

## Joint Research and Design of Educational Adaptation Tools in Mathematics for Foreign Students in the LMS Moodle

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*Abstract: The number of foreign students in the universities of Russia is increasing every year. Traditionally, one of the most difficult subjects for 1-2 years of study is mathematics. For foreign students who have difficulties with the perception of Russian speech, problems with different levels of basic mathematical training often become an insurmountable difficulty. Therefore, the design of educational adaptation tools that help students learn mathematical disciplines becomes an integral part of the teacher's methodological work. The purpose of the article is to consider the most effective tools for adaptation in joint work with foreign students. During the studying and summer practicum, 10 international students participated in the investigation and development of adaptive instructional materials. Subsequently, 42 international students evaluated the outcomes of this work. As a result, a set of educational adaptation tools was proposed, along with techniques for organizing interaction between instructors and non-native language learners within a blended learning model. The online course, built in the LMS Moodle, allows not only the use of developed tools for foreign students, but also organization of joint work with them on the improvement of these tools. The article presents the list of the most effective educational adaptation tools in students' opinion.*

Keywords: academic adaptation, foreign students, bilingual students, educational adaptation tools, bilingual approach, studying mathematics, blended learning.

### INTRODUCTION

Currently, the number of foreign students in Russian universities is constantly increasing. In the Institute of Radioelectronics and Information Technologies-RTF of the Ural Federal University, which is located in the Yekaterinburg city, Russia, over the past 6 years (2018-2024), admission to the bachelor's degree of foreign students included 57, 83, and 137 in 2018-2020, 194 students in 2022-23, and 203 students in 2023-24. To date, the total number of international students of the university exceeds 4,600. The geography of the foreign contingent is diverse: China, African countries (Sudan, Egypt, Morocco), neighboring countries (Kazakhstan, Uzbekistan, Tajikistan,

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Ukraine), Iraq, Syrian Arab Republic, Turkish Republic, Yemen, South American countries (Colombia, Ecuador, Peru), and more.

On the one hand, the expansion of the number of foreign students has a positive effect on the status of the university, while on the other hand, it requires solving issues of social and educational adaptation of students (Arkatova, Danakin & Shavyrina, 2015). We consider the educational adaptation as the socio-pedagogical process of interaction of students with the changed conditions of the educational and social environment in order to coordinate their individual characteristics and capabilities at the linguistic, interpersonal, and didactic levels. The purpose of the article is to search and select the most effective, according to the opinion of students, tools for the educational adaptation of foreign students when they study mathematical disciplines.

In the process of teaching mathematics, foreign students and teachers face a lot of problems, primarily related to the language barrier. The level of students' proficiency in the Russian language is insufficient for learning at the pace that the university curriculum assumes. The problem connected with the lack of readiness to study mathematical disciplines is also associated with the discrepancy between the level of basic training of most foreign students and the level and training program of Russian students (Kochetova, Mumryaeva & Egorchenko, 2018; Pykhtina, 2017). This fact is confirmed by statistical studies on this issue and feedback from teachers at the university.

The application of a bilingual approach to teaching foreign students, the experience of which is described, for example, by colleagues of the Financial University under the Government of the Russian Federation (Moscow) (Ganina, Dubinina & Stepanyan, 2019), seems successful if students at a high level speak one of the languages (most often, English). In practice, we are dealing with a mixed audience of native speakers and equally low proficiency in Russian and English. Therefore, the selection of educational literature in the student's native language to accompany the Russian-language course is reasonable to be carried out by linguistic groups. This raises the question of how to organize linguistic groups. The so-called random option is ineffective due to spontaneity and is possible only if students actively communicate outside of classes. This approach is not suitable for students who have difficulties in communication. It remains an option to form linguistic groups through the guidance of a teacher with constant student-lecturer interaction. How to organize such communication taking into account the opinions of students belonging the same linguistic group but studying in different academic groups? The article suggests a variant of using a blended learning model on the Moodle platform.

The idea to create a multilingual online support course is also considered in papers (Snegurenko et al 2019; Sosnovsky et al, 2012) where the Math-Bridge platform is offered as a learning environment. This platform supports 7 languages: English, German, French, Spanish, Finnish, Dutch and Hungarian and has a wide functionality for studying various math sections with interactive tasks, illustrative examples, and theoretical material. However, the Math-Bridge platform may be inconvenient for students with Arabic, Chinese, and other native languages who study Russian as a foreign language. Moreover, LMS Moodle has become more widespread in Russia than Math-Bridge.

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Czarnocha and Prabhu (2016) explored the influence of learning mathematics on the development of language. Their research demonstrates an influence of mathematical thinking on the development of descriptive writing. In the Elementary Algebra course, the authors propose using the new instructional strategies for mastering algebra to learn English. These strategies include verbalization, explication, and analysis of algebraic procedures. For example, students are asked to write a symbolic statement in English. Such an approach could be also effective on the supporting course of Math in the universities in which the goal of studying math is connected with the studying a second language.

In addition to the linguistic problem, researchers (Kochetova, Mumryaeva & Egorchenko, 2018; Osipova & Tereshchenko, 2018; Pykhtina, 2017) unanimously focus on organizing a mandatory propaedeutic course in mathematics to equalize the level of mathematical training of students. In the process of revising the basic sections of the school mathematics course, future students learn mathematical terminology in Russian and at the same time fill in the existing gaps in knowledge of the discipline.

Unfortunately, training in a propaedeutic course does not exclude the problems of further perception of new terminology by students. Therefore, the task arises to design the structure of the educational course and determine the requirements for its content, including propaedeutic or adaptive material for each topic and class in higher mathematics. The task, including the development of educational tools for students' adaptation to the course of higher mathematics, was solved in the interaction of teachers with foreign students during the semester and their summer practice.

## METHODS

There is a lot of research devoted to the question of academic adaptation for foreign students and revealing the diversity of their key problems. Readiness for adaptation is being studied. This term characterizes a wide range of adaptation components: cognitive, informational, evaluative, motivational, dispositional, emotional, volitional, operational, communicative, and sociopsychological (Arkatova, Danakin, & Shavyrina, 2015). The phenomenon of sociocultural adaptation helps explain learners' lack of readiness to perceive educational information, which may be influenced by personal anxiety, situational anxiety, aspects of culture shock, and language anxiety (Valieva, Ivanova, & Dashkina, 2020). Ways to reduce anxiety are associated with supporting students not only in learning and are described in terms of psychological and socio-cultural assistance or adjustment (Marinenko, 2021).

In contrast to the surveys aimed at studying the problems and structure of adaptation of foreign students, various approaches and recommendations to the organization of the adaptation process, this paper focused on the question: "What means of adaptation to mathematical courses do foreign students consider effective in practice?" The study emphasizes the fact that students are partially involved in the creation of adaptation tools; they fill in multilingual dictionaries and texts and evaluate the materials received.

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The article synthesizes both the practical experience of teachers working with international students at Ural Federal University (Yekaterinburg) and relevant scholarly literature addressing the issues discussed. It also presents the results of analyses conducted jointly with students on methods and approaches to teaching higher mathematics, along with findings from a survey of international students.

Nineteen foreign students, who were undergoing summer practice at the Department of Mathematics, participated in the joint discussion about the structure of the adaptation course in mathematics and search for adaptive teaching tools. The students were asked to listen to a traditional lecture (it was a lecture on the parametric equation of an ellipse), read the text of the lecture, and then solve a typical problem on the same topic with an explanation of the solution in Russian. The task imitated typical actions in the educational process. After completing the task, the students made a list of problems they experienced when working with the task. Analyzing the difficulties they encountered in the process of learning mathematics, students and teachers identified a range of tools for adapting to the educational process.

To evaluate the results of the study, namely the practical significance and effectiveness of the tools received, an experiment was conducted with 42 foreign 1<sup>st</sup> year students who agreed to take part in the study. During the term, they were offered to learn more about the set of tools for adaptation within the training course on the Moodle platform and use them in the learning process. Teachers monitored the completion of tasks on the platform and gave recommendations on working with the course. The students participating in the experiment study in a mixed environment with Russian-speaking students from different teachers. The final control for all students is carried out in the form of independent automated testing. Therefore, in order to get feedback from foreign students on how useful and effective the adaptation tools offered to them were, a survey using a Google form was conducted. For each adaptation tool in the questionnaire, students were asked whether the tool was used in the learning process, to rate its effectiveness on a scale from 0 to 10, and to provide recommendations or comments regarding its use.

## RESULTS

The most convenient form of work with foreign students is blended learning with the support of full-time training with e-learning in LMS Moodle. Researchers note the importance of interactive teaching methods in working with a foreign contingent using electronic resources (Kochetova, Mumryaeva & Egorchenko, 2018). The Moodle educational platform attracts teachers with no payment for use, open source code, customization of the service to individual needs, support for courses in the popular SCORM format, and the ability to integrate the platform with other services (Handayanto, Supandi & Ariyanto, 2018; Surjono, 2014).

In matters of training organization, the advantage of e-educational content lies in its flexibility in the presentation of information, ease of filling, changes, and speed of transmission in accordance with the needs of students. The Moodle platform allows you to design an electronic course that

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includes various means to solve the problems of foreign students' adaptation: lecture presentations, texts of theoretical and practical orientation, tests, surveys, and game elements. In addition, Moodle allows you to organize the course while taking individual learning styles into consideration.

When preparing educational content, special attention should be paid to the ways in which information is presented. Based on the results of an experimental comparative analysis examining the quality of students' performance on different types of tasks, Yakovleva (2020) concluded that a cognitive-visual approach is advantageous for teaching foreign students. Using generalizing, systematizing, and visualizing methods to present information helps reduce the cognitive load for foreigners working with the text. By considering individual learning styles—whether visual, auditory, or kinesthetic—the presentation methods can be adapted, such as employing global or sequential approaches, with the latter being more suitable for an adaptation course.

The principles of presenting instructional material include three-level adaptation, information visualization, invariance of mathematical competencies across languages of instruction, repetition of mathematical terminology, as well as individualization and motivational strategies (Weinstein, Esin, & Zykova, 2022). The literature identifies three main types of adaptation materials based on their placement within the course:

- Introductory adaptation, which can be considered in relation to the entire course and each of its topics. This is a description of the competencies necessary for the assimilation of the material, motivational material, and the formulation of problems that will be solved in the lecture/topic/course.
- Ongoing adaptation of the studied material, which involves the use of specially structured materials adapted to the presentation considering the principles listed above. Adaptation also involves the use of additional elements of the electronic course (e.g., videos, game elements, tests, surveys, etc.) to simplify the perception of the material by students.
- Assessment and corrective adaptation, which includes the adaptation of control and measuring materials, requirements for verification activities, and means of correcting the results obtained.

The main issue of the study was to find and analyze techniques and means of adapting lecture and practical material. During the analysis of literature, communication with teachers and foreign students, the following options and means of work were considered and proposed:

1. Revision of the lecture (practice) listened to: Involves attending the scheduled lecture and taking notes on the materials posted in the electronic course.
2. Preliminary work with the lecture text: The student reviews the online course materials or prints the lecture text, then listens to the lecture while summarizing only the main points in a concise format (e.g., diagrams or figures) and highlighting important or unclear information.

3. Notes-commenting: Students work with pre-downloaded or printed notes containing gaps (e.g., empty columns) for annotation. Since international students cannot take notes in Russian at the pace of the lecture, teachers should prepare printed materials or practice tasks with gaps for comments. For both options, using an electronic tablet is recommended to avoid printing notes for each lesson.
4. Fragments of a lecture or practice exercises with word/phrase selection: Allows students to practice Russian grammar, expand vocabulary, and reinforce the topic studied.
5. Step-by-step problem-solving plan: Language barriers in understanding symbolic mathematical texts are addressed by providing students with ready-made instructions. For example, the classroom problem “Build a second-order curve in a rectangular coordinate system given in polar coordinates” can be adapted as follows:
  - a. Substitute expressions for  $x$  and  $y$  using formulas for converting from polar to rectangular coordinates.
  - b. Complete the square in expressions with one variable.
  - c. Transform the equation to canonical form and determine the type of second-order curve.
  - d. Construct the second-order curve and specify its key parameters (e.g., center or vertex, eccentricity, lengths of semi-axes, asymptotes, or directrix).
6. Brief reference material for the lesson: Summarizes concepts and formulas to be used during the lesson and can serve as a reference for individual tasks.
7. Test simulator based on a completed lecture or practice: Assesses understanding of key concepts and formulas. Tests can be bilingual or include task texts in multiple languages. Task enrichment in different languages is developed gradually in collaboration with foreign students.
8. Multilingual glossary: Can be thematic (per section) or general (course-wide). Thematic glossaries may include audio components, such as short videos demonstrating correct pronunciation of key terms.
9. Feedback survey (online course): Evaluates difficulties affecting comprehension on a scale of 0–10, including language barriers, gaps in mathematical knowledge, complexity of the material, self-organization, tutor interaction, and other social or personal factors (Rusticus, Pashootan, & Mah, 2023)."

In addition to the development of adaptation tools, it is important to take into account the organizational nuances of their implementation in the educational process. Normally, the solution of issues that are incomprehensible to the student on the educational material is carried out at weekly consultations with the teacher. But for the implementation of organizational, linguistic support to a foreign student, the most convenient way is to assign an intragroup tutor. This is a student who helps a foreign classmate to navigate the online course (e.g., what elements of the course they need to view before the lesson, which to prepare for work in the classroom, which to use to consolidate the topic, etc.) to deal with the teacher's setting of educational tasks. The designation of the course elements can be accompanied by prefixes PRE, IN, AFTER—before, during and after class, respectively. The tutor may be changed as the topic changes or remain a tutor throughout the semester.

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Successful tutoring is an additional factor in providing a student with an increased scholarship, benefits, etc.

The following is an example of the structure of an educational module of a mathematical course with adaptation tools for international students:

### Pre-Tasks

1. Before listening to the full-time lecture, read the glossary of the lecture topic. Write down the topic in your notebook and write down the key terms from the glossary in Russian.
2. Study the purposes of the lecture and the requirements for its development (they are listed in the training module of the course). Continue the phrases: "To understand the lecture, I need to know / be able to...", "After the lecture, I will know....".

### In-Tasks

1. During a lecture (or reading a presentation for a lecture), pay attention to the phrases highlighted in blue in the presentation slides. These are the key points in understanding the material. A presentation with missing "blue phrases" is attached to the task. Write down these phrases from memory and test yourself.
2. According to the plan with step-by-step recommendations, describe the solution to the problem.
3. Write comments on the given study text. Use the questions like what problem is being solved, what methods, mathematical statements, transformations are used.
4. Describe the steps of action in this solution of the problem. Decipher the notation.

### After-Tasks

1. After listening to the full-time lecture, make a short mind map indicating the main elements of the lecture in your native and Russian languages. Mind map is a common international name for a diagram used to structure information. The main concepts, formulas, ideas are arranged radially from the central concept outward.
2. In the lecture presentation add comments in your native and Russian languages: which points in this part of the lecture are the most significant; describe what this part of the lecture is (theorem, introduction of the concept, example); if there are questions about this part of the lecture, unclear points – write about them.
3. Take a test to check the understanding of the material you have studied. The emphasis in the test is on the assimilation of terms, theorems, statements of typical tasks, methods of solving problems and reasoning.

The proposed set of basic tasks is repeated in each learning module, which ensures that students develop a strategy for studying the material, providing the ability to identify the main elements of the course and assimilate them.

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To assess the proposed educational adaptation tools and methods of organizing the teaching of mathematics, questionnaire were given to 42 foreign students. The chart below (Table 1) shows the results of the questionnaire by groups assessing the practical significance of the several tools: 0-4 points - low; 5-7 points - average; 8-10 points - high.

For assessment, the following training tools were proposed:

1. Tasks for the translation of mathematical text into the native language and Russian.
2. Dictionary of mathematical terms in different languages.
3. Tests to consolidate the material in different languages.
4. Preparatory work with the material of the lecture/ practice before the lesson according to the schedule (familiarization with the terms, problems of the lesson).
5. Audio reference material with pronunciation of the basic concepts of lectures and practice in Russian language.
6. Forum for discussing problems when studying the material.

Tool's number	Low (%)	Average (%)	High (%)	Positive effect (%)
1	19.05	19.05	61.90	80.95
2	28.57	19.05	52.38	71.43
3	19.05	28.57	52.38	80.95
4	19.05	38.10	42.86	80.95
5	23.81	14.29	61.90	76.19
6	14.29	28.57	57.14	85.71

Table 1. Distribution of the number of students by groups assessing the level of importance of adaptation tools (compiled by the authors).

The result of the survey confirmed that the proposed educational adaptation tools are relevant and effective, since most students (Table 1) find practical significance in the use of additional means for mastering educational material in a non-native language.

In addition to the proposed means, students indicated the desire to increase the hours of practice of more problems accompanied by a simplified explanation of their solution.

## DISCUSSION

As the study showed, 80% of the experiment participants on average indicated a positive result in the application of the proposed adaptation tools to the educational process. All the experiment participants successfully passed the exam test: with a maximum of 100 points, the marks are in the range of 55-100 points. Given the varying levels of Russian proficiency and, consequently, different rates of material assimilation, while all students had the same time to complete the test, a direct correlation between exam scores and knowledge level is questionable. Therefore, investigating this relationship was not the focus of the study. The primary goal was to gather student feedback on the use of adaptation tools, which facilitated self-organization in learning a foreign language, mastery of core course elements, structuring reasoning in a non-native language, and earning points in ongoing assessments that they might not have obtained in class due to language difficulties.

The tasks repeated in the training modules create a comfortable environment for students to understand the structure of the course and the requirements of the teacher, as well as form a minimum set of necessary knowledge and skills for mastering the material.

The speed of perception during the study of the material by Russian-speaking and foreign students in a mixed group is very different. Therefore, the tasks from the PRE-TASK series, such as preparing the perception of the material in a foreign language, are especially important. Not understanding the teacher during face-to-face lecture and practice causes foreign students to quickly lose interest in learning and stop attending classes. Therefore, we consider the use of adaptation tools at the introductory, current, and assessment-corrective stages of adaptation in a convenient online format on educational platforms as a necessary condition for working with foreign students.

Since, even in the presence of additional educational elements, the main factor of success is motivation to learn, the involvement of foreign students in the educational process is a priority for the teacher. Joint research with foreign students of the most convenient and effective academic adaptation tools contributes to a more conscious and active construction of educational content and its use. Therefore, the study of the opinions of foreign students, wishes, and suggestions helps university teachers to identify ways to overcome the problems of interaction with their multilingual audience.

Feedback in the educational process is one of the most important tools for assessing its effectiveness. For example, information from students could be used to correct the presentation of course material according to their learning styles (Surjono, 2014). In the case of foreign students, conducting joint surveys and implementing proposals based on the results of the study creates positive motivation from the foreign audience, which needs special attention and assistance.

Based on the research data obtained, it is possible to design an online course to accompany the teaching of mathematics to foreign students. Taking into account the individual level of mathematical training and the student's knowledge of the Russian language, in addition to the main elements of the online course, it is possible to build additional elements of the course together with students and evaluate their effectiveness within one language group.

## CONCLUSION

The joint analysis of adaptation tools in mathematics with foreign students made it possible to conclude that the design of electronic educational content should be aimed at helping the student in elementary educational activities that do not cause problems for a Russian-speaking student.

Based on the results of a survey of foreign students, a list of the most effective and useful adaptation tools was identified:

- Notes-commenting
- Step-by-step problem-solving plan
- Test simulator
- Multilingual glossary

In the case of foreign students, the stage of preparation for the lecture, which is absent for Russian-speaking students, can help the perception of the lecture material and, therefore, should become mandatory, at least in the form of familiarization with the terminology (pronunciation and spelling of new terms) and the problems of the lecture and practice.

The selection of educational literature and the compilation of multilingual educational content should be carried out in a dialogue, jointly filling the student's individual library. Translation of educational texts into the native language by a student, compilation of a glossary of mathematical terms in Russian and native languages, and other tasks not only create a complex of individual adaptive learning tools, but also contribute to increasing awareness and motivation of students in a foreign language environment

## LIMITATIONS

Interpreting the results of the study, it should be noted that the stage of selecting effective adaptation tools together with foreign students took 1.5 years and the study continues. The number of students participating in the experiment is expanding, and new students fully confirm the results stated above. The presence of students who chose a low level of significance for some adaptation tools indicates that they have subjective preferences related to their cognitive style, mastery of self-organization techniques for learning, etc. Analysis of students' choices may be a further topic of research.

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