the chosen course, it is supposed to promote the development of various learners' skills and competencies. As a consequence, such a model can be considered the key to achieving successful learning outcomes.

4 Discussion

When comparing the research outcomes with the findings of other scholars, one can reasonably assert their similarity. At the same time, it should be agreed that modern

distance learning technologies need to change approaches to training and the development of personalized educational content.

Many researchers emphasize the importance of Moodle courses' adaptivity for the implementation of eLearning in education [24,25]. This opinion is largely consistent with the position and findings of the present research. Moodle is deemed one of the best alternatives to introduce the proposed adaptive eLearning conceptual model since it is an open-source platform with all the necessary features [26].

Asia-Pacific International University has recognized the importance of teaching and learning through electronic media and now uses Moodle to manage the teaching information system of educational courses (setting, submitting, and assessing assignments, creating tests, online examination, lesson improvement, etc.). It has been established that the monitoring capability during learning through Moodle allows the instructors to be aware of individual learning behaviors and provide timely help to students, especially those in the at-risk group [18].

In Kazan Federal University, just like in most leading higher educational institutions of Russia, Moodle is the foundation of eLearning. Currently, this system is translated into dozens of languages, including Russian, and is widely used in more than two hundred countries. Its important advantage is the possibility of free use, which does not provide for licensing, but allows free upgrading. One more Moodle's benefit is extensive opportunities for interaction and the provision of fast feedback. These pros provide a reasonable basis for creating adaptive eLearning courses all over the world [27].

Moodle LMS has several features available for educators to assist them in teaching. The LMS is generally used for delivering learning material, course progression plan, grading, creating activities, collecting course feedback, and communicating with other course participants. Among several features, only a few of them, such as assignment, feedback, quiz, and workshop modules, are considered essential and heavily used [19].

Recently developed LMS with hypermedia Smart Tutoring Systems facilitates more personalized learning that is more in line with student's personal learning pace. Furthermore, the use of records that the interactions between learners leave on the system allows one to collect a vast amount of data concerning the study process that can be analyzed using data-mining techniques. Consequently, the teacher can access real-time information that contributes to a better understanding of student preferences and systematical adjustment of the curriculum throughout the entire learning process [28].

The use of Moodle LMS in education contributes to the advancement of cognitive and practical skills of managing various information sources and ICT tools while searching for historical and biographical information. Additionally, online courses have created preconditions for the promotion of students' independent learning activity [29].

Over the past several years, much attention has also been paid to the identification of student learning styles to create adaptive learning systems. Today, studies on this issue can be classified as theoretical and practical. Theoretical research is centered mainly on introducing learning models and tools for the determination of individual learning styles. The practical examinations are oriented at designing and constructing adaptive learning systems that are aimed at enhancing the learning experience according to individual learning styles [30].

5 Conclusion

Effective adaptation of eLearning in accordance with the needs of students facilitates the development of the necessary students' skills and competencies. It remains crucial for outstanding academic achievements.

The survey designed to determine the capabilities of Moodle LMS for adaptive eLearning revealed that the majority of respondents (54.3%) are satisfied with the quality available eLearning courses. Most students believe that the current online educational courses take into account their individual learning styles (82.7%). However, according to the collected questionnaires, the prevailing part of respondents does not get good in self-learning and receiving educational information by ear (36.4% and 36.4%, respectively).

The development of the model for adaptive eLearning in the Moodle LMS was based on the personalization of a student's training experience. It provides an automatic adjustment of educational content according to a person's knowledge and learning style. This model was developed using the network structure of interaction between a student, database of educational content, and a teacher using a special module that should provide a personalized approach to the choice of educational materials and courses.

Thus, the adaptivity of Moodle is essential for the successful implementation of eLearning in education. The provided submissions can be useful for the international exchange of approaches directed at ensuring adaptivity in Moodle LMS courses.

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8 Appendix 1

Questionnaire

Question	Yes	No
Does distance learning take into account a student's learning style?		
Do you prefer to receive information audially?		
Do you prefer to receive information visually?		
Do you perceive online lectures better than in-class ones?		
Are you comfortable with the self-study learning method?		
Do you need a teacher's help while studying the educational material?		
Does the course content correspond to the disciplines you study?		
Have you acquired the necessary knowledge and skills during the course?		
Are you satisfied with the number of e-courses introduced into the educational process?		
Are you satisfied with the quality of e-courses introduced into the educational process?		