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AUGMENTED REALITY AS A WAY TO PRESENT EDUCATIONAL CONTENT IN THE MOBILE APPS

Abstract

This article deals with the issue of implementing the capabilities of augmented reality in learning mobile applications, which is very topical for modern education. The aim of the article is to consider the application of augmented reality in the learning content of mobile applications. This article is devoted to the main aspects of the educational mobile technologies and practical application of the research results in the educational process of the general education institutions. The article deals with the application of the educational content of the mobile application module with the application of augmented reality on the example of teaching the subjects "Informatics" and "Digital literacy" in the secondary general education schools of the Republic of Kazakhstan. The basic definitions associated with educational mobile applications and augmented reality technology are given, an analysis of the subject area is carried out. The international experience of applying this technology in the educational process is considered. The stages of studying the subjects "Informatics" and "Digital Literacy" using mobile technologies of educational direction, such as mobile applications for the organization of the learning process and assessment of knowledge, skills and abilities of students are described. As a result of the experiment, the mobile application was practically realized and the adapted author's program "Application of mobile technologies at the lessons of informatics and digital literacy" was developed. The received results of application of mobile technologies in studying of a school course of computer science and digital literacy confirm the relevance of the carried out research.

Keywords: mobile technology, augmented reality, learning content, computer science, mobile applications, education.

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МОБИЛЬДІ ҚОСЫМШАЛАРДА БІЛІМ БЕРУ МАЗМҰНЫН ҰСЫНУ ТӘСІЛІ РЕТІНДЕ ТОЛЫҚТЫРЫЛҒАН ШЫНДЫҚ

Аңдатпа

Бұл мақалада қазіргі заманғы білім беру үшін мобильді қосымшаларға толықтырылған шындық мүмкіндіктерін енгізу мәселесі қарастырылады. Мақаланың мақсаты мобильді қосымшалардың оқу мазмұнында толықтырылған шындықты қолдану мәселесін қарастыру болып табылады. Жұмыс білім берудегі мобильді технологияларының негізгі аспектілерін және жалпы білім беретін мекемелердің оқу үдерісінде зерттеу нәтижелерін практикалық қолдануды қарастыруға арналған. Мақалада зерттеу барысында әзірленген

«Информатика» және «Цифрлық сауаттылық» пәндерін Қазақстан Республикасының жалпы орта білім беретін мектептерінде оқыту мысалында толықтырылған шындықты қолдана отырып, мобильді қосымша модулінің білім беру мазмұнын қолдану туралы айтылады. Білім берудегі мобильді қосымшаларымен және толықтырылған шындық технологиясымен байланысты негізгі анықтамалар берілді, пәндік салаға талдау жүргізілді. Рассмотрен международный опыт применения данной технологии в образовательном процессе. «Информатика» және «Цифрлық сауаттылық» пәндерін оқу үдерісін ұйымдастыруға және оқушылардың білімін, іскерлігі мен дағдыларын бағалауға арналған мобильді қосымшалар сияқты білім беру бағытындағы мобильді технологияларды пайдалана отырып оқыту кезеңдері сипатталған. Эксперимент нәтижесінде мобильді қосымша іс жүзінде іске асырылды және «Информатика және цифрлық сауаттылық сабақтарында мобильді технологияларды қолдану» атты бейімделген авторлық бағдарламасы әзірленді. Мектептегі информатика және цифрлық сауаттылық курсын оқуда мобильді технологияларды қолданудың нәтижелері жүргізілген зерттеудің өзектілігін растайды.

Түйін сөздер: мобильді технологиялар, толықтырылған шындық, оқыту мазмұны, информатика, мобильді қосымшалар, білім беру.

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ДОПОЛНЕННАЯ РЕАЛЬНОСТЬ КАК СПОСОБ ПОДАЧИ ОБРАЗОВАТЕЛЬНОГО КОНТЕНТА В МОБИЛЬНЫХ ПРИЛОЖЕНИЯХ

Аннотация

В данной статье рассматривается актуальный для современного образования вопрос внедрения возможностей дополненной реальности в обучающих мобильных приложениях. Целью статьи является рассмотрение вопроса применения дополненной реальности в обучающем контенте мобильных приложений. Работа посвящена рассмотрению основных аспектов образовательных мобильных технологий и практического применения результатов исследования в учебном процессе общеобразовательных заведений. В статье речь идет о применении разработанного в ходе исследования образовательного контента модуля мобильного приложения с применением дополненной реальности на примере преподавания предметов «Информатика» и «Цифровая грамотность» в средних общеобразовательных школах Республики Казахстан. Даны основные определения связанные с образовательными мобильными приложениями и технологией дополненной реальности, проведен анализ предметной области. Рассмотрен международный опыт применения данной технологии в образовательном процессе. Описаны этапы изучения предметов «Информатика» и «Цифровая грамотность» с использованием мобильных технологий образовательного направления, такие как, мобильные приложения для организации учебного процесса и оценивания знаний, умений и навыков учащихся. В результате проведенного эксперимента было практически реализовано мобильное приложение и разработана адаптированная авторская программа «Применение мобильных технологий на уроках информатики и цифровой грамотности». Полученные результаты применения мобильных технологий в изучении школьного курса информатики и цифровой грамотности подтвержают актуальность проведенного исследования.

Ключевые слова: мобильные технологии, дополненная реальность, обучающий контент, информатика, мобильные приложения, образование.

Basic Provisions. The main provisions of the study include such concepts as the introduction of augmented reality capabilities in educational mobile applications, the analysis of the use of augmented reality in the educational content of mobile applications, and the practical application of the results obtained in the educational process of general education institutions. Emphasis is placed on the main aspects of the use of educational mobile technologies and the use of virtual reality technology in the classroom. On a practical example, the stages of studying the subjects “Informatics” and “Digital literacy” using mobile technologies in the educational process, such as mobile applications for organizing the educational process and assessing students' knowledge, are considered. As a result of the experiment, a mobile application and an author's program “Application of mobile technologies at the lessons of informatics and digital literacy” were

developed. The results of the use of mobile technologies in the study of the school course of informatics and digital literacy confirm the relevance of the study.

Introduction. Historically, school education has emphasized the use of technology such as stationary, desktop, or semi-mobile handheld systems in the classroom to collect or analyze experimental data and as a means of engaging or motivating interest in science. However, the advent of mobile devices such as smartphones, tablets, supported by a huge number of inexpensive or free applications suggests that new opportunities are becoming available for teachers to explore how these resources can be useful in supporting "hands-on" science instruction in general and computer science in particular. Analysis of the results of research on mobile technology in education has shown that the relevance of the use of these technologies is increasing every day. Most researchers consider mobile technology as one of the most progressive trends in the modern educational process.

Falloon, G. й published a paper investigating elementary school students' use of mobile apps integrated with hands-on science activities in a topic exploring energy concepts. He used an innovative screen capture tool to examine how learners used the apps and features of their tablets to shape their hands-on work at different stages of the experiments. The results identify device functions and key app features that helped these learners structure their experiments, understand procedures, think about the impact of variables, and communicate and share results. However, they also found limitations in the ability of apps to support conceptual knowledge development, identifying the critical role of teachers and the importance of task structure and design to ensure that conceptual knowledge goals are met [1].

A study by scholars Zhai, X. and Shi, L. (2020) examined how the pedagogical role of students and teachers in mobile learning mitigated the relationship between the perceived usefulness of mobile technology by high school students and the actual frequency of use, and how students' perceived usefulness influenced their achievement in physics learning. This study involved 803 high school students who used 20 specific tablet functions while learning physics over a five-month period. Based on the pedagogical roles played by students and teachers, 15 of the 20 functions were categorized into three pedagogical categories: five for students, five for teachers, and five for collaborative functions. Results showed that students perceived collaborative functions to be most useful compared to student- and teacher-led functions. In addition, the frequency of use of mobile functions was significantly consistent with students' perceived usefulness across pedagogical categories, and the pedagogical category was found to moderate the relationship between perceived usefulness and actual frequency of use. That is, the link between perceived usefulness and frequency of use varied significantly across the three pedagogical categories. Which confirms the relevance of the research topic [2].

Many studies by scientists provide theoretical and empirical evidence of factors influencing smartphone use among adolescents. Mobile devices have become popular among teens, however, there are a number of studies that focus on the negative effects of smartphones. Although smartphone use can have adverse effects, it can also allow students to participate in flexible mobile learning, access important information and achieve their personal goals. A study by Yoon, M. and Yun, H. (2023) examined patterns of smartphone use in subpopulations of adolescents and associations with their self-control, achievement goals and academic achievement to fill the gap in adolescent smartphone use [3].

One of the modern educational technology is the BYOD (Bring Your Own Device) model, which provides students the opportunity to use their own mobile devices in the classroom. The BYOD model includes the use of students' own devices, such as laptops, tablets, and smartphones, as a tool for learning. This model gives students greater freedom in their choice of device and software, allowing them to customize learning to their needs and characteristics. The BYOD technology model is increasingly being used in education, citing several studies on how to integrate various BYOD applications into pedagogical practices that are based on elementary school requests.

The authors of one such study, Wen, Y., Song, Y. (2018), in their article report on a case study that examines which BYOD applications can help students improve their learning and how they develop their academic knowledge in a continuous learning environment based on the inquiry supported by these applications. The study collected and analyzed a variety of qualitative data. The results show that the capabilities of applications on BYOD can help learners improve their science knowledge without time and place constraints and enhance the learning process [4].

Augmented reality is currently seen as a technology with potential for application in the educational process. However, in the scientific context, research on augmented reality learning is at an early stage of development. A study by Cheng, KH. and Tsai, CC. (2013) identifies two main approaches to use augmented reality technology in education - image-based AR and location-based AR. These approaches can show different possibilities for learning science. Within the research conducted with AR support, several suggestions for future research have been described. For example, more research is needed to explore learning experiences (e.g., motivation or cognitive load) and student characteristics (e.g., spatial abilities or perceived presence) involved in AR. Mixed methods of learning research (e.g., content analysis and sequential analysis) and in-depth studies of user experience should be considered [5].

In general, the use of AR in educational mobile applications can help students in learning information and communication technology to better understand a topic and learn new skills in an interesting and engaging way. However, it must be remembered that the use of AR must be consciously tailored to the educational goals and needs of students.

The research of the scientists Khlaif, Z.N., Sanmugam, M., & Ayyoub, A. (2023), is devoted to the issues of integration of mobile technology in teaching practices to improve learning outcomes. The results of the study show that despite the fact that due to the rapid development of new technologies had to integrate mobile technology into the learning process, teachers are reluctant to integrate these technologies into teaching because of technostress. To shed light on the boundary condition of using new technology in education, this study looked at technostress as a boundary condition that affects the perceived usefulness for continued intentions to use portable technology. Therefore, the authors presented a model to describe the relationship between technostress, perceived usefulness, and teachers' attitudes toward the use of mobile technology in the classroom. The results showed that technostress has an insignificant direct effect on intentions to continue using mobile technology, where perceived usefulness plays a decisive role in intentions to continue learning [6].

Against the backdrop of the COVID-19 lockdown, many countries replaced traditional learning with distance or mobile learning. It was noted that students' motivation became significantly less with the transition to distance learning. In her study Al-Said, K. (2023) analyzes how motivational processes affect the quality of mobile learning. The study aims to analyze the factors that increase students' motivation to learn in today's isolated environment and to identify the main demotivating factors that affect the quality of mobile learning. Motivation is considered a key factor in increasing student engagement in distance learning. The author surveyed 200 students and 46 teachers regarding factors that influenced their motivation in terms of mobile learning. The results showed that 178 of the 200 participants agreed that intrinsic motivation influenced their interest in mobile learning. About 78% of the students approved of mobile learning, while the remaining 22% felt they should return to the traditional face-to-face learning format. The authors considered the importance of feedback and communication with teachers and its impact on the process of mobile learning. Equally important is the role of embedded mechanisms in information systems and the positive role of gamification. The research paper looked at plugins that are compatible with the user-friendly WordPress system, that is, applications that help organize the learning process. This paper presents specific recommendations to increase student motivation in the learning process, which can be used by relevant educational institutions around the world [7].

The analysis of literary sources showed the relevance of the topic of the study. That is confirmed by the study of Glotova M.Y., Samokhvalova E.A. (2022), which considered the feasibility of using mobile applications in education. In 2020 the authors conducted a survey on the use of mobile technologies in the educational process among the students of Moscow State Pedagogical University. The survey involved 82 first-year undergraduate pedagogical students. According to the survey results, 75.6% of the students use mobile devices for educational purposes; 90.3% use mobile devices more than 3 hours a day. Also, most respondents appreciated the benefits of mobile learning and instant access to learning content, as well as the ability to interact with other participants in the educational process and mobility. 79.3% of students agreed with the statement that the availability of learning content available on modern gadgets creates a positive motivation to learn. 92.7% noted the positive impact of mobile technology on learning outcomes [8].

Thus, our study aims to identify the requirements and development of augmented reality mobile app learning content. The development of a mobile learning app with augmented reality is necessary because of several reasons. Firstly, it increases the interest of students in the learning process. Due to the use of AR technology, learning becomes more visual, intuitive and interactive, which contributes to deeper and easier learning. Secondly, a mobile learning app with AR technology can be accessed anytime and anywhere. This allows students to learn in a comfortable environment and use their time more effectively. Thirdly, AR technology allows the creation of unique educational materials that can be adapted for different subjects and learning levels. This can increase the amount of educational information available and make the learning process more individualized. The development of a mobile learning app with augmented reality is necessary to increase the intellectual level and general culture of students, as well as to improve the learning process in general.

Materials and methods. The analysis conducted during the study showed that the development of educational content for mobile applications includes several stages:

- Defining the topics and learning objectives. It is necessary to determine what topics the app will cover and what knowledge and skills users should acquire. The age category and the level of training of the target audience should also be taken into account.
- Creating the structure and content. At this stage it is necessary to develop the structure and content of the educational material. It is important to keep in mind that educational content for mobile apps should be short but informative, so that users can quickly absorb the necessary information.
- Selection of interactive learning methods. In order to make educational content more engaging, you should use interactive learning methods such as tests, games, quizzes, video tutorials and so on.
- Choose a user-friendly user interface. The user should be comfortable using the application, so a simple and intuitive user interface should be created.
- Testing and improvement. After developing the educational content, you need to test it on different audiences and analyze user feedback. This will help to identify shortcomings and improve the quality of learning.

In general, the development of educational content for mobile applications requires special knowledge and skills in pedagogy, marketing, programming and design. When creating the mobile application “AppMobileSchool” the identified requirements were taken into account. The results of literary analysis on the topic of research and available in the market of mobile applications also showed that the educational content of mobile applications in modern education in addition to text, graphic, audio and video information, should contain elements of augmented reality, interactive chat bots and knowledge testing system. Figure 1 schematically shows the composition of the educational content of a mobile application.

Figure 1 - Venn Diagram - the structure of the educational content of the mobile application

A mobile learning app developed using augmented reality technology is an innovative platform that allows users to gain knowledge and information in an engaging and interactive way. Augmented reality captivates children and teenagers, making them better absorb information and more interested in learning, allowing students to see and visualize complex concepts and processes, which undoubtedly improves understanding of the material. Using augmented reality in mobile learning apps helps students remember information better because they can see and interact with the material in real time. Augmented reality provides students with the opportunity to solve problems and create new projects on their own, which develops their creativity. The use of augmented reality in learning will allow students to actively participate in the learning process by including them in interactive and game-based tasks, making learning more effective. The interaction of students with the material through augmented reality allows them to receive direct feedback, thus improving their understanding, skill development, and the development of creativity and logical thinking. Augmented reality technologies are part of the modern educational technology that will be used in the future.

One of the training tools in the app is a chatbot, which helps users ask questions and get quick and accurate answers to their queries. The chatbot is also capable of tutoring users on specific topics and tasks. For example, if you need to learn a certain topic from a computer science or digital literacy course, the chatbot can provide a selection of different lessons and study tips.

Assessment of knowledge in the mobile app is carried out through a system of testing and task checking. Assessment is done with the help of tests, which users can take at any convenient time and in any place. The tests allow to determine the level of knowledge and encourage users who achieved high results.

The augmented reality technology is one of the main advantages of this application. It allows users to interact with objects and images in the real world, improving the experience and quality of learning. Augmented reality also allows creating unique interactive tasks and games that motivate users to learn and develop their skills.

All in all, a mobile learning app with a chat-bot, augmented reality and a knowledge evaluation system is an excellent pedagogical tool. It allows users to learn new topics and tasks in an unconventional and fun way, which increases interest in learning the discipline.

Results and Discussion. As a result of the study, a mobile application and learning content for it were developed, a methodology for the use of mobile learning technology in the lessons of computer science and digital literacy in secondary general education schools in the Republic of

Kazakhstan was compiled. On the basis of these developments there was a pedagogical experiment with the use of a mobile application, which was aimed at testing the effectiveness of new forms and methods of teaching in the conditions of increased interest of students in mobile technology. The pedagogical experiment was conducted in the classes on the subjects "Informatics" and "Digital Literacy" in the high and junior classes in schools of Pavlodar. During the experiment, students were invited to use a mobile application as an additional tool for teaching the subjects "Informatics" and "Digital Literacy" in the classroom and outside the classroom.

The tool of the pedagogical experiment was the developed mobile application "App-MobileSchool", which contains interactive tasks and elements of augmented reality for secondary school students. The application is a mobile learning system and is designed to study the school subjects "Informatics" and "Digital Literacy". The mobile app is a mobile cloud service that requires no additional hardware or software. "AppMobileSchool" gives students the opportunity to take instruction anytime and anywhere. Students can study materials either independently or with the support of a teacher, using a chat-bot. After studying a particular topic, it is possible to reinforce the material through assignments and tests.

The mobile app provides the teacher with the ability to monitor student work, analyze learning outcomes, and engage in dialogue with students using the built-in chat bot. "AppMobileSchool" has the functionality to download learning materials, create tests, check assignments, view results and provide feedback.

A wide range of functions of the application is available to absolutely any student and teacher, as the interface and navigation of the mobile application is intuitive and does not require special training to work with it. Within the framework of this article much attention is paid to the formation of the learning content of the mobile application. This is one of the most important and time-consuming parts in the development of mobile applications for education. The training content was developed taking into account specificity of mobile gadgets and according to requirements of the State obligatory standard of basic secondary education [9, 10]; the instructional-methodical letter "About features of educational process in the organizations of secondary education of the Republic of Kazakhstan in 2022-2023 academic year". [11]; the model curriculum for the subject "Digital Literacy" for grades 1-4 of the primary education level from September 16, 2022, № 399 [12]; the model curriculum for the subject "Informatics" for grades 5-9 of the basic secondary education level from September 16, 2022, № 399 [13]. The study focuses on such part of the educational content as augmented reality. The latest technologies such as augmented reality and mobile technologies are progressing at a fast pace, while learning practices that integrate them are lagging behind. It can be concluded that new opportunities are emerging to develop techniques for applying technological innovations, especially with mobile technologies and augmented reality. Augmented reality remains an innovative practice in the context of learning, and the literature associated with it is often part of a descriptive paradigm. The study examined the integration of augmented reality to achieve its learning goals. Observations have shown that science education is often stereotyped and deserves the introduction of approaches that approximate experimental procedures. In this regard, the study focuses on the use of game-based learning situations designed to increase student interest, effective decision-making, automation of learning processes, and the introduction of new technologies. The involvement of students in the study of science is facilitated by a rational context leading to the use of research results, because learning is an adaptive process in which the student and the didactic environment interact, and finally, the game allows the simulation of real situations, forming consistent solutions. The integration of the latest technologies and teaching methodologies has made it possible to develop a mobile application that integrates different types of learning content.

The augmented reality module in the "AppMobileSchool" mobile learning application on the topic "Computer Composition" is an innovative educational tool for teachers that allows students to interact with virtual models of computer components in real time. When launching the augmented

reality module, it is necessary to activate the device camera, point it at the QR code of the computer component and a virtual model of the corresponding device will be displayed on the user's screen. Then the student can explore each component, get acquainted with its purpose, characteristics, features and peculiarities. Such interactivity allows students to immerse themselves more deeply into the process of studying the topic "Computer Composition" and memorize the material better. Module of the augmented reality training mobile application "AppMobileSchool" on the topic "Composition of the computer" is an effective tool that contributes to a more productive and interesting learning and allows users to delve into the process of studying computer components.

The main stage of the augmented reality module of the mobile application "AppMobileSchool" features the name of the application and 4 panels with buttons. The interface of the module is intuitive and easy to use. The "3D models" button allows to display a list of computer components. After clicking on the "3D models" button, a list of the 7 main computer components is opened. Each of the buttons, when clicked, displays a child window with the name, an illustration of the component and a button to close the "Close" panel. Figure 2 shows the interface of the mobile application "AppMobileSchool" demonstrating the augmented reality module.

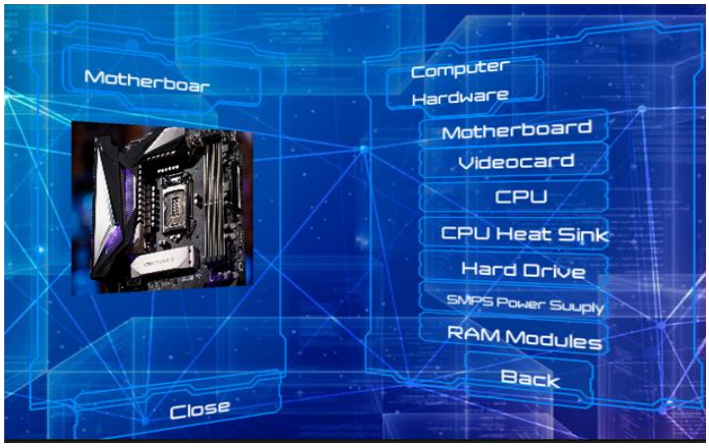

Figure 2 - Interface of the augmented reality module of the mobile application "AppMobileSchool"

The illustrative picture of the device has the property of a button. When clicked, the application takes the user to Vuforia Camera, where with the camera of a smartphone, tablet or other gadget that supports the Android platform, you can scan the QR code and design a 3D model of the corresponding computer device. Figure 3 shows the generated 3D model of the device.

Figure 3 - 3D model of the device, generated by the augmented reality module of the mobile application "AppMobileSchool"

The “Hardware” button allows you to proceed to the study of the theoretical material of the presented components. The window with the description of the selected device is shown in Figure 4.

Figure 4 - Scene of the information window of the augmented reality module of the mobile application “AppMobileSchool”

The following indicators were obtained during the experiment:

- Increased mastery of knowledge and skills in Computer Science and Digital Literacy by students after using the mobile app.
- Sustainability of acquired knowledge and skills after using the mobile app for some time.
- Increased students' motivation to learn information and communication technologies while using the mobile app.

The results of the experiment showed the effectiveness of using a mobile application in informatics and digital literacy instruction and its positive impact on students' knowledge, skills, and motivation levels. This can be the basis for further development of pedagogical practice with the use of new technologies in teaching.

Conclusions. As a result of this research, a mobile application with an augmented reality module was developed and tested. Also, learning content that meets the requirements formulated during the study was developed. The results of the study showed that the use of mobile applications in computer science classes has a number of advantages compared to traditional teaching methods, namely:

– mobile applications provide the opportunity to use visual materials, graphs, interactive tasks and tests, and most importantly the capabilities of augmented reality, which undoubtedly makes learning more interesting and effective. Students can easily interact with the material, work and learn at their own pace, regardless of location or time;

– the use of mobile apps with learning content in computer science and digital literacy classes increases the effectiveness of learning by increasing student motivation. Students are more willing to learn when learning is interesting and interactive;

– mobile applications with learning content in the form of augmented reality allow teachers to conduct a lesson at a high-tech level in accordance with modern trends in the development of educational technology;

– the use of chat-bot functions in mobile applications with learning content help to implement instant feedback;

– the use of educational mobile applications allows teachers to easily monitor the progress of students and individualize the learning process to the needs of each student.

As a result of the study, it was found that the use of educational mobile applications with an augmented reality module in computer science and digital literacy classes can bring many benefits for students and teachers. Such applications allow learning in an interactive format, which

significantly increases students' interest in the learning process. In addition, the use of mobile applications reduces the time to prepare materials for the lesson and allows calculating educational material for the specifics of each student. This is especially relevant in a distance learning environment. It is important to note that such apps can increase students' knowledge and skills in computer science and digital literacy. Therefore, the use of mobile apps with educational content in computer science and digital literacy lessons in schools has great potential to improve the quality of education. In general, the use of mobile applications in computer science classes in schools can increase the effectiveness of learning, increase students' motivation, and facilitate the monitoring of the level of achievement. The results of the study can be used in the educational activities of secondary general education schools, as the study has high practical and scientific relevance.

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