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E-learning as a Way to Improve the Quality of Educational for International Students

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Abstract

The article focuses on the problem of teaching mathematics to students of an engineering university learning in a non-native language. The results of a survey helped us identify the main difficulties facing international students when they begin their studies at Russian universities. We also describe a methodology of teaching mathematics using e-learning as web-based instruction. The use of e-learning in the educational process improves the quality of practical training and provides a better understanding of the course.

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Introduction

Due to accelerated technological progress, the modern world has seen abundant changes in the technologies of information transmission. In less than 200 years, the invention of the telegraph was replaced by the radio, which, in its turn, gave way to television. With the advent of the computer, the Internet, and mobile communication, the volume of information in the public domain has increased. As a result, most of the information we acquire comes from these sources. Therefore, necessary information has become easier to access and problem solving takes less

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time. Technological advancement has rapidly broadened the mind of the average person. As recently as 20 years ago, finding information required considerable effort. After all, you needed to know what source might contain this information, and even if you did, that source might be unavailable. Since then, the situation has changed dramatically. Wherever we are, all we need to do is turn on a computer and run a browser, and all the necessary information will be at our disposal on the screen. Searching for information largely depends on the availability of the Internet access in the region rather than on the person's location or native language. Thus, as part of a rapidly changing world, people have become more mobile and better at multitasking almost everywhere around the globe. In order to solve problems competently, however, one needs some knowledge in the field. Therefore, new teaching methods are in high demand that would provide the necessary knowledge in an accessible environment and over a short period (Ryan, 2015; Shafaei, Nejati, Quazi 2015). Since many students from different countries choose Russia as their destination for studying, it is necessary to introduce teaching approaches that would be effective for both Russian native speakers and Russian learners. One of these approaches is e-learning. Advanced technologies of information processing and means of communication have opened up unprecedented opportunities for the use of electronic content in teaching.

Let us outline three main factors of modern life that are prerequisites for new electronic technologies of teaching in both students' native and non-native languages.

Firstly, information technologies are universal for all countries and the interfaces of many software products have a unified look that does not depend on the language or nationality.

Secondly, current students and schoolchildren see the electronic way of exchanging information as an integral part of their life. Information and communication technologies have become their everyday tools. As a result, informal education is playing an increasingly important role alongside traditional, formal education. Young people independently acquire information from their IT environment (electronic mass media, e-books, reference books, encyclopedias, video repositories, and social networks, as well as online courses and open educational resources, etc.).

Thirdly, the speed of the modern world requires the fastest and cheapest possible ways to generate and transmit knowledge.

Technological advancement and the current state of education gave rise to electronic learning, or e-learning, which is now successfully used in many countries for training future professionals in higher education and for corporate training.

E-learning was originally meant as a support system for distance learning and this is why e-learning is now often called distance education, although e-learning is a narrower concept. E-learning, which is based on remote communication between a teacher and a student by means of information technologies, is one type of distance education. UNESCO experts define e-learning simply and clearly as "learning through the Internet and multimedia".

We are going to rely on the classical definition of e-learning as a system of electronic learning through information and communication technologies.

Let us review the use of e-learning in higher education. Conventional forms of study in higher education (intramural, extramural, intra-extramural, externship) can be implemented in different models of learning. The most common learning models in higher educational institutions are as follows:

1. *Traditional model.* A conventional model known from school and requiring face-to-face communication with the teacher during all training sessions.

2. *Electronic model.* This model involves information technologies: Internet resources, communication with the teacher on forums and web chats, watching learning materials online, computer testing, etc. This model is the basis for e-learning and has several varieties depending on the proportion of traditional and electronic learning in the total number of learning hours.

3. *Open model.* What differentiates it from the models above is that teaching materials are freely available and any student can use them for self-study. Here, students are not bound to demonstrate the knowledge acquired by taking a summative assessment. Such a model is used in open universities (e.g. British Open University and Indira Gandhi National Open University in India) and academic institutions that are providers of open educational resources.

Among the models of e-learning, which are different forms of integration of traditional learning and e-learning, the following models are most commonly used today:

1. *Web-based instruction* is a model of e-learning, in which up to 30% of the time planned for mastering the discipline is in an electronic course. The electronic environment is used as a supplement to the traditional learning process by providing self-guided work (electronic materials for self-study, preparation for laboratory work, using virtual laboratory equipment, self-testing, etc.); consultation using forums and webinars; formative and interim assessment; and project work by students in the electronic environment.

2. *Blended learning* encompasses both classroom-based and extracurricular educational activities with the use of complementary technologies of traditional and e-learning. In blended learning, the time allotted to work on e-learning courses can range from 20% to 80%.

3. *Full e-learning* (online training): most of the educational process (90-100%) takes place in an electronic environment; the learning content is highly interactive and students regularly communicate with both the teacher and each other.

When educators realized that the conventional form of teaching requires modernization, their efforts led to the emergence and implementation of new methods and forms of teaching, as well as new technologies in education (Wisneski, Ozogul, Bichelmeyer, 2015; Gillani, Eynon, 2014). At this stage of the development of new modes of learning, it is e-learning that is becoming one of the top priorities in college education (Parkes, Stein, Reading, 2015; Toven-Lindsey, Rhoads, Lozano, 2015; Ji, Michaels, Waterman, 2014; Chae, Shin, 2015). Many countries have successfully used e-learning in the educational process for a long time (Tsai, 2015; Wongso, Rosmansyah, Bandung, 2015; Alanazi, Abbod, Ullah, 2015). Some scientists focus on the questions related to creating models of e-learning courses (AndhariniDwi, Basuki, Eka Mala Sari, Kustiyahningsih, 2015). For example, teachers from the United States have used e-learning in education for over ten years already (O'Donnell, Lawless, Sharp, Wade, 2015; Chauvot, Lee, 2015).

2. Methodology

There are more and more supporters of this type of learning in Russia.

Russian educators are introducing e-learning to the teaching process at universities for both domestic and international students. They study the conditions and possibilities of its implementation and proceed from the premise that education is an ongoing process of human development. The purpose of education is to form a harmoniously developed personality through mentoring and mastering certain professional skills, which include a systematic acquisition of knowledge and development of experiences, abilities, and expertise.

We must understand that we cannot adopt a new type of learning without a specific study on whether the audience and the teachers are ready for new forms of education. It is impossible to introduce new technologies if the target audience is not ready to absorb the information presented by new methods; students need some coaching before they can study effectively in an electronic environment. New technologies are only useful if teachers see how these technologies can improve the quality of the learning process (Renda dos Santos, Okazaki, 2015). Moreover, the effectiveness of e-learning should be checked for different academic subjects (Frias-Blanco, Del Campo-Ávila, Ramos-Jiménez, Ortiz-Díaz, Caballero-Mota, 2015). Some studies describe methods for evaluating the effectiveness of e-learning at universities (Aguti, Wills, Walters, 2015; Tenriawaru, Djunaidy, Siahaan, 2015).

2.1. Objectives

The objective of this study is to determine the optimal e-learning model for teaching a mathematics course.

2.2. Experimental check on whether students are ready to learn in an electronic environment

In order to make it possible for a teacher at Tomsk Polytechnic University to choose the form of e-learning consistent with the capabilities of students learning in a non-native language, we surveyed 65 international students starting their first year at TPU. International students of TPU mostly come from three countries: Mongolia, China, and Vietnam. The purpose of the survey was to check if these students were ready to take a course of mathematics in Russian in an electronic environment and to choose their preferred learning type (see Table 1 for the results of this survey).

Table 1. Results of the survey on preferable learning type.

Mode of study	Mongolia	China	Vietnam
<i>Traditional learning</i>	30%	10%	12%
<i>Learning with web-based support</i>	50%	40%	45%
<i>Blended e-learning</i>	15%	40%	28%
<i>Full e-learning</i>	5%	10%	17%

If we analyze the results, we will note that most citizens of Vietnam and China choose blended e-learning or learning with web-based support. This is due to the following key facts:

First, schooling takes different forms in Vietnam and Russia. At the beginning of an academic year, Vietnamese pupils receive a list of topics they are supposed to study and take tests on within a given time. Moreover, each pupil is assigned a teacher on the subject. A schoolchild studies the topic on their own but they can visit the assigned teacher at a review session and ask questions on the topic they could not work out by themselves. There is no time limit to study a topic.

Second, the attendance of practical classes and lectures is not obligatory for students at their homeland universities: they can decide which classes to attend and which to study for on their own. In Russia, attendance is still a compulsory factor in learning.

Third, the sounds of the Chinese and Vietnamese languages significantly differ from those of Russian. Learning the Russian language presents a considerable challenge for students from these countries, so a classic lecture in the form of a teacher's monologue and online courses in Russian are very difficult for them to understand.

Thus, we can conclude that students from Vietnam and China can already study independently and are good at time management. It is difficult, however, for them to master theoretical knowledge provided in Russian on their own, mainly due to insufficient knowledge of the Russian language in general and subject terminology in particular. In addition, a student-teacher dialogue provides for conditions for mastering the language. For this category of students, it is advisable to use blended e-learning or learning with web-based support.

The situation with students from Mongolia is somewhat different. The form of schooling in the country is similar to that in Russia and the sounds of the Russian and Mongolian languages are not that different either. Therefore, students from Mongolia speak quite good Russian and most of them have no problem understanding their teachers. These students are not self-sufficient enough in their studies, however, and they usually have low competence in mathematics.

Another important point is that the school curricula in different countries do not always coincide. Russian students learn some branches of mathematics at school, while international students do not, although this knowledge is crucial for their further studies of mathematics at university.

Since all students learn together, it was necessary to find the optimal form of e-learning for first-year students from Vietnam, Mongolia, and China at TPU. To this end, we conducted an experiment in which first-year engineering students of TPU were to explore the topic of "Curves of the second order" in the course of Linear Algebra and Analytic Geometry using three technologies:

- 1) Conventional lecture and practice (the e-course is used without web-based support);

2) Web-based instruction (students listen to a lecture, take a test and then undergo some practical training with a teacher); in this case, the e-course is used as web-based support;

3) Blended e-learning technology (students explore the theoretical material on their own, take a test and undergo practical training with a teacher).

After studying the topic, the students were to perform two tasks: 1) to reduce a five-term curve equation to a standard form and construct a curve; 2) to construct a conic curve given by the general equation.

Here is a chart of task success in different forms of learning (Fig. 1).

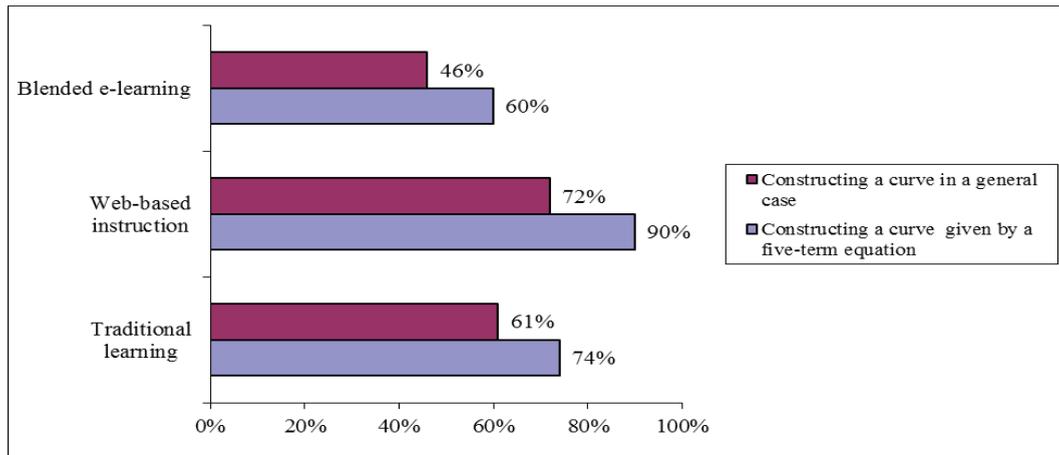


Figure 1. Chart of task success in different forms of learning.

2.3. Analysis of reasons for the students' success when learning mathematics with web-based instruction

The chart shows that web-based instruction was the most efficient and effective. Conventional technologies and blended e-learning proved to be less effective for first-year students who study in a non-native language.

A later survey targeted the same group of students to identify the reasons for the success of web-based instruction. Students were to answer the following questions:

1. Your level of computer skills:
 - a. User (able to operate a PC but unable to solve hardware or software problems)
 - b. Confident user (able to operate a PC and solve most of the software problems)
 - c. Advanced user (able to eliminate problems arising during operation of the computer and software)
2. Owning a computer or tablet:
 - a. I have a computer
 - b. I have a tablet
 - c. I use a computer in a library or my friend's computer
3. Internet access:
 - a. Wired Internet
 - b. Mobile (tablet)
 - c. Mobile (smartphone)
 - d. Access from a library or my friend's place
4. Your main difficulties studying Mathematics at university:
 - a. No difficulties
 - b. Hard to perceive printed material due to insufficient knowledge of the Russian language
 - c. Wide range of tasks
 - d. No visual illustrations (many abstract concepts that cannot be visualized)
 - e. Gaps in knowledge

- f. Not enough analyzed examples
 - g. Doing homework by a fixed time
 - h. No clear understanding of how to apply mathematics in professional and daily life
5. Difficulties encountered when working with the electronic course:
- a. No problem
 - b. Problems with the Internet or computer
 - c. Problems with the perception of texts in Russian
 - d. No visual illustrations
 - e. Gaps in knowledge
 - f. Not all kinds of tasks are analyzed
 - g. Not enough examples are analyzed in detail
 - h. There were some questions and no answers to them in the given material

The survey shows that students are ready to learn in an electronic environment from the technical viewpoint: 95% of students have a computer or a tablet with Internet access and 90% of students describe themselves as confident or advanced users. There are no technical problems among the difficulties outlined by the students when working with an e-course. The difficulties marked by the students belong to the substantive part: only certain types of tasks are analyzed when studying the material; there are some questions and no answers in the proposed material (which in our opinion is more often connected with gaps in knowledge); and insufficiently detailed solutions to problems (Fig. 2, Fig. 3).

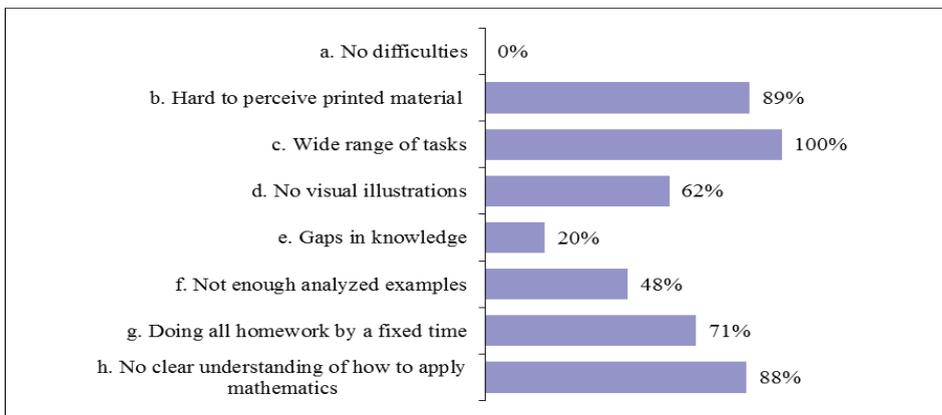


Figure 2. Main difficulties of studying mathematics at university.

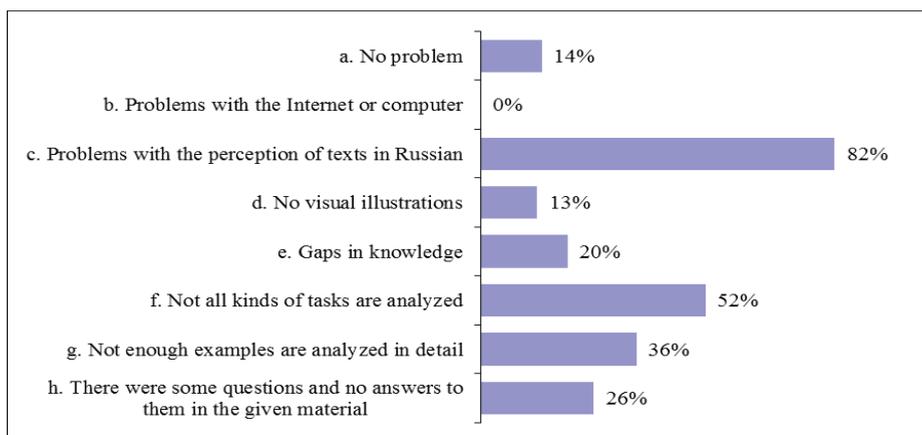


Figure 3. Difficulties encountered when working with the electronic course.

2.4. Problems faced by teachers of mathematics when working with first-year international students.

In addition to questioning the students, we also interviewed 10 teachers. The purpose of this survey was to identify the challenges facing mathematics teachers when working with first-year international students. Almost all the teachers, when working with this category of students, outlined the following major difficulties:

1. Most students who study in a non-native language occasionally get distracted from the learning process, referring to a phone or tablet. As a rule, this happens because a student first translates the teacher's question into their native language looking up unfamiliar words in a dictionary and then translates their answer from their native language into Russian. The lack of language skills and, as a result, the need to refer to a dictionary slow down the learning process and reduce its effectiveness.

2. Insufficient Russian language skills also increase the time it takes for students to do all their homework.

3. There is no clear understanding of the application of mathematics in professional and daily activities.

The results of the students' answers to questions 4 (Fig. 2) and 5 (Fig. 3) of the questionnaire as well as the results of the teachers' survey make it possible to draw the following conclusions about the nature of the challenges involved in studying mathematics.

1. As a rule, first-year international students studied at school in their native language. The education system in their home country does not always coincide with the Russian one. Therefore, it is difficult for the students to adjust to a new system and meet all of its demands.

2. Another problem of international students is the lack of ability or desire to do their homework systematically, although competencies are formed as a direct result of their independent work.

3. Lack of knowledge on the subject necessary for further study. Teachers have to return constantly to the school course in order to review some facts with the students or to teach them some things anew. This is especially true for the groups composed of students from different countries and, hence, with different school bases. It is impossible to foresee all the questions coming from students as they study mathematics, because not all the students know what they are supposed to know at this stage of their education.

4. Students do not consider mathematics a significant profession-related discipline in higher professional education. Unlike other general subjects, it is more detached from reality, from life, from problems of professional activity; it is more abstract. The connection of the concepts being studied with professional subjects is difficult to trace.

5. Lack of feedback from the teacher when studying the theoretical material, and a lack of face-to-face contact with the lecturer (blended learning).

3. Research results and discussion

We have drawn the following conclusions from our findings:

1. Electronic learning cannot replace face-to-face communication between a teacher and a student: for example, lectures, which are especially important to students who study mathematics in a non-native language. Personal attendance at lectures does not only mean better digestion of subject material by such students, but also extra language practice.

Let us highlight the positive features of the lecture, due to which it has remained a fundamental education format for over four centuries.

Firstly, lectures enable the teacher to leverage their pedagogical experience (which they have been building up for years) through personal contact with students, while also evaluating students' comprehension and digestion of the subject material. Students may have different and individual lacunas in their knowledge: they might have never learnt or forgotten this or that specific piece of knowledge. It is critical that the teacher can make an on-the-spot decision about what material needs to be repeated or studied on top of the standard curriculum work.

Secondly, a coherently shaped lecture is not just a teacher's monologue: it involves a teacher-student discussion that stimulates students' creativity. Not to mention the fact a teacher can make comments in the process, facilitating the mastery of subject material not as administered knowledge, but as something being created ad-hoc.

Besides, as an education format, lectures shape students' personal qualities through participation in a joint effort by teacher and students.

2. Web-based instruction improves the learning process. If we compare the training results of students who have been taught a subject via traditional and mixed education models vs. students who have also relied on web-assisted instruction, then the latter come out ahead. That said, however, we should not forget that using web tools also puts a higher workload on the teacher.

We have used the course of linear algebra and analytical geometry to test the web-assisted education technology. The course we have developed comprises 80 hours of classroom work (40 hours of lectures and 40 hours of practical training). The course covers four areas of algebra and mathematics: elements of linear algebra, vector algebra, elements of linear spaces theory and linear operators, as well as analytical geometry. Each section includes theoretical material subdivided into blocks as per the subject plan of practical training. Each block of theoretical material is supplemented by texts that allow students to assess how well they have digested the theory that the upcoming practical test will be based on. Here we should emphasize that the theoretical materials included in the course are not a substitute for lectures. They are a supplement to lectures: the teacher highlights the parts of the material that students will need in the upcoming practical training. Studying the theoretical material of the course is not compulsory for students: they can take tests after listening to a lecture only. Before taking the tests, however, most students do look at the theoretical material. This is but natural, as a lecture provides students with a large bulk of information that needs digesting and structuring. The theoretical material of the course is compiled so as to assist students in doing so. This is of critical importance for a student who studies mathematics in a non-native language. Besides the theoretical material, students receive audio recordings of the main concepts and definitions delivered in lectures. This enables students to better understand the new terms and to better master the Russian language.

Besides the tests that aim to determine the degree of theoretical material digestion, each course topic includes tests for assessing the practical skills acquired during classes. Students take these tests after they have completed a topic and they mostly involve calculations (students must enter the numerical value of the task solution).

In addition, the e-course includes tasks for students' independent work. Those are normally non-typical tasks and engage a deeper understanding of the acquired theoretical knowledge.

Our experience shows that the use of the e-course improves the efficiency of the classroom work: theoretical tests taken before a class enable students to not only better navigate through the material, but also memorize new terms. This leads to faster responses to the teacher's questions and better problem solving.

A better quality of classes also influences the end results. We have analyzed the results of students' training in Linear Algebra and Analytical Geometry throughout the last 5 years. The students of the groups involved in web-assisted instruction have shown better results when compared with the average (by almost 12%). We believe that this is a substantial argument in favor of using e-courses to supplement the educational process at institutions of higher education.

4. Conclusions

The implementation of most modern educational models and concepts rests on the independence-based approach. This approach envisages that students already possess a sufficient level of independence that allows for efficient planning, designing, evaluating, and adjusting their own educational activities to plot their educational pathway. Still, typical gaps in knowledge from school curricula in the majority of students, coupled with low motivation for studying mathematical disciplines at school, leads to decreased student interest in the mathematical sciences and, as a result, in independent studying. That generates the need to find teaching techniques and formats that would allow students to achieve bachelor degrees in mathematics while acquiring the necessary knowledge, skills and expertise, all while leveraging their potential in independent work. In modern society, e-learning technology is an increasingly popular educational model.

By relying on the e-learning technology, a lecturer can undoubtedly teach more students over a wider geographical area. However, will this provide the desired educational and economic effect? The traditional "face-to-face" educational process provides the teacher with instant feedback which is critical for instruction, and the teacher responds by re-shaping the course material on the fly. Here, the teacher can adjust this material in real time so that it becomes more easily digestible for the students. In our research, we wanted to demonstrate that e-learning should be

introduced gradually, and with regard to student categories. We have proven that students who study in a non-native language are not ready to understand information in the format of mixed e-learning, let alone web-based courses. Lecture-based web-assisted instruction is still one of the most optimal e-learning formats. It has been observed that this educational format makes it possible to make the curriculum truly appealing, efficient, flexible, economical, and convenient within the framework of traditional education, while leveraging the technology and the teachers' talents with maximum efficiency.

If used systematically, web-assisted lecture-based instruction focuses effort on each student, which results in increased instructional efficiency due to the following factors:

1. Breaking the language barrier;
2. Overcoming students' fragmented thinking and, therefore, filling in gaps in their knowledge;
3. Deeper understanding of the subject as well as student progress in mathematical sciences;
4. Student-teacher feedback allows the teacher to adjust the material delivery;
5. Student motivation for learning is stimulated;
6. Independent and individual student work is intensified;
7. Cognitive work is intensified.

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