International Journal of Innovative Research and Scientific Studies, 8(6) 2025, pages: 425-438

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Mobile school of informatics: Integration in the educational process of secondary general education schools of the republic of Kazakhstan

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Abstract

Despite the fact that mobile learning technologies have been sufficiently studied and there are many studies on their application, they have not yet become widespread. This study is conducted to address the problem of motivating students for learning and enhancing their information competence through mobile technologies in computer science lessons within the school education system of the Republic of Kazakhstan. An in-depth analysis of both domestic and international experiences in the use of mobile technologies in education has been carried out. During the study, a model and methodology for integrating mobile learning into the teaching of the disciplines "Informatics" and "Digital Literacy" in Kazakhstan's school system have been developed. The model and educational resources were implemented in experimental schools. The article presents the results, which are supported by evidence of the effectiveness of the methodology through the Mann-Whitney U-test. The findings suggest that the developed approach can be scaled and applied not only in computer science lessons but also across other subjects, contributing to the broader integration of mobile technologies in education.

Keywords: Digital literacy, Education, Information competence, Learning process, Mobile Learning, Mobile technology.

DOI: 10.53894/ijirss.v8i6.9633
Funding: This study received no specific financial support.
History: Received: 3 July 2025 / **Revised:** 7 August 2025 / **Accepted:** 11 August 2025 / **Published:** 3 September 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

In the modern world, new technologies are changing the content and process of learning. Teaching strategies focus more on students' digital skills and competencies. There is an active transition from traditional methods to technologies associated with information and technical resources. Such means include mobile learning technologies, which form the

motivation for learning and information competence of students. At this stage of the development of the secondary education system in Kazakhstan, mobile technologies have not been introduced into the educational process. Computer science training takes place in classrooms with stationary computers. The analysis of educational methods carried out in the course of the study showed the need to adapt educational content to the characteristics, needs, and pace of each student, using mobile applications and platforms. Mobile technologies make it possible to create flexible, interactive, and accessible educational environments that support learning anywhere and at any time, which is relevant due to the rapid progress of information technology, as well as the active development of digital platforms and strategies for the digitalization of education at the national and international levels.

2. Literature Review and Problem Statement

The modern format of classes requires a revision of traditional forms and methods of teaching, and as a consequence, the emergence of new technologies in education. One of the promising areas of research in the field of modern education is the use of mobile technologies. The use of mobile applications in education is dictated by the current stage of development of the education system and the level of information technology development [1-3].

The concept of "mobile learning" in contemporary theory and practice is multifaceted; it is seen by scholars as a technology with positive and negative aspects [4-6]. Mobile devices are effective learning tools; smartphones have the technical potential to engage young people in learning, as well as in training teachers to use them [7]. Mobile learning characteristics, such as usefulness, ease of use, and perceived behavioral control, can provide more cognitive engagement than using any of them separately [8].

The key characteristics of a strategic framework for adapting and sustaining mobile learning are explored by Moya and Camacho [9] based on a systematic review of 15 studies published between 2009 and 2018.

Most of nowadays learners are technically and psychologically ready to use mobile technology in education [10-12]. At this moment of development, new possibilities for better harnessing the potential of mobile learning must be considered. Meeting this challenge requires organizational efforts on the part of educational leaders, research, and methodological work of scientists and teachers to implement strategies, forms, and methods of mobile learning in the educational process of educational establishments.

According to Kearney et al. [13], mobile technology is any portable technology that potentially supports learning and includes laptops, tablets, and smartphones. The authors of this study have developed a rigorous scale to cover mobile pedagogical methods used in mobile learning tasks developed by teachers. Specifically, the scale focuses on the measurement of pedagogy related to the iPAC framework, which includes three overarching dimensions of mobile learning: personalization, authenticity, and collaboration. As a result, the authors provide a measure of the overall experience of using mobile learning, which is predicted by the pedagogy of mobile learning, and the study also provides information about the differences between the teaching methodology in the practice of mobile learning, taking into account the period of training and the subject area [13].

The process of implementing mobile learning must be relevant to the current stage of development of the economy and society as a whole. It is also necessary to take into consideration the fact that the introduction of technology is impossible without a clearly developed methodology. The analysis of the application of mobile learning technology in different countries demonstrated that, at present, the methodology of mobile learning is in the process of formation.

In today's world, the culture of understanding the importance of using mobile technologies in education, the reality of smart devices' employment in teaching and learning from the perspective of instructors, is relevant [14].

A study by Folger et al. [15] showed a problem, such as educators' preparation for using mobile technologies in the classroom. The survey found that students rated their own abilities to use iPads as good or excellent, and teachers' skills as relatively poor, and they wanted more digital assignments.

Mobile apps and technologies are currently being used in pilot projects and large studies [16]. A model of mobile learning can provide a more accurate representation of the population of smartphone users in the study area. Despite the difficulties encountered, there is a general dynamic of growth in the popularity of mobile learning technology. The idea of mobile-free schools occasionally arises because of the problematic use of mobile devices during classes, which is distracting and makes it difficult for teachers to manage the classroom. Separating students from their smartphones can increase their anxiety levels, especially for those who are more attached to their devices [17]. On the other hand, classroom engagement has not increased in a day without mobile devices. Therefore, strict rules on device use should be carefully reconsidered. Thus, smartphones and similar devices can be integrated into the learning process, making it possible to take advantage of them. Educators and parents can develop appropriate guidelines to support students with different smartphone models [18]. Smartphone use is not necessarily associated with problem behaviors, as evidenced by students in the study group who used their smartphones primarily for educational purposes, which had a positive impact on their academic achievement. Therefore, rather than viewing the smartphone as a disruptive tool, it may be appropriate for students who benefit academically from using their smartphones to be encouraged to learn through mobile educational apps.

The effective integration of mobile technology into blended learning environments determines the impact of educational environments on student acquisition of knowledge, academic achievement, and social relationships [19]. Readiness for mobile learning to advance student attitudes and construct knowledge is an emerging trend in the integration of technology into educational institutions. The successful implementation of mobile devices has the potential to improve learning. In this sense, blended learning environments that combine the strengths of traditional education and the strengths of mobile learning can be seen as a promising trend. The findings of this research study show that integrating mobile technologies into a blended learning environment significantly impacts students' acquisition of learning in a positive way.

It is important for new educational models to incorporate learning strategies that allow students to customize their learning based on their competencies, skills, and preferences, as well as strategies that support individualized monitoring of student learning [20]. However, the implementation of these strategies in teaching is challenging for professors, and it becomes more complex as the number of students in the classroom increases. This article presents the design and development of a mobile learning platform that provides professors and students with multiple services to monitor and customize learning based on learning styles, contextual information, and mobile learning objects.

An analysis of mobile technologies for student-centered learning in distance higher education with a focus on mobile online webinars or conferences using mobile applications and devices such as laptops, smartphones, or tablets, is important [21]. Mobile interaction enhances student learning, guides theoretical concepts, aids in the ability to critically analyze information, and provides experiences that integrate professional learning methods.

The widespread use of smartphones in the Pacific region, especially among college-aged populations, creates a niche for mobile learning in the educational landscape [22]. However, there are growing concerns about the effectiveness of this innovative intervention given the digital literacy of students. This article explores the readiness and perceptions of students using mobile devices for learning.

In the works of Ko and Lim [23], Zhan et al. [24], Bikanga Ada [25] and Zogheib and Daniela [26], aspects of the development and use of mobile applications for learning in various subjects were considered. As a result, mobile apps developed in these studies serve as classroom assistance tools that enhance students' learning and enable them to receive personalized feedback. Despite the significant benefits that mobile learning systems offer to students, academic staff, and universities—such as easy access and the ability to learn anytime and anywhere Almaiah and Al Mulhem [27] highlight that the adoption and use of this technology in Jordan remain very low. Their study proposes a comprehensive model to identify the most influential factors that may encourage or hinder students and universities in Jordan from adopting and accepting mobile learning applications. The findings provide valuable insights for educational stakeholders, mobile learning providers, and the research community to develop more effective strategies for implementing mobile learning technology. This study supports the conclusion that mobile learning technology needs to be integrated into the school system. Despite the current stage of development of mobile learning technology, numerous studies emphasize its importance and the necessity for its adoption in education. Yu et al. [28] studied motivation, strategies, learning outcomes, and their mutual correlations in mobile learning. The results showed that in mobile English learning, motivation was significantly stronger, and learning outcomes were significantly better than in traditional English learning.

The aim of the article is to consider the main trends in the formation of motivation for learning and information competence of students using mobile technologies in the learning process. The conducted research and analysis of foreign experience with mobile technologies in education allowed for the development of a model and methodology of mobile learning in the study of the discipline of Computer Science within the system of school education. The results of the study are confirmed by evidence of the effectiveness of the application of the developed methodology in the learning process.

3. The Aim and Objectives of the Study

The study involved 618 students from secondary schools and 20 teachers who teach subjects such as Computer Science, Information and Communication Technologies, and Digital Literacy. It should be noted that digital literacy began to be taught to Kazakhstani first-graders from January 2022. The introduction of this subject meets the needs and requirements of the time, when the digital world is rapidly developing and digital literacy is becoming one of the basic skills. The discipline of Information and Communication Technologies has been studied by children starting from the 3rd grade. The school program for Computer Science includes the study of programming languages such as Python, training in 3D modeling, 3D printing, IT-StartUp, virtual and augmented reality, artificial intelligence, Big Data, and others. One of the topics of study is mobile applications and their development. Undoubtedly, curricula are developed taking into account modern trends in the development of the IT sphere. However, school practice shows the existence of a number of problems associated with the fact that the quality of teaching the above-listed disciplines does not always meet the necessary level. One of the reasons may be the lack of high-quality high-speed Internet in remote or rural areas.

The purpose of the study is to identify the main aspects of increasing the effectiveness and motivation of learning with the help of mobile technologies and the development of a mobile learning system for teaching Computer Science and Digital Literacy subjects in secondary schools in Kazakhstan.

Research questions:

1. Mobile Learning Model.
2. Mobile learning system Mobile School of Informatics.
3. The method of infographics to form the content of a mobile application.
4. Conclusions as a result of the study: Recommendations.

4. Materials and Methods

Following the logic of the research, the identified problems and reasons for the insufficient level of teaching ICT disciplines, information literacy, and information security, we conducted a survey among students and teachers. The survey provided research information. By directly addressing the respondents with questions, the content of the answers allowed us to draw conclusions about certain aspects of the problem under study.

In the work with teachers and school administrators, the method of expert survey was used, which allowed to clarify the main provisions of the research methodology, determine procedural questions, assess the reliability, and clarify the data.

Subsequently, it allowed for to prediction of the nature of changes in the phenomenon under study and to carry out confirmation and clarification of information. The survey was conducted anonymously and was approved by the administration of the experimental schools. The experiment allowed analyzing the results of the study, identifying the limitations, and outlining the prospects for further research practices.

The search for solutions to existing problems in the field of mobile technology has led to the need to develop a model of mobile learning within the school education system, its application, and practical implementation in the form of a mobile learning system. The value of the study is to develop and implement a model of mobile learning technology in the school education system, specifically in the study of the discipline of Computer Science. The model is presented in Figure 1 and clearly demonstrates the technology of mobile learning. The model includes four components: an organizational component, a pedagogical component, an information component, and a technical component. Each part covers a large segment of the interrelated concepts and objects of mobile learning technology in the education system, is important, and makes a significant contribution to the system of mobile learning.

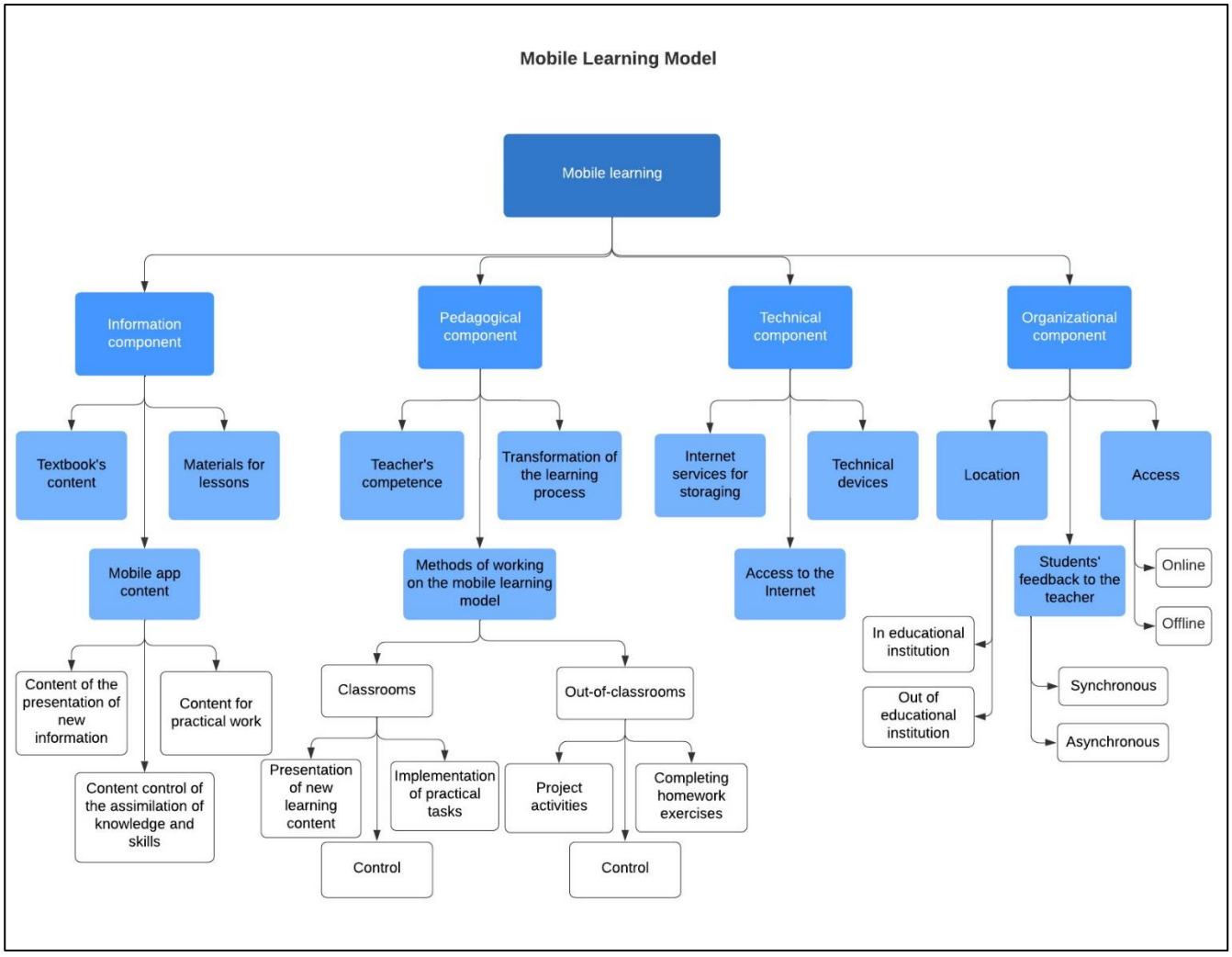

Figure 1.
Mobile Learning Model.

The organizational component characterizes issues such as the workplace for classes, forms of classes, the schedule of classes, and the preparation of the necessary teaching staff. A very important aspect of the application of our developed model is the freedom to choose the location of classes; there is no reference to the premises of the educational institution, and students can be at home during the learning process. The content of learning materials and the content of the mobile application form the basis of the information component of the mobile learning model. Learning materials need to be adapted to mobile devices. The technical component requires a careful selection of the necessary devices to ensure uninterrupted access to the Internet, acceptable data exchange speeds, and the ergonomics of the learning process. The pedagogical aspect involves developing a methodology for the use of this technology at school. The system being developed is used in computer science classes, which require considering the specifics of teaching this subject at school. The use of mobile technologies in the school course of Computer Science should encompass both content and methodological aspects. On one hand, students learn about mobile devices and mobile technologies as part of the Computer Science subject; on the other hand, teachers utilize mobile technologies when implementing teaching methods. Therefore, it is necessary to develop the content of the school course of informatics concerning mobile technology and to address the

methodology of teaching Computer Science based on mobile technologies. The system aims to implement principles of individualization of the learning process and self-education by increasing visibility and using interactive tasks. The expected results of implementing the developed system in schools include increased student motivation, improved quality of training, and heightened student interest in the educational process as a whole.

As a tool for mobile learning, a mobile learning system was developed in the form of a mobile application, Mobile School of Informatics, which performs the following functions:

- Presenting didactic materials in the most convenient and visual form;
- Stimulate interest in learning and fill knowledge gaps;
- Review and analysis of training material;
- Testing with a choice of answers, monitoring and approval of results.

The mobile learning system includes two components: a mobile application written in Kotlin and the web interface of the mobile site. The Mobile School of Informatics mobile application is developed in the Android Studio integrated development environment using the Kotlin programming language. The system functions on any device in the Android operating system environment.

In the Mobile School of Informatics app, users are divided into the roles of administrator, teacher, and student. The first time users visit the application, they need to register and create a unique login and password. Then, the administrator verifies the authenticity of the user's data and assigns the user type (student, teacher). The administrator has access to all functions of the mobile app. After entering a login and password, if they are available in the database, the user's data are saved on the device, and after saving, the user's data are redirected to the main service, which checks the user's type. Figure 2 shows the user selection and assignment interface in the Mobile School of Informatics mobile application. To use the app, the user needs to register and validate their account. After logging into the mobile application, the user has access to the menu, which depends on the type of user; for teachers, students, and administrators, it is different and includes only those functions that are available to the particular category of users.

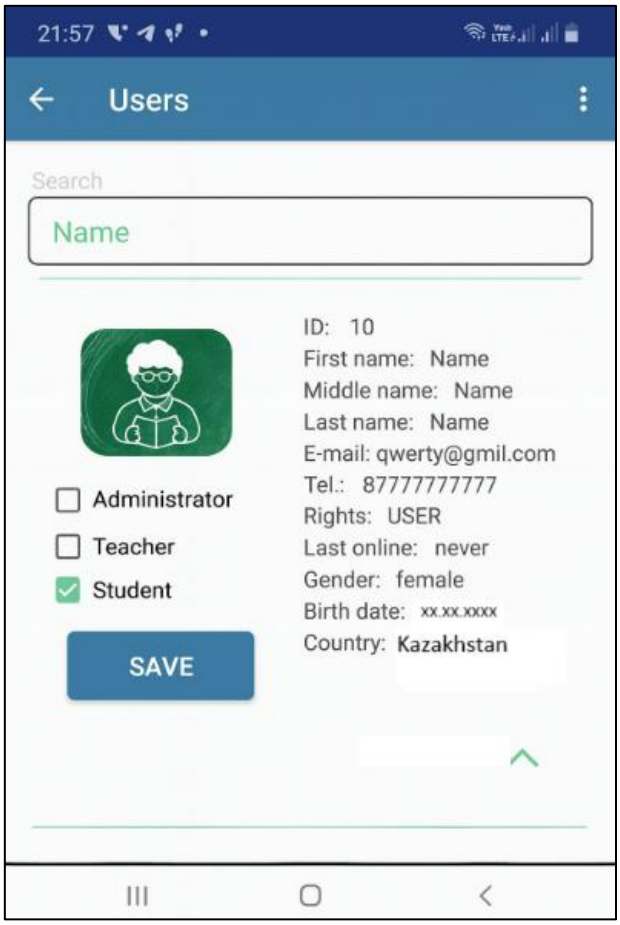

Figure 2.
Selecting and assigning users in the Mobile School of Informatics mobile app.

"Teacher" mode involves the ability to edit the learning trajectory in the mobile app, edit and add assignments, view and analyze student progress, and provide timely feedback to students. In the Mobile School of Informatics mobile app, teachers can create classes for students in advance and track their progress and results using a smartphone. Figure 3 demonstrates the logic behind the app. In the "Teacher" mode, it is possible to create, maintain, and use educational modules, share experiences among colleagues, and optimize student work (including the creation of new modules). The

mobile application is freely available. The advantage of the mobile application is the ability to work in online and offline modes.

The Mobile School of Informatics mobile application is a system of mobile learning capable of implementing various types of exercises in the classroom, ensuring active use of new information technologies. The "Student" interface assumes two operating modes: "Class selection (Classroom)" and "Self-study (Out-of-classroom)." In the "Class selection" mode, it is possible to go through the topics of the Computer Science course for a particular class using different methods of mobile learning. There are provisions for the presentation of new material, performance of practical assignments, and control. Moving from one topic to another will be possible after the end of the previous lesson. All completed tasks are evaluated, and the progress of the student is recorded. This mode also provides feedback to the teacher. In the "Self-education" mode, training is available in any random mode. This mode of the mobile application provides the choice of various topics, saves progress, and provides feedback to the teacher. The main functions of the mobile app provided to students are shown in Figure 3 as a logical flowchart of the mobile app. The Mobile School of Informatics online service is designed to support the learning process with interactive modules, in which students can perform interactive exercises using the materials of the Mobile School of Informatics application on mobile devices.

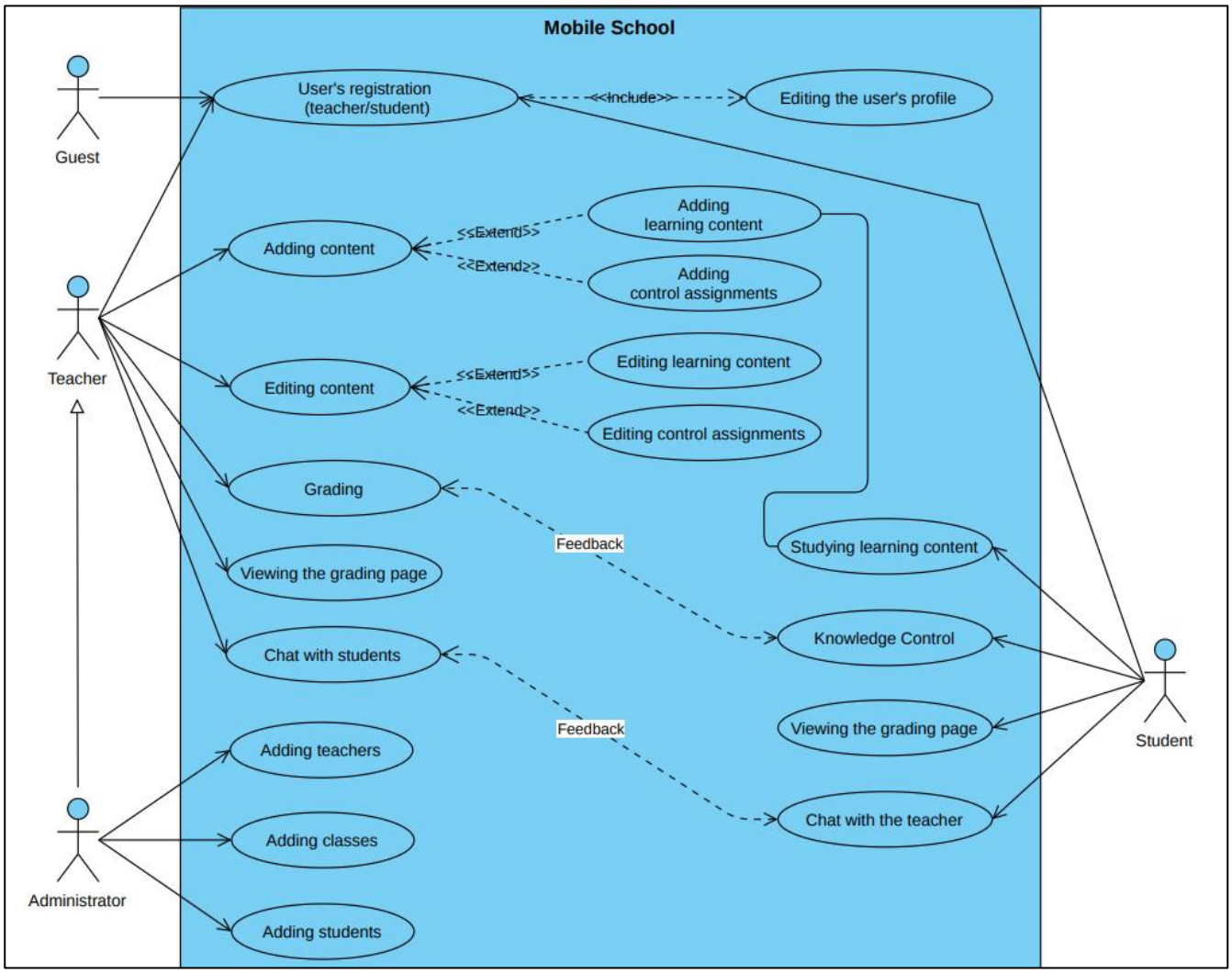

Figure 3.
Logical scheme of the mobile application Mobile School of Informatics.

The menu sections of the mobile app are simple, concise, and intuitive. The app offers information, testing, and feedback functions. Each student can personalize the app and view updated content at a convenient time and place. The instructional content consists of a lecture, a practice assignment, and tests. The teacher can add content to the mobile app from either a smartphone or a computer. The interface for adding learning content to the mobile application is shown in Figure 4.

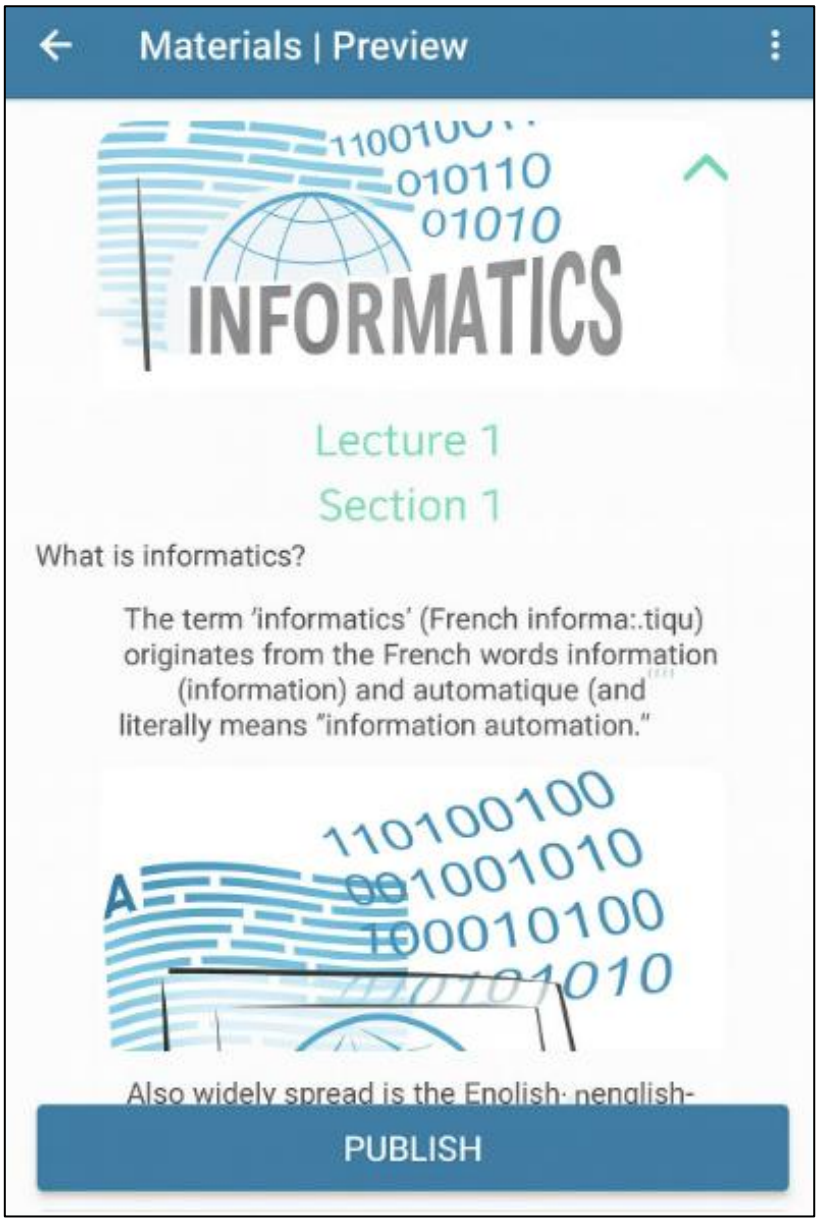

Figure 4.
The interface for adding learning content to the Mobile School of Informatics mobile application.

It should be noted that in addition to the mobile application, the system has a web interface. It is designed for teachers and allows downloading materials from a computer. Downloading materials is also available from the mobile app, but the web interface allows teachers to choose the more appropriate interface for their particular situation to download learning materials, taking into account factors such as age, health, and mobile device proficiency level. Teaching material should be adapted to the content for mobile devices. The guidelines for composing and formatting learning content were developed for mobile devices.

The use of mobile technology helps to encourage students to study independently and gain additional knowledge. This can be realized by organizing simple lesson modules with different tasks and questions on diverse topics. The use of the developed mobile application in school education is not only useful for students, for the development of necessary skills, but also convenient for teachers, because the application implements a testing module, and evaluation is carried out objectively. The most common variant of controlling knowledge of a subject is testing with closed and open test tasks. Easy-to-use and accessible service Mobile School of Informatics allows creating distance learning courses in the Computer Science subject, conveniently publishing, commenting, and evaluating tasks, as well as organizing effective interaction among all participants of the educational process in school. Teachers added by an administrator can log in to the application with their logins and passwords, create groups of students, and create subjects for them. After adding subjects, teachers, using the Mobile School of Informatics application, are able to create tests to check their knowledge. Figure 5 shows the interface for adding tests using the Mobile School of Informatics mobile app.

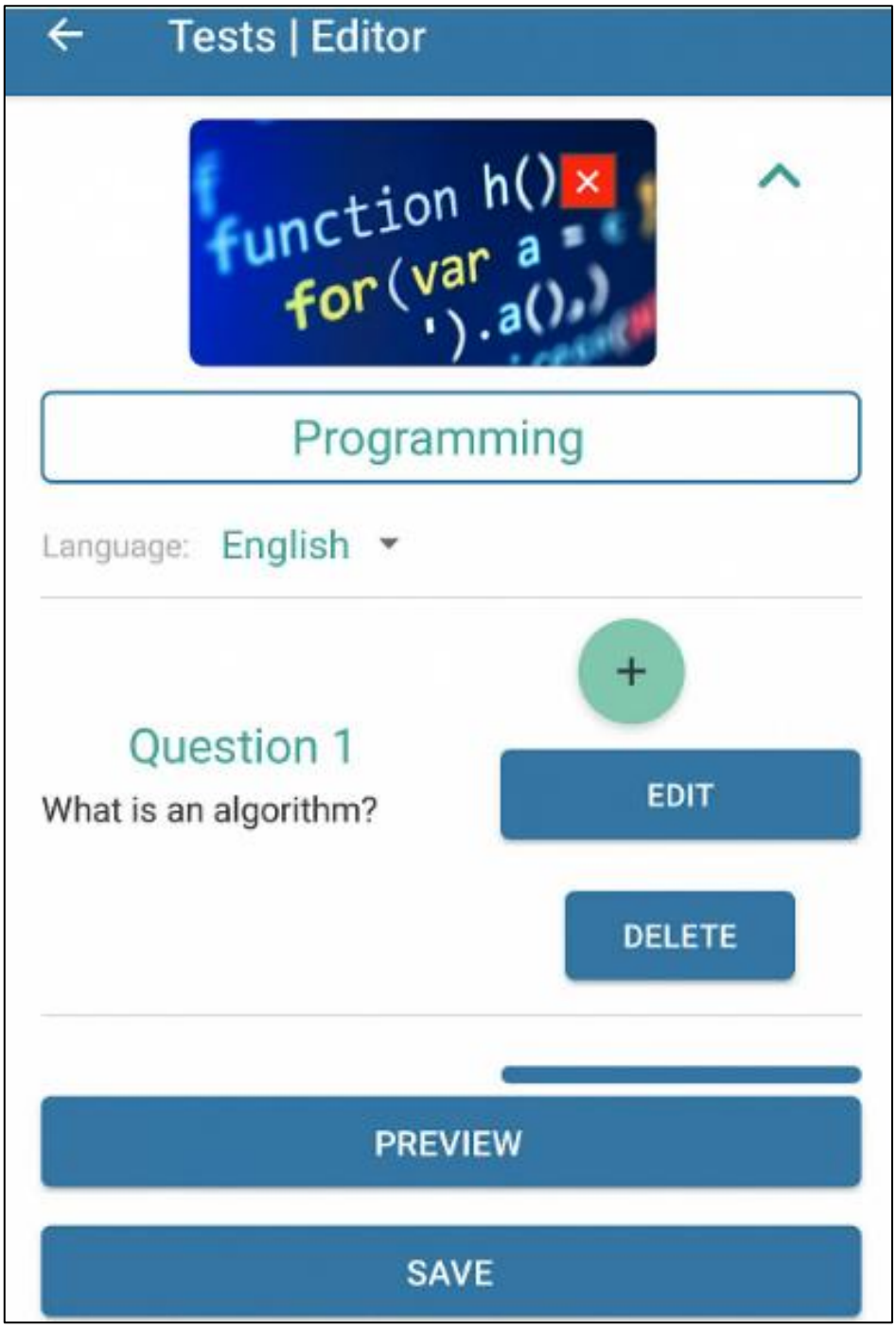

Figure 5.
Interface for adding test tasks in the Mobile School of Informatics mobile application.

The Mobile School of Informatics mobile application, developed during the study, is designed for Computer Science classes and allows interaction between the participants in the educational process. The mobile application has been implemented and tested in schools. Students and Computer Science teachers from secondary general education schools in Kazakhstan participated in the experiment. They were offered to take a Computer Science course with the help of the Mobile School of Informatics mobile application. Students can perform exercises on their mobile devices using the mobile application, which is designed to support the learning process through interactive modules. The service enables teachers to create, maintain, and utilize educational modules, share experiences among colleagues, and optimize student work, including the creation of new modules.

Modern lessons involve the active use of information and communication technologies and the development of students' abilities for independent creative activity. To date, there are a large number of pedagogical technologies and teaching methods that are based on information and communication technologies, which can significantly enrich the content of the educational process, fill it with bright content, thereby motivating students, and activate their thinking activity. In the development and implementation of mobile learning technologies, an urgent problem is the development of learning content adapted to mobile devices. Among the existing variety of methods that allow working with a large flow of information using mobile applications, the most optimal is the method of infographics. This method offers great

opportunities for teachers and learners, as due to its non-standard form, it strongly attracts the attention of students. The method of infographics, otherwise called the method of visualization, consists in the fact that the teacher only has to show an illustration on which all the materials necessary to explain the topic are collected. This is very convenient, as mobile learning technologies are aimed at a compact, bright, expressive, and meaningful presentation of information. Students are not interested and sometimes bored with rereading monotonous paragraphs and articles with long comments.

Figure 6 shows one of the developments of infographics for the Mobile School of Informatics mobile application. Using the method of infographics makes it easier to remember a large amount of new information, allows you to analyze it and draw conclusions, as the use of graphics, numbers, tables, graphs, and a small amount of text helps to build a consistent visual series, not overloaded with unnecessary information.

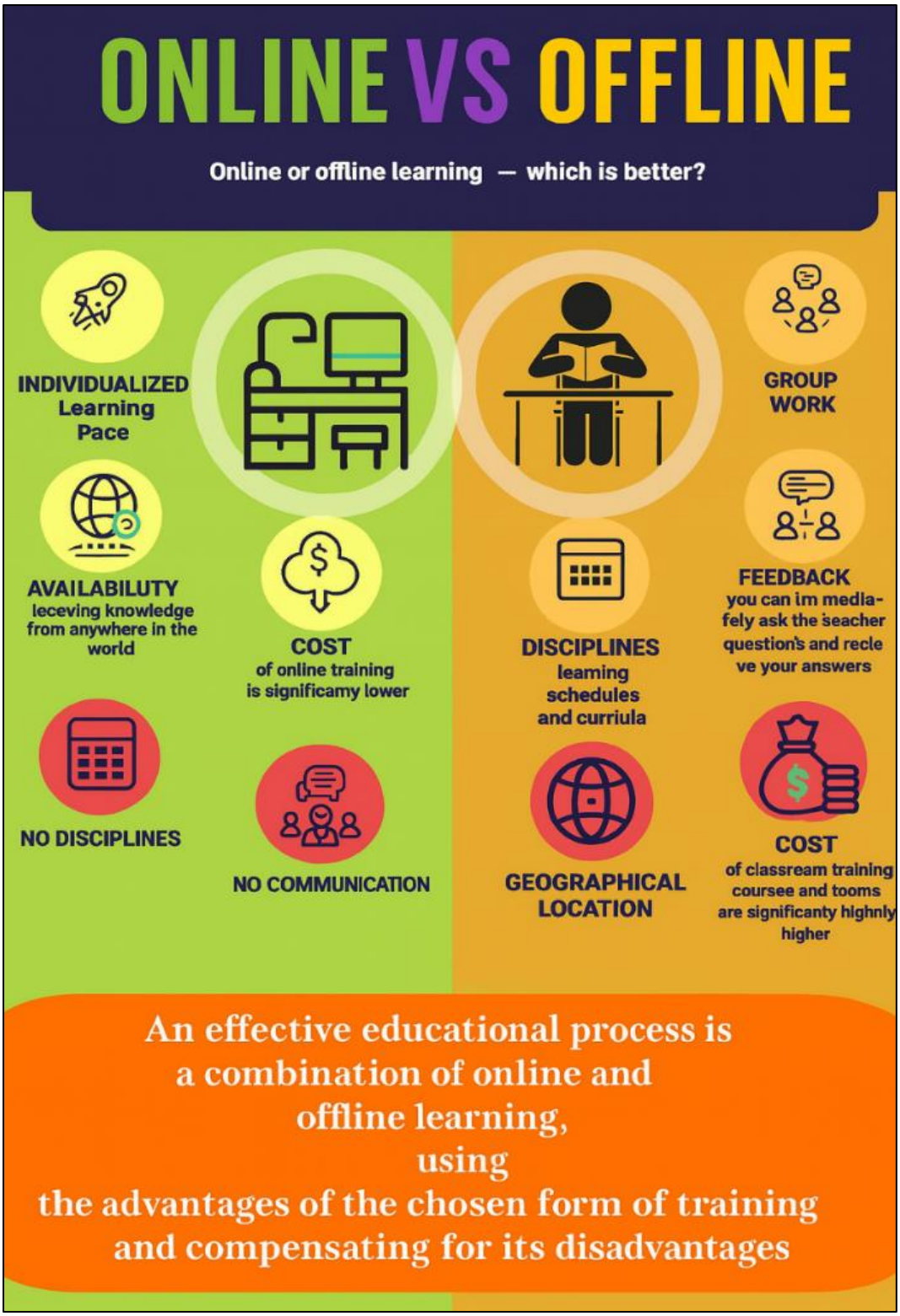

Figure 6.
Infographics for Mobile School of Informatics app.

The main purpose of using mobile technology in teaching is to engage students. Infographics use bright images and pictures, dynamic structures, and animations. This method is effective because it involves two sides in its realization - the teacher, who is the coordinator of the learning process, and the learner. Infographics allow teachers to transform complex, monotonous information. Through the use of this method, information is transformed into clear, accessible, understandable, and adapted to the characteristics of mobile devices.

5. Results

At the initial stage of the study, a survey was conducted among students. Data collection was carried out online using an electronic questionnaire. The survey was anonymous, targeting the study's audience, and was approved by the school administration. The online survey method facilitates comparative analysis and enables quick and straightforward data interpretation. To conduct the survey, a questionnaire titled "Use of Mobile Technology by Modern Schoolchildren at Home and at School" was developed. Consisting of five questions, the questionnaire aimed to gather information on the availability and accessibility of mobile devices in the classroom and during free time, access to the Internet via mobile devices, and the use of mobile devices in Computer Science classes and for homework. A total of 618 respondents participated in the survey. The results, presented in Table 1, confirm the increasing popularity of mobile learning technology among Kazakhstani students.

Table 1.
Descriptive results of the online student survey.

Question	Parameters	Quantity	%
Specify your Age (years)	8-11	221	35.8 %
	12-15	336	54.4%
	16-18	61	9.9%
Would you like to study Computer Science using a mobile app?	Yes	270	43.7%
	No	179	29%
	I can't answer that	169	27.3%
Do you study Computer Science in depth as part of the curriculum?	Yes	216	35%
	No	402	65%
Do you use your smartphone or other gadget during class if you need to find some academic information (other than when the teacher asks you to do so)?	Yes. I do	265	42.9%
	No. I don't	295	47.7%
	I can't answer that	59	9.4%
Have you ever been asked to use your personal mobile devices or Internet-enabled gadgets in class (e.g., to find information, watch videos, view images, etc.)?	No. There never were any assignments like that	191	30.9%
	There are tasks when there is a need to use gadgets in the class. but rarely	305	49.4%
	Quite often, there are tasks when there is a need to use gadgets in the class	34	5.5%
	It happens when the teacher needs help quickly finding the information he or she needs	32	5.2%
	I can't answer that	56	9.1%

Figure 7 shows a chart in which 66.3 percent of respondents chose mobile devices and gadgets as frequently used to access the Internet while being at home. 14.2 percent of students accessed the Internet equally often from stationary devices and mobile devices or gadgets when they were at home. Only 12.9 percent of the students surveyed use a stationary device (a stationary computer) to access the Internet. The remaining 6.5 percent answered "can't answer" and "don't use the Internet at home." The answers to this question show that mobile devices are more popular among students than computers or laptops. To the question "Would you like to study the subject Computer Science with a mobile application?" 270 students answered in the affirmative, and 169 students had difficulty answering the question. The negative answer was given by 179 respondents, which is 29% of the respondents. Based on the analysis of the respondents' answers, it can be concluded that teaching the subject Computer Science with the help of mobile technologies arouses students' interest. Analyzing the dynamics of answers to the question "Do you use your smartphone or other gadget during the lessons if you need to find some information about studies (apart from the cases when the teacher asks to do this)?" It is noteworthy that there are also affirmative answers. This indicates that teachers do not forbid the use of mobile devices by students in class, but this technology is not yet fully used, only partially.

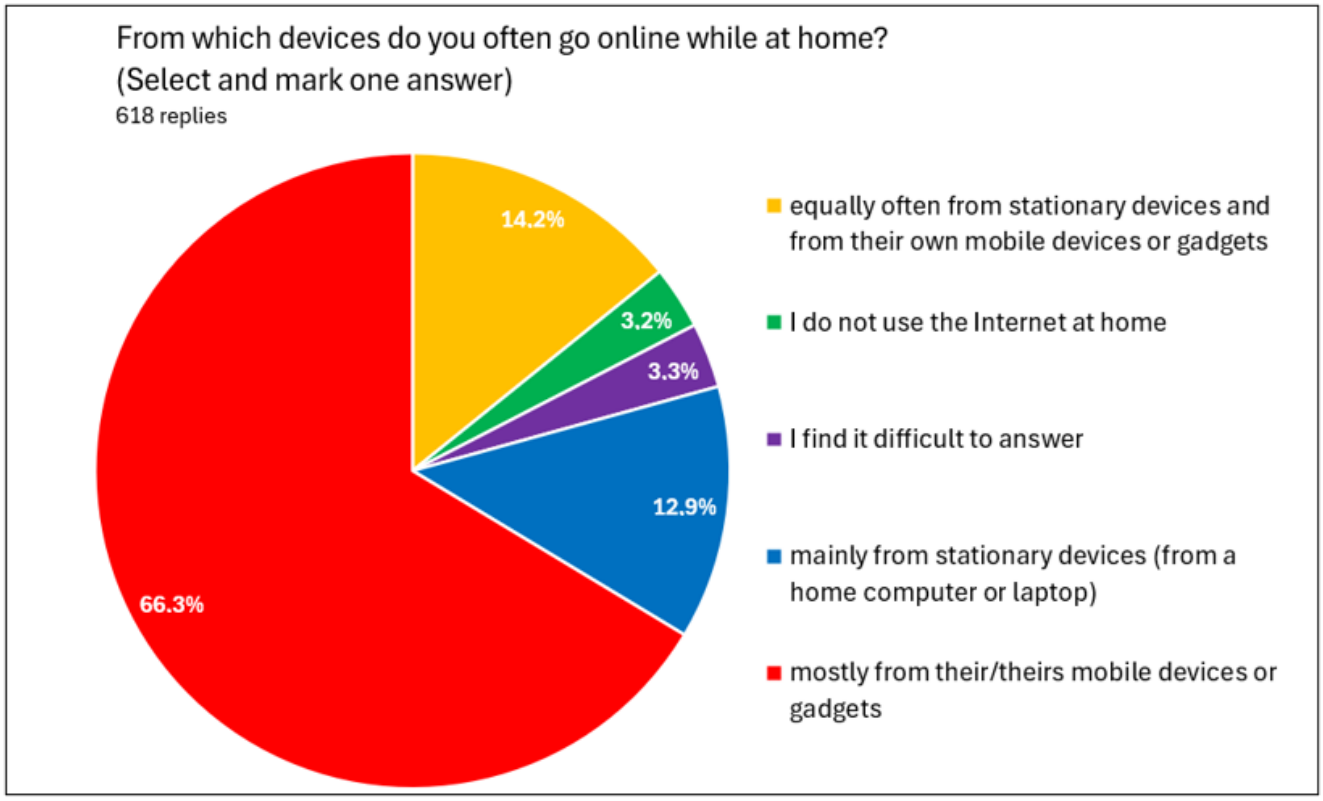

Figure 7.
Survey results.

According to an analysis of the responses to the online survey, most respondents expressed a desire to use mobile technologies in the learning process. At the same time, some students responded that it was inconvenient to work with the phone and read from an additional interface. A small portion of respondents expressed the opinion that the use of devices interferes with concentration on homework. The main evidence of interest in mobile learning is that students can choose their own pace of learning and study at a convenient time and place. It is noteworthy that 100% of respondents have a personal smartphone or tablets, with access to the global Internet.

The conduction of an experiment confirmed the results of the study. Two groups of students participated in the experiment: a control group and an experimental group. The students in the experimental group were trained using the mobile learning system Mobile School of Informatics. The students were asked to complete a test to assess their knowledge of Computer Science, which consisted of 100 test questions. The success indicator was the number of correctly answered questions. The question was whether the knowledge levels of students in the control and experimental groups were the same or different. The Mann-Whitney U-test was employed to answer this question. The null hypothesis H0 posited that the knowledge levels of students in the two groups, based on the number of correctly answered questions, were similar, while the alternative hypothesis H1 suggested that there were differences. All data obtained were entered into a table for the calculation of the U criterion (Table 2).

Table 2.
Ordered integration of experimental data from two groups of subjects.

Students in the control group (CG) (n1=15)		**Students in the experimental group (EG) (n2=15)**	
Number of correct answers out of a possible 100	Rank	Number of correct answers out of a possible 100	Rank
From 65 to 90	1 – 24.5	From 73 to 99	8 - 30
Sum of CG ranks (T_1)	178.5	Sum of EG ranks (T_2)	286.5

Table 2 shows that the sum of the ranks of the EG is greater than that of the sum of the ranks of the CG, which indicates the significance of the formulation of the alternative hypothesis in the direction of increasing students' level of knowledge in the experimental group. To verify the hypothesis proposed, it is necessary to calculate the empirical value of the criterion using the appropriate formula, $U_{\text{emp}} = n_1 * n_2 + \frac{n_{max}*(n_{max}+1)}{2} - T_{max}$ = 58,5;

where n_1 is the number of students in the CG;
n_2 is the number of students in the EG;
T_{max} - the greater of the two rank sums;
n_{max} - the number of students in the group with the higher sum of ranks.

For $n_1 = 15$ and $n_2 = 15$, we find $U_{cr} = 72$ for the level of statistical significance $p = 0.05$. Figure 8 shows how the obtained value of U_{emp} fell into the area of acceptance of hypothesis H_1; therefore, hypothesis H_1 is applied, and hypothesis H_0 is rejected.

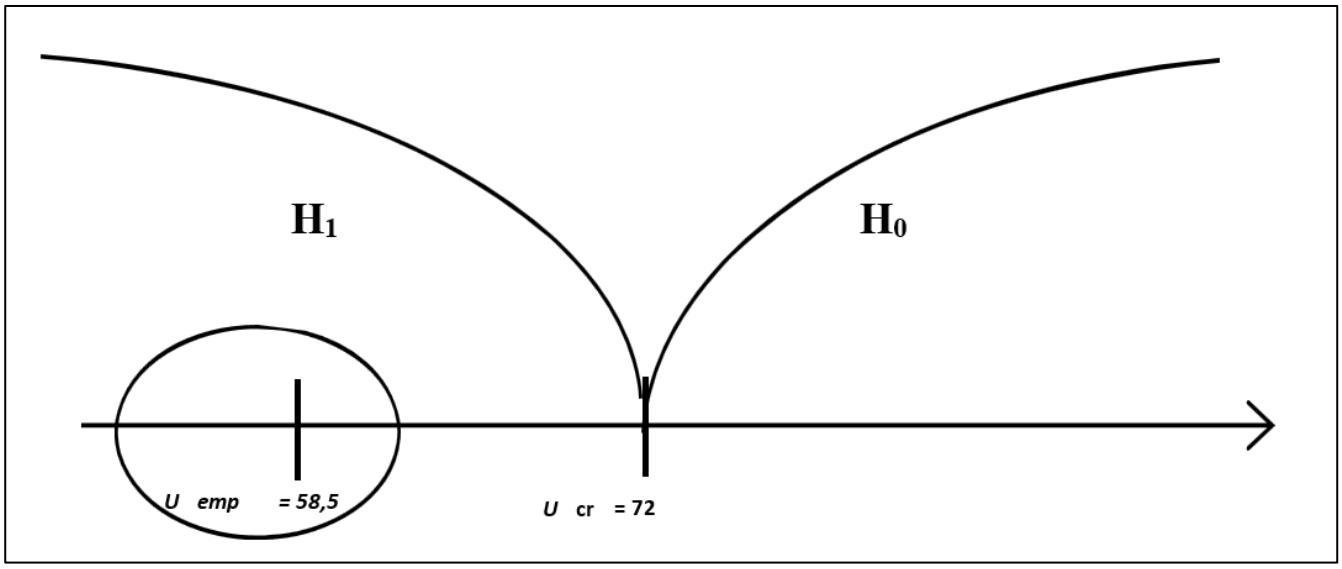

Figure 8.
Numerical axis showing areas of acceptance of hypotheses H_1 or H_0

Thus, as a result of the experiment, it was obtained that the level of knowledge of Computer Science in the experimental group is higher than in the control group after the training with the developed system of mobile learning in the form of a mobile application with educational content. It should be noted that before the experiment, the level of knowledge in these groups had no significant differences. This confirms the significance and relevance of the study.

6. Discussion of Results

Developed and implemented in the educational process, the Mobile School of Informatics required an analysis of the advantages and disadvantages of using the developed system of mobile learning. To this end, an online discussion was held, which drew important conclusions for this study. The advantages of the mobile application Mobile School of Informatics include: reducing the need for books and papers; providing students with the opportunity to move freely while being in online learning mode (wherever the student is, he/she is always in touch); enabling communication with peers and teachers, which facilitates access to education for students with disabilities; and the relevance and convenience of mobile devices for students, potentially increasing interest in learning, especially among students with low motivation. Additionally, the system's ability to operate both online and offline is a significant advantage. The disadvantages encompass the risk of battery depletion at any time, leading to potential data loss if unsaved; the limited screen size of smartphones restricting the amount of information viewable; the comparatively smaller memory capacity of mobile devices relative to computers; and the difficulty of performing complex tasks on mobile applications, such as handling equipment and executing extensive practical activities. Most of these disadvantages are technical in nature and can be addressed effectively. For example, utilizing a centralized database allows for the restoration of all courses and student work after reinstallation of the app, provided the user logs into their account. Furthermore, materials for mobile applications are developed by teachers considering the characteristics of mobile devices, which helps mitigate issues related to small screen sizes.

The results confirm that mobile technology, when intelligently integrated, can improve learning outcomes and student engagement. Similar trends were identified in the earlier works of the team of authors. For example, Kerimbayev et al. [29] proposed a feedback-based management model to optimize the deployment of mobile tools in virtual educational environments, demonstrating improved adaptability and learning efficiency.

In addition, the impact of long-term exposure to mobile technologies was previously studied by the authors and presented in the article [30]. As a result of an earlier study, it was found that the electromagnetic fields emitted by mobile phones affect the activity of the human brain. The results highlight the importance of balancing mobile exposure with pedagogical strategies. The results of this study were taken into account in the current scientific work.

The development of a virtual conferencing platform with adaptive learning features, detailed in an earlier study Jotsov et al. [31] is consistent with our findings on the need for flexible and student-centered digital environments, especially in the context of distance and hybrid education.

As a result, it has been proven that with the help of the mobile learning system, users are given the opportunity to develop intellectual skills, conduct research activities, and self-learning. The mobile application, along with traditional learning, builds students' information competencies and motivation for intellectual self-development. The didactic potential of the mobile learning system lies in that, through this system, students get access to a source of relevant and useful information.

7. Conclusion

As a result of this research, a mobile learning system called Mobile School of Informatics was developed and tested, implemented in the form of a mobile application. The system enables the creation of a learning trajectory for the school subject Computer Science by grade, allows assigning teachers to specific trajectories, publishing courses for students, adding attachments of common document formats to courses, assessing student work, creating tests in various formats, and displaying notifications of new assignments. The app facilitates distance learning for students online via smartphones. The online survey conducted about the Mobile School of Informatics mobile application demonstrated a positive trend in the adoption of mobile technology and an increase in students' information competence levels. Before the experiment involving the use of the developed mobile application, students' performance in the participating class was at an average level. The results of the experiment confirmed the hypothesis that using the mobile app would improve students' learning outcomes. The Mobile School of Informatics mobile application can serve as a tool for mobile learning technology. Its implementation in the learning process indicates that the application will be beneficial for both teachers and students. The use of the system in the classroom can enhance motivation for learning and optimize the interaction process among all participants in the educational process. This affirms the effectiveness of mobile technologies in education. The study's results can be applied in developing curricula for the Computer Science subject and transforming traditional lessons through interactive methods. The research holds significant practical and scientific value. It has identified certain problems, and their solutions are necessary for the effective integration of mobile technologies in education. The importance of further research into mobile technology applications in education is underscored by current conditions and the demands of the information and digital age.

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