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THE USE OF M-LEARNING IN THE EDUCATIONAL PROCESS OF HIGHER EDUCATIONAL INSTITUTIONS

Abstract

M-Learning has evolved into a major factor that determines how the academic process of an educational institution is organized. Mobile technology has largely affected the shape of the modern educational sector. Mobile-based learning is one of the trendsetting models of E-learning. This model puts a special emphasis on using mobile technology. When used appropriately, mobile-based learning provides an effective way of improving the quality of the educational process and increasing students' academic achievements. The current paper describes the experiment conducted in a higher educational institution with the purpose of evaluating the academic benefits which mobile-based learning brings to the educational process. The current paper's findings demonstrate that mobile-based learning has the potential to modernize and facilitate the learning process, make it more relevant and in-depth, increase students' satisfaction with learning, positively affect their attendance rates, and improves the level of interaction between instructors and learners. The questionnaire surveys conducted within the framework of the current study prove that students have a positive overall attitude towards using mobile technology in their educational activities. These advantages brought by mobile-based learning are of special importance these days when a big number of educational institutions have adopted the distant form of instruction and implemented various concepts of M-Learning in their academic process. The use of M-learning technology allows you to expand the number of disciplines for independent study, and form the basis for the implementation of the most important principle of the Bologna system of education - the mobility of students and lifelong learning. It also allows students to build an individual educational trajectory depending on the complexity of their professional tasks.

Keywords: E-Learning, mobile-based learning, M-Learning, ICT in education, online training, distant learning

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ЖОҒАРЫ ОҚУ ОРЫНДАРЫНЫҢ ОҚУ ҮРДІСІНДЕ M-LEARNING-ті ПАЙДАЛАНУ

Аңдатпа

Білім беру мекемелеріндегі оқу процессін ұйымдастыруда электрондық оқыту негізгі фактордың бірі болып отыр. Қазіргі білім секторында дамуға информациялық технологиялар ерекше орын алуда. Электрондық оқытудың негізгі үлгісінің бірі болып мобильді оқыту болады. Бұл әдіс мобильді технологияларды қолдануға негізгі мән береді. Оқу процесінің сапасын арттыруда және студенттер ұлгерімін көтеруде мобильді оқыту тиімді әдіс болады. Бұл жұмыста оқу процесіне мобильді технологияның оң әсерін бағалау мен анықтау университеттте жүргізілген тәжірибе арқылы қарастырылған. Бұл жұмыстағы нәтижелер оқу процесіне мобильдік оқытудың оң әсерің студенттердің оқу процесіне қатынасын және оқытушы мен студенттер арасындағы қатынастардың деңгейін көтеруде

оң әсерін байқатады. Оқу сапасына мобильдік технологияның оң әсерін студенттер сұраныс кезінде көрсетті. Көптеген оқыту мекемелеріндегі онлайн-форматқа көшу мобильді технологияның қазіргі уақытта ерекше маңызды екенің көрсетеді.

Түйін сөздер: E-Learning, мобильді оқыту, M-Learning, білімдегі ақпараттық және қатынастық технологиялар, онлайн-оқыту, қашықтық оқыту

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ИСПОЛЬЗОВАНИЕ M-LEARNING В УЧЕБНОМ ПРОЦЕССЕ ВЫСШИХ УЧЕБНЫХ ЗАВЕДЕНИЙ

Аннотация

Электронное обучение превратилось в один из основных факторов, влияющих на организацию учебного процесса в образовательном учреждении. Информационные технологии в значительной мере повлияли на развитие современного образовательного сектора. Мобильное обучение стало одной из основных моделей электронного обучения. Эта модель уделяет основное значение использованию мобильных технологий. При правильном использовании, мобильное обучение является эффективным способом повышения качества учебного процесса и повышения успеваемости студентов. В данной работе описывается эксперимент, проведенный в университете с целью выявления и оценки положительного влияния мобильных технологий на учебный процесс. Результаты, полученные в данной работе, демонстрируют, что мобильное обучение может модернизировать и улучшать учебный процесс, делать его более современным и полным, положительно влиять на отношение студентов к учебному процессу и их посещаемость и повышать уровень взаимодействия между преподавателем и студентами. Опрос, проведенный в рамках исследования, показал, что студенты относятся положительно к использованию мобильных технологий в учебной деятельности. Эти положительные стороны мобильных технологий особенно ценны в настоящий момент, когда большое количество образовательных учреждений перешло на онлайн-формат.

Ключевые слова: E-Learning, мобильное обучение, M-Learning, ИКТ в образовании, онлайн изучение, дистанционное обучение

Introduction. E-Learning is an educational concept that is based on the heavy usage of information and communication technology (ICT) in the educational process. It is the concept that aims to replace the traditional analog educational media with their digital counterparts. E-Learning has gained wide adoption in educational programs of various disciplines taught at school and university levels. According to [1], the most common ways of introducing ICT to the learning process are the usage of interactive multimedia material with educational content, computer-based training, and online-based training. The usage of ICT in the educational process implies relying on Internet as the primary source of learning content.

There have been multiple reports from educators around the globe concerning the positive results brought by the usage of E-Learning in their teaching activities. These positive reports have stimulated a significant amount of research dedicated to the study of the impact which E-Learning has on the educational process. According to the existing research, E-Learning offers a large number of educational advantages that positively affect both teachers and students. So, for example, according to [2], the interactive means enabled by E-Learning have a positive impact on students' cognitive processes and improve the effectiveness of their educational activities. E-Learning provides better conditions for improving the students' learning experience than the traditional forms of teaching. Also, E-Learning increases the level of interaction between students and instructors, thus making the learning process more profound and attractive. These findings from [2] are further confirmed and supported by such studies as [3], [4], and [5].

The study [3] shows that the concept of E-Learning is approved by a large percentage of students. The results obtained by [4] demonstrate that E-Learning contributes to increasing the academic performance of students. The study [5] claims that E-Learning creates the factors and the learning environment that positively

affect students' satisfaction with the learning process. The study [3] also reveals that the successful adoption of E-Learning by an educational institution is almost impossible without the careful choice of a particular way of delivering the learning content to students.

Depending on the needs of a particular educational institution, it can choose between multiple ways of delivering the learning content to students. For example, the so-called learning management systems (LMS) and learning content management systems (LCMS) are commonly used for organizing and delivering learning content. Blended learning systems (B-Learning) provide the learning content by varying ICT with other approaches.

E-Learning has always developed hand in hand with the latest trends in ICT. In its current state, E-Learning has mostly evolved into the so-called mobile-based learning. Mobile-based learning (M-Learning) is a form of E-Learning that makes an emphasis the usage of mobile devices as the means of delivering the learning content. This form of E-Learning is considered to be a relatively new sphere of educational activity and attracts a big number of studies from around the globe. It is aimed to support students and teachers as they navigate the options available in the expanding world of distance learning. It also brings with it several benefits to its practitioners [6].

One of the many benefits brought by M-learning is that it encourages both teachers and students to take personal responsibility for their learning. It helps to cause a substantial positive change in the methods of knowledge acquisition and representation and improves the overall quality of education. [7]

The general focus of the current study is the educational benefits that the usage of ICT brings to the learning process in the context of the natural science and technical disciplines. The main emphasis is made on applying the methods of M-Learning to teaching mathematical, technical, and physical disciplines in online lessons.

Theoretical Framework. M-Learning, as a part of educational technologies, has specific prerequisites for its successful implementation. As is stated by [8], the principal prerequisite for the development of an effective curriculum for the wide range of academic disciplines based on M-Learning is understanding the competencies required by educational technologies. The ultimate goal of creating an efficient and valid curriculum framework can be achieved only with the means of adopting a competency framework. The competency framework is made up of several separate clusters. Among them, it is possible to distinguish five main clusters of related competencies of an educational technologist. These clusters are described in Table 1.

Table 1. Clusters of competencies

Competency domain	Description
Knowledge competency	Refers to the well-developed knowledge in such areas as learning psychology, cognitive psychology, social psychology, human-computer interaction, instructional design, software technologies, and so on.
Process competency	Refers to understanding what can be achieved in terms of available hardware and software; maintaining a relevant knowledge of what can and cannot be accomplished; at what cost it can be done and what expertise is required
Application competency domain	Refers to such responsibilities as creating specifications for a learning environment or academic subject and practical implementation of these specifications. These responsibilities require a well-developed competency in the creation of educational media resources and assessment methods.
Personal competency domain	Refers to the work with a specific person who may have different academic expertise and different educational background. This competency requires effective coordination, collaboration, and communication skills.
Social competency domain	Refers to the work within a group of persons who may have different academic expertise and different educational background. As the personal competency domain described above, this competency requires effective coordination, collaboration, and communication skills.
Innovation and creativity competency domain	Refers to new learning technologies and methodologies for the appropriate use of available technologies and resources to achieve desired learning outcomes. Also refers to a general openness to innovations. This implies readiness for significant changes in learning and teaching activities and methods and instruction design.

Besides adopting a valid competency framework, the successful integration of M-Learning into the educational process also requires the application of an appropriate psychological and learning model. There are many various psychological and learning models which can be used to facilitate the educational process. The opinion of the current study's authors is that in the context of M-Learning the most effective of these learning models are cognitivism and the so-called Technological Pedagogical and Content Knowledge Framework (TPACK).

Cognitivism is a learning theory that was developed to explain the process and mechanisms which determine, for example, how an infant develops into an individual with reasoning capabilities and hypothesis-based thinking [9]. According to cognitivists' basic outlook, a person adapts to the world in different ways. The whole process of adaptation includes assimilation and accommodation. Assimilation describes the learning process of a child acquiring new knowledge and absorbing it into his existing knowledge. If the assimilation of new knowledge fails, it starts the process of reorganization of a child's cognitive structures and mechanisms. This process of reorganization is called accommodation.

The described process of assimilation was further expanded in cognitive assimilation theory. This theory proposes the concept of meaningful learning. According to this concept, any new information is related to a learner's existing knowledge. The ability to acquire new knowledge depends on existing concepts held in a learner's cognitive structures. These concepts are responsible for establishing the connection between a learner's new and existing knowledge. Also, the concepts are responsible for the formation of other relevant concepts in the existing cognitive structure. But new knowledge can be successfully integrated with existing cognitive structures only when it has meaning.

The views of cognitivism were largely influenced by certain deficiencies in another learning theory called behaviorism. It was noticed that behaviorism, as a learning theory, cannot be used to explain all complex phenomena related to human learning. The problem lies in the fact that behaviorists ignored the human mind as an object of their observations. According to [10], any valid explanation of human behaviors is possible only through careful study of how the mind absorbs and processes information. Behaviorists treated the mind as an unobservable black box from which no information can be obtained. Unlike behaviorists, cognitivists do not view learners as participants of stimuli-response acts. Instead, they are considered to be the processors of information. Cognitive development is based on the continuous restructuring of mental processes. Cognitivism aims to explain mental processes which are affected both by extrinsic and intrinsic elements. These elements determine how an individual absorbs learning information. The study [11] argues that all processes related to learning can be explained in the terms of mental processes. Cognitivism distinguishes three main variables involved in learning: behavior, personality, and environment. These variables are linked to each other and affect the development of cognitive mechanisms. The success of the learning practice is determined solely by effective cognitive mechanisms. These cognitive mechanisms facilitate the process of the long-term storage of information in a learner's memory. Consequently, learning difficulties are caused by some drawbacks in the functionality of cognitive mechanisms.

Cognitive psychology views learning as a process of acquiring knowledge. Learners themselves are viewed as processors of learning information. Cognitivism treats the human mind like a computer that can receive, process, store, and apply information. Learners are engaged in absorbing and analyzing information and storing it in their memory. There are three main phases in the process of storing and processing information: sensory memory, short-term memory, and long-term memory. These phases are characterized in Table 2.

Table 2. Description of the phases

Phase	Description
Sensory-memory	Allows learners to perceive structured patterns in the learning environment and helps them to analyze these patterns and obtain some form of new information. This information is then transmitted to the short-term memory after a learner activates his receptors. The information is transmitted in organized chunks. The short-term memory holds the information for about 30 seconds. After that, the information is encoded to a form acceptable by long-term memory.
Short-term memory (working memory)	Enables a learner to store perceived information briefly to interpret it and find its connection to what is already stored in long-term memory.
Long-term memory	Allows the learner to hold and apply the information long after it was originally perceived.

Cognitivism does not view learning as a mechanical stimulus-response sequence. Instead, it views the learning process as the consequential formation of the so-called cognitive structures. According to [8], the reaction of a learner to external stimuli is not mechanical and passive but rather describes the events of instruction that create the most effective and suitable learning conditions for effective information processing. These events are described in Table 3.

Table 3. Instructional events

Instructional event	Internal mental process
Gaining attention	Receptors get activated by stimuli
Informing learners of objectives	Level of learning expectation is created
Stimulating the link to prior knowledge	Information from short-term memory is retrieved and activated
Presenting the content	Selective content is precepted
Providing learning guidance	Information for long-term memory is encoded
Eliciting performance practice	Questions enhancing encoding and verification are responded
Providing feedback	Desired response (performance) is assessed and reinforced.
Assessing performance test	Learning content is retrieved and reinforced as the final evaluation
Enhancing retention and transfer	A learned skill is retrieved and generalized to adjust to new situations in the learning environment.

As is seen in Table 3, a learner can make deliberate non-mechanical choices related to the process of knowledge acquisition.

Another learning theory, besides cognitivism, which can be successfully applied with mobile learning is the Technological Pedagogical and Content Knowledge Framework (TPACK). The principal motivation behind the creation of TPACK was to provide educators with an effective tool to solve various problems aroused in the process of implementing the methodology of educational technology in their classrooms. The TPACK framework is widely used to combine technology, pedagogy, and knowledge [12]. The basic idea of the TPACK framework is that the technology communicates with the content and this communication provides support for pedagogy to enable the improvement of students' learning and performance. According to [13] the TPACK framework distinguishes the three basic types of knowledge: technological knowledge, pedagogical knowledge, and content knowledge.

Technological knowledge denotes how teachers employ technological tools. It encompasses various computer hardware and software means used in the learning process and associated resources. For example, personal computers, tablet computers, smartphones, operating systems, educational software applications, multimedia files, and so on. Technological knowledge implies a deep understanding of the possibilities of educational technologies in a specific subject or classroom. It also requires an ability to recognize whether, in the specific case, educational technologies can facilitate or impede the process of learning and teaching. Technological knowledge also means an ability to adapt a classroom to the latest technological developments and trends. The key points of this domain are:

- A good understanding of information technology and methods of information management is required;
- Such a good level of understanding is necessary for teaching students to solve different tasks and solve them in different ways.

Content knowledge refers to the educational material being taught and teachers' knowledge of the subject. It encompasses various learning theories, concepts, evidence, and frameworks within the subject. Content knowledge differs from one teacher to another depending on the subject and educational institution. Content knowledge implies taking into account the following key points:

- When applied to Arts and Humanities, content knowledge also includes knowledge of historical contexts and psychological and aesthetic factors;
- An inappropriate content knowledge demonstrated by a teacher leads to incorrect information and misconceptions on the subject being provided to a student.

Pedagogical knowledge refers to how a teacher presents the material and what approaches and practices he applies. It mostly encompasses general knowledge concerning various practices, processes, and methodologies used in learning and teaching. It also covers such aspects of the educational process as the goals and objectives of education, lesson planning, and classroom management. The key points of this domain are the following:

- Classroom management and lesson planning become the most important activities;
- Encouraging feedback provided through assessment establishes a positive atmosphere for learning.

Keeping in mind these three types of knowledge, an instructor should choose a specific combination of technological tools to enable the maximum positive impact on students' learning experience and help them understand the learning content better. An instructor should come up with various combinations of these types of knowledge within the TPACK framework to enable the maximum educational effect. Three common combinations are technological pedagogical knowledge, technological content knowledge, and pedagogical content knowledge.

Technological pedagogical knowledge is the combination of technical knowledge and pedagogical knowledge. It encompasses various relationships which can be established in the process of communication between technological tools and pedagogical practices. It describes the various ways in which technological tools can affect teaching and learning and what pedagogical constraints they can create. Technological pedagogical knowledge also includes an understanding of the most efficient and appropriate ways of employing technological tools in the context of a specific discipline. The key points of this domain are the following:

- Technological pedagogical knowledge requires a good understanding of technological tools. Without an appropriate level of understanding, it is impossible to achieve the desired learning outcomes;
- Teachers must have a comprehensive understanding of how to integrate technological tools to facilitate the learning process. Even if a teacher has a proper understanding of technological tools, it might not be enough if he also does not possess enough knowledge on how to organize the process of integration of technology into the educational process;
- Teachers must be able to customize the existing software applications to make them more suitable for educational purposes. A big percentage of existing software applications used in the learning context is not tailored specifically for use in the educational context. It becomes a teacher's responsibility to find the most rational and optimal ways to configure the applications so that they become available for use in the learning process.

Pedagogical content knowledge is the result of the combination of pedagogical knowledge and content knowledge. It describes various interactions and relationships that can exist between learning aims and objectives and pedagogical approaches and methodologies. Pedagogical content knowledge is concerned with teachers' knowledge of the foundational aspects of the educational process, such as student assessment, curriculum development, and reporting. Pedagogical content knowledge makes an emphasis on facilitating the learning process by discovering the relationships between the pedagogy itself and the practices it supports, for example, assessment and curriculum. The main goal of pedagogical content knowledge is to enhance teaching by establishing the links between pedagogy and the content. The domain's key points are the following:

- The essence of pedagogical content knowledge lies in teachers' choice of interpretation and presentation of the subject with the use of selected methodologies and technologies;
- The embodiment of pedagogical content knowledge lies in the facilitation of learning and establishing the links between pedagogy, curriculum, and assessment;
- Teachers must be able to evaluate the learning environment from different standpoints and angles and assess the teaching methods to select the most effective of them;
- Teachers must take into account students' prior knowledge to re-evaluate the current curriculum;
- Teachers must constantly explore different learning strategies;
- Teachers are expected to explore various ideas concerning the content,

Technological content knowledge is the combination of technological knowledge and content knowledge. It encompasses various relationships and connections that can exist between learning goals and objectives and technological tools. Basically, it refers to how teachers understand how content and technology affect each other. Technological content knowledge implies understanding how a learning material can be delivered with the means of a particular technological tool and which particular technology is best suited for a particular subject. The key points of this domain are:

- teachers must understand what specific technologies are best suited for a specific subject matter;
- the usage of technology is dictated and even changed by the subject matter and vice versa.

Figure 1 provides a general presentation of the structure of the TPACK framework.

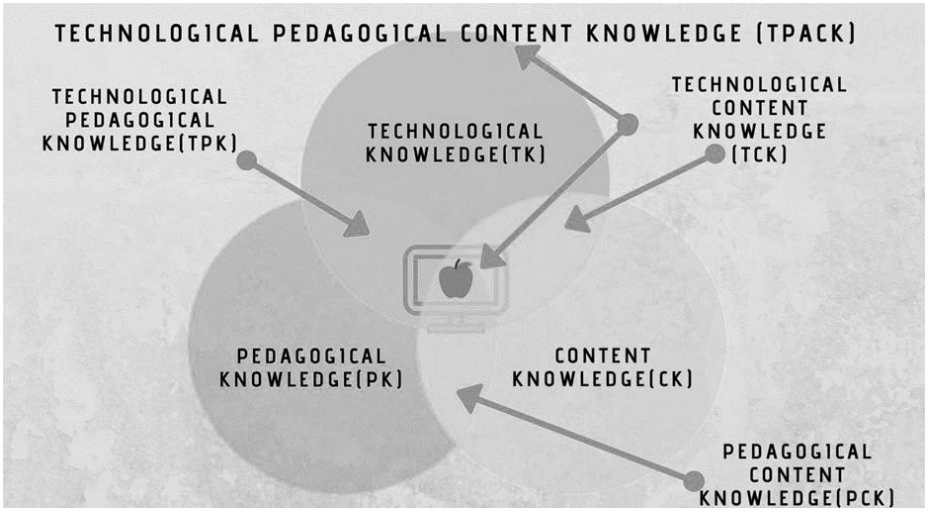


Figure 1. The structure of the TPACK framework

The TPACK framework, as the result of these three combinations, provides an effective basis for the successful integration of educational technology with the learning process. But to achieve this integration teachers must be ready to accept the following key ideas:

• the learning content can be successfully delivered using information technology; in the majority of cases information technology does it more efficiently than traditional methods;

• technology provides an effective way to establish communication and relationships between the learning content and educational objectives and goals;

• technology can be useful in adapting the level of student's skills to the requirements of a particular subject;

• educational technology is well adapted for cases when the same classroom includes students with different learning backgrounds, that is, with different levels of knowledge;

• technology works well with students' current knowledge allowing them either to strengthen what they know or develop new knowledge.

Since its invention, the TPACK framework has remained one of the leading theories of integrating educational technologies with the educational process. Using the TPACK framework, teachers can integrate technology and learning in the most productive way. One of the strongest points of the framework is that the constituents upon which it is based can be conveniently adjusted to suit the needs of specific educational circumstances. Additionally, the framework allows to measure the level of instructor's knowledge, thus affecting the training programs offered to teachers. Finally, another benefit of the framework is that it explicates the types of knowledge that teachers must possess to make the integration of technology and the classroom successful. Teachers don't need to master all the aspects of the framework to get benefits from it. They simply need to keep in mind that the prerequisite for successful learning outcomes is using sound pedagogical approaches driven by learning content and educational technology.

The TPACK framework was first invented in 2006 by Punya Mishra and Matthew Koehler, researchers from Michigan State University. They noticed that the biggest change happening in education was the use of technology in the classroom. The main motivational factor behind this invention was the lack of other theories able to promote the successful integration of educational technology into the learning process. In its original form, the TPACK framework leaves room for further research to address some particular issues within the original findings.

The choice of the appropriate learning model, such as TPACK, in itself is not enough to create conditions for achieving the desired learning outcomes. Successful integration of educational technology into existing learning process also requires taking into account such important factor as a learner' perception. All aspects of the learner's perception taking place in the process of using some form of educational technology are grouped together under the concept of UX, that is user experience. Spector in [10] defines UX as a person's perceptions and responses that result from the use of a product, system or service". Following this definition, UX includes everything that is related to the users, that is, their preferences, abilities, attitudes, emotions, perceptions,

physical and psychological responses, and behaviors that occur before, during, and after the use. In the context of the current work, the users are students as well as other participants of educational process. As is implied by Spector[10], from the users' perspectives, an educational technology used in the classroom must be characterized by the such properties as usefulness, usability, desirability, accessibility and credibility. Usefulness refers to the technology's ability to allows teachers, students, parents and other participants of the educational process to achieve their academic goals and objectives. Usability describes the technology's ability to be easy to use, simple, familiar and convenient, and come with easy-to-read tutorials. The learning curve of usable systems should be as short and painless for the users as possible. Desirability refers to the visual aesthetics of the educational product, service, or system. The technology must be easy to understand and appealing to the users in the classroom. Though the visual appeal is a subjective emotional factor, nevertheless it often affects the users' attitude towards a technology. Other emotional factors implied by desirability are an appreciation for the power and value of the brand, image, identity etc. Accessibility is the ability of an educational product or service to be used by all categories of users, including those with disabilities and special needs. Moreover, the users with disabilities and special needs are expected to have the same experience when using a technology as other users. Credibility describes the level at which the users trust and value the provider of an educational product or service. The users expect the technology to deliver an educational value and bring educational benefits. Also, the technology must provide a seamless and consistent user experience. An educational product or service cannot be considered reliable also when the users are not satisfied with them.

A successful integration of educational technology into existing learning process requires that both learning model and user experience are given equal consideration.

Materials and methods. The current research was organized as quasi-experimental research based on tracking the performance of the online academic process of twelve students from the same group of the same university. The performance was tracked in the selected range of subjects distinguished with heavy usage of ICT tools. The research was held at the Technical faculty of Zhetysu University during the 2020-2021 academic year and consisted of three stages.

The first stage of the research was dedicated to forming the control and experimental groups. The students from both groups represented the Computer Science specialty. The control group was represented by students preferring traditional desktop computers for performing classroom tasks and delivering the learning content. The experimental group was represented by students preferring mobile devices for performing classroom tasks and delivering the learning content. The academic process in the experimental group was built upon the psychological and educational principles proposed by cognitivism and the TPACK framework. Before the experiments, all students from both subgroups shared the same level of overall academic performance and demonstrated the same level of ICT skills and competency. Table 4 provides information about the range of the disciplines studied by the students from both subgroups and how ICT is used in each of these disciplines.

Table 4. Disciplines studied by students from experimental and control groups

Discipline title	Lesson forms	Instruction Language	Number of credits	Usage of ICT
Physics	Lecture, practical lesson, laboratory lesson	Russian and English	5	Viewing non-interactive textual learning content; viewing non-interactive multimedia-based learning content; viewing interactive multimedia-based learning content; accessing educational online resources
Computer Modeling in Physics	Lecture, practical lesson	Russian and English	5	Using Computer Algebra systems for solving mathematical models; using LCMS applications to build multimedia presentations
Mathematics	Lecture, practical lesson	Russian	5	Viewing non-interactive textual learning content; viewing non-interactive multimedia-based learning content; viewing interactive multimedia-based learning content; accessing educational online resources; Using Computer Algebra systems for

				solving mathematical models
Information Theory	Lecture, practical lesson	Russian	6	Viewing non-interactive textual learning content; viewing non-interactive multimedia-based learning content; viewing interactive multimedia-based learning content; accessing educational online resources
Database Management Systems	Lecture, practical lesson	Russian and English	6	Viewing non-interactive textual learning content; viewing non-interactive multimedia-based learning content; viewing interactive multimedia-based learning content; accessing educational online resources; accessing Web-based database administration tools
Object-oriented programming	Lecture, practical lesson	Russian and English	6	Accessing educational online resources; accessing Web-based and cloud-based development environments

The discipline of object-oriented programming from Table 4 is distinguished by the heavy usage of online-based programming resources such as various Web-based programming environments and online compiler and debugging tools.

The discipline of information theory is largely theoretical and dedicated mostly to studying the mathematical concepts of Computer Science.

The tasks given to the students from both groups mainly involved the methods of differential and integral calculus. The general description of these tasks is given in the Table 5.

Table 5. The general description of the tasks given during the experiment

Discipline	Description of the tasks
Physics	Solving problems from mechanics, thermodynamics, electrodynamics, optics, atomic and nuclear physics, and molecular physic. The problems are mostly based on finding the unknown physical quantity and require intensive computations involving numerical differentiation, integration and manipulations with series.
Computer Modeling in Physics	Building and solving mathematical models of various physical problems, mostly from such fields as atomic and nuclear physics, molecular physics and astrophysics. The problems depend on multiple input parameters and are solved mostly with the help of numerical methods involving differentiation, integration and manipulations with series.
Mathematics	Solving problems from such mathematical disciplines as analytic geometry, differential and integral calculus and linear algebra. The problems require intensive computations and are usually solved with the help of various online mathematical environments. Numerical problems are solved using online
Information Theory	Solving various applied problems related to the transmission and processing of information, entropy and implementing cryptographic and compression algorithms. The problems require intensive computations involving differential and integral calculus
Database Management Systems	Solving theoretical problems from relational algebra. Designing and creating databases with the help of online-based SQL environments and tools. Data analysis.
Object-Oriented Programming	Solving problems of mathematical and technical nature with the help of object-oriented programs written in C++ or Java. The problems require intensive numerical computations involving differential and integral calculus. The programs are written in online-based programming environments.

The students from both groups used the same online environments and tools for performing the assigned tasks

The second stage of the research was dedicated to collecting the data from the groups. The main method for collecting the data was observation of the students' scores from the university's online journal. At this stage, the authors collected the data related to the academic performance of the students from both groups and then carried out a statistical analysis and comparison of these data. The main approach to carrying out the statistical analysis at this stage was using the Mann-Whitney U test. The Mann-Whitney U test was carried out the

following way. First, the observations from both groups were put in one set. Then all the observations were assigned numeric ranks starting with 1. Then the ranks for the observations from various samples were added up. And in the end the value of U was calculated using the total number of observations, the sample size and the sum of the ranks in the given sample. The tools used for the statistical analysis were online statistical environments.

At the last stage of the research, the authors used surveys and interviews to gather the students' opinions on M-Learning. Particularly, two questionnaires were held among the students using e-mail. The first questionnaire was conducted right after the end of the first half of the experimental period. The second survey was conducted directly at the end of the second half of the experimental period. The questionnaires were conducted in Russian and Kazakh languages and contained the questions, given in Table 6.

Table 6. The questions from the questionnaire

No	Question	Answer variants
1	Are you satisfied with the online educational process	Yes or No
2	Do you use the mobile Internet as the primary source of educational information?	Yes or No
3	Do you use mobile Internet as the primary source of communicating with teachers and other students?	Yes or No
4	Do you use mobile Internet for accessing online lessons	Yes or No
5	How do you evaluate the mobile-based learning process	Grade from 1 to 5

The results obtained at each stage of the experiments are given in the Results section below.

Results. During the experiments, two categories of data were obtained. The first category includes data related to academic performance. The second category includes the results of the questionnaires.

The first category of data is displayed in Figures 2 and 3. Figure 2 provides information about the average academic performance of both groups per subject in the first half of the 2020-2021 academic year. The average academic performance was calculated using the following method. First, the total sum of all grades obtained by students is counted. Then this sum is divided by the total number of these students. In this process grade A was considered as having five points, grade B as four points, grade C as three points, and grade D as two points.

Figure 2. Performance of both groups in the first half of the experimental period

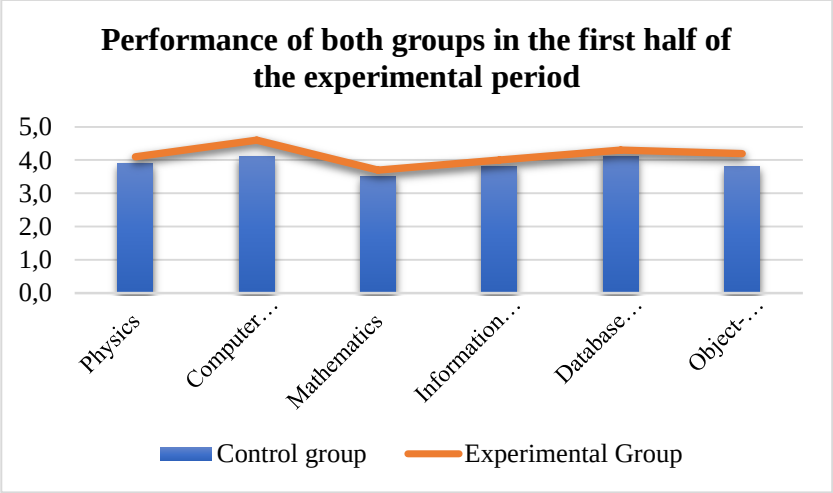
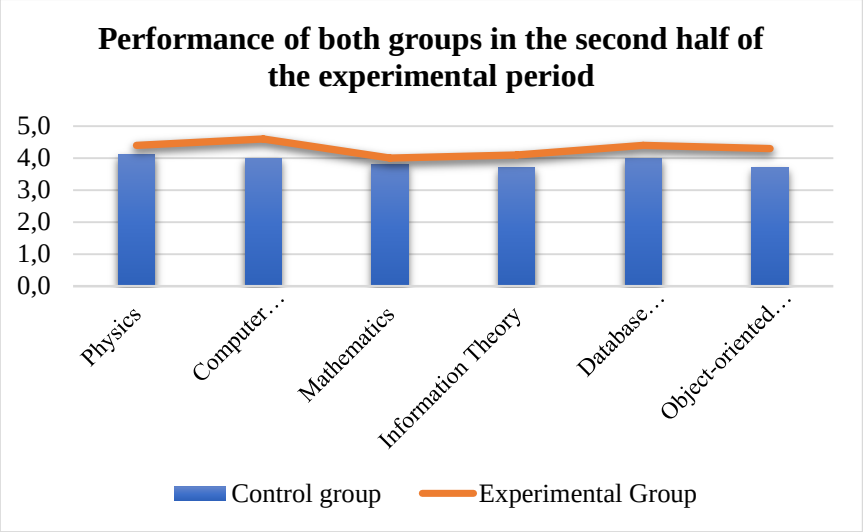


Figure 3 provides information about the average academic performance of both groups per subject in the second half of the 2020-2021 academic year. The average academic performance was calculated using the same approach as in Figure 2.

Figure 3. Performance of both groups in the second half of the experimental period



As is evident from Figure 3 the experimental group demonstrated a better average academic performance than the control group in both halves of the experimental period.

Another result obtained during the experimental period was that the average attendance rate of participants from the experimental group was higher than that of the control group.

Tables 7 and 8 contain the second group of data. Table 7 displays the results of the first questionnaire.

Table 7. Results of the first questionnaire

Question No.	Results
1	60 percent of the respondents answered “Yes”
2	70 percent of the respondents answered “Yes”
3	70 percent of the respondents answered “Yes”
4	65 percent of the respondents answered “Yes”
5	The average grade given by the respondents is 3.9

Table / displays the results of the second questionnaire.

Table 8. Results of the second questionnaire

Question No.	Results
1	70 percent of the respondents answered “Yes”
2	80 percent of the respondents answered “Yes”
3	75 percent of the respondents answered “Yes”
4	70 percent of the respondents answered “Yes”
5	The average grade given by the respondents is 4.4

As is seen in Tables 7 and 8, the respondents have a positive attitude towards the usage of mobile devices in their learning activities.

Discussion. The results of the current study clearly demonstrate that M-Learning provides effective means for improving the academic performance of students in the context of Mathematics, Physics and Computer Science. The reliance on mobile technology in the classroom enabled the experimental group to perform better at all of the disciplines taught during the experiment.

A better academic performance of the experimental group can be explained by a lot of psychological and technical factors. The first factor to consider is the attractiveness of a mobile device. To almost any student, his personal mobile device is the environment in which he prefers to spend most of his time. Moreover, it is the environment in which he performs almost all of his daily activities. And the possibility of using his favorite

mobile device for performing a classroom task contributes greatly to the attractiveness of a classroom, and as a result, creates conditions for the student's academic achievements.

The second factor to consider is the usability and ergonomics aspects. Mobile devices are easier to carry, handle and use than traditional desktop computers and their relatively small sizes allow users to absorb more information presented on the screen than it is possible with personal computers. Besides, the graphical interfaces of mobile applications are usually made up of the minimum of components which make them more convenient for users.

The third factor to consider is that mobile-based learning provides an optimal environment for applying the concepts proposed by the TPACK framework. The combination of mobile technology with the TPACK framework makes the process of the delivering the educational content more effective than in the traditional methods. It allows to establish more effective relationships and communications between the learning content and educational objectives. Moreover, it helps a student to adapt the level of his current skills to the needs of a particular subject, thus creating conditions for academic achievements. The combination of mobile technology with the TPACK framework allows students and teachers to organize the usage of technology in a classroom in the most effective way.

The academic performance of the experimental group allows the authors to state that in the context of the educational process mobile devices can serve as a valid replacement to traditional personal computers. Moreover, mobile devices can replace traditional computers in such activities as solving computation-intensive problems involving differential and integral calculus. This view of a mobile device as a valid replacement of a personal computer in solving computation-intensive problems constitute the current study's main contribution to the published research on E-Learning and M-Learning.

From a more general point of view, the results of the current study serve as an additional proof of the M-Learning's tendency to fulfill its potential as an efficient tool for modernizing the learning process, increasing its attractiveness to students, and positively affecting their academic performance and attendance rates. The questionnaire surveys show that students have a positive opinion on the M-Learning model and consider their mobile devices to be the primary sources of accessing and delivering the educational material. These results correlate with the findings of [14] and [15] demonstrating that E-learning improves students' academic achievements. At the same time, the current paper extends these findings by testing them in the specific context of using the M-Learning model in the academic process of a higher education institution. Also, the current study demonstrates that the possibilities of the M-Learning model are not restricted by the specifics of a particular discipline in which context it is applied. Moreover, the competencies developed by mobile-based learning can help students achieve their academic goals in other disciplines as well. These competencies include among others such competencies as knowledge competency, process competency, application competency, personal competency, social competency and innovation and creativity competency.

Mobile learning develops knowledge competency by involving students in the processes of instructional design, usage of educational software and human-computer interaction. Process competency is developed by stimulating students' abilities to understand and estimate what can be achieved in terms of available mobile hardware and software technologies and what expertise is required to accomplish their educational task. It is worth noting that process competency involves not only students, but all other participants of educational process as well. Application competency is mostly developed by engaging students in creating their own specifications for a mobile learning environment or academic discipline and taking an active part in their practical implementation. A useful side-effect of developing application competency is that it simultaneously develops students' skills in using and assessing educational media resources. The development of social competency is stimulated by mobile learning's dependance on students' skills in collaboration, coordination and communication so that to be successfully applied in situations where a group of students may have different educational background and educational expertise. In its turn, the development of social competency is always done in parallel with the development of personal competency when mobile learning can adjust itself to the particular educational needs of a specific person. And, finally, mobile learning develops students' innovation and creativity competency by involving them in learning and using new information technologies which help them achieve the desired learning outcomes. Reliance on mobile technology makes students open to technological innovations and stimulate their readiness for changes in the fields of instructional design and learning environment.

The results of the current study may serve as the theoretical premises for the future process of reorientation of ICT usage in higher education institutions towards mobile learning.

Conclusion. The usage of M-Learning in the academic process of higher education institutions brings with it a significant number of educational benefits. It improves the academic performance of students and increases the level of attractiveness of the educational process. M-Learning contributes to students' satisfaction with learning and positively affects their attendance rate. Mobile-based education has the potential of changing the way educators think about the learning process. It enables a non-traditional, flexible and personalized approach to learning and provides a huge space for innovation. It is a significant step in the development of the modern education system, which removes the obstacles in learning caused by physical abilities and language and cultural differences. The use of mobile-oriented Internet resources in the educational process provides convenient and effective real-time means for acquiring relevant knowledge from various locations, such as social networks, blogs, podcasts, videocasts, videoconferencing, and webinars. It helps to achieve a high degree of socialization among students and develop their communicative competencies and teamwork skills. The positive impact of M-Learning is confirmed by the results of the questionnaire held during the study. These results demonstrate that students approve the idea of integrating M-Learning into their educational process.

As the current study shows, the usage of mobile devices in the educational context cannot be limited only to viewing the learning content and interactive multimedia material. The mobile technology can also be effectively used in the tasks usually associated with traditional personal computers, for example solving computation-intensive problems involving differential and integral calculus. Moreover, the mobile devices can successfully replace traditional computers in doing these tasks.

The integration of M-Learning with the existing educational process is effective only when an appropriate psychological learning model is applied. There are many various psychological learning models which can be used in tandem with M-Learning. The current study demonstrates that in the context of M-Learning the most effective of these learning models are cognitivism and the Technological Pedagogical and Content Knowledge Framework (TPACK). These learning models are flexible and, as a result, work well with the main objectives of M-Learning.

To meet the challenges of the rapidly-changing world, the sphere of education must go hand in hand with the latest developments and trends in information and communication technologies. It means that M-Learning should be adopted as the primary strategy by those educational institutions which care about improving the teaching and learning activities with ICT. [16]

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IMPLEMENTATION OF SMART TECHNOLOGIES IN THE INTERNAL ECOSYSTEM OF THE UNIVERSITY

Abstract

This article is devoted tothe impact of smart technologies to the educational process at the university.In the modern age of digital technologies - smart technologies as an innovational and intellectual tool in development of the system of higher education formactual skills for enhancing learning process for students and teachers.The characteristic features ofproblems in the adaptation and work of a teacher in a digital educational environment were identified. The results demonstrated that the implementation of smart technologies in the teacher's personal educational environment brings positive changes and increases the overall performance of pedagogical process. The use of modern technologies and tools improves student learning for teachers and in accordance with the barriers to obtaining these tools the authors propose solutions. They discovered that the teaching stuff's attitude towards digital sphere is a key factor for mastering smart technologies. The authors conclude that the impact of smart technologies on the educational process at the university can be positive, as long as they are implemented effectively and with consideration for the needs of students and faculty.

Keywords: digital technologies, smart technology, digital educational environment, internal ecosystem of a university, teacher's personal educational environment.

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ИМПЛЕМЕНТАЦИЯ СМАРТ ТЕХНОЛОГИЙ В ВНУТРЕННЕЙ ЭКОСИСТЕМЕ УНИВЕРСИТЕТА

Аннотация

Статья посвящена влиянию смарт технологий на образовательный процесс в вузе. В современную эпоху цифровых технологий смарт-технологии как инновационно-интеллектуальный инструмент развития системы высшего образования формируют у студентов и преподавателей актуальные навыки повышения эффективности учебного процесса. Авторами выявлены характерные особенности проблем