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Brief Report

Features of teaching natural disciplines in institutions of general secondary education in Ukraine

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Abstract: The article highlights a theoretical study based on educational experience and modern challenges of teaching natural sciences in the context of secondary education reform. Natural sciences play a major role in shaping students' worldviews and their understanding of the modern scientific picture of the world. Modern education in Ukraine is in a difficult period of transformation, which requires the development of innovative teaching methods and techniques. Traditional approaches to lesson construction, which still prevail in the training of future teachers of natural sciences, do not always provide a sufficient level of subject competence for both future teachers and students. Analyzing the literature and surveying teachers, we see the need to introduce a specialized information educational environment—an educational mobile application. The results of observations and analysis of the literature showed that the effectiveness of using a mobile application contributes to better and more effective achievement of educational goals and ensures better integration of information and communication technologies into the educational process. This use of modern technologies can create conditions for a harmonious combination of traditional teaching methods with modern digital educational resources.

Keywords: educational process; educational mobile application; natural sciences; training; digital educational technologies

1. Introduction

It is known that the main task of Ukrainian education at all levels is the formation of a comprehensively developed and conscious personality. The main contribution to this process is made during the educational process in schools. At the same time, it is necessary to emphasize the importance of studying sciences, in particular physics, in the process of mastering the content of which certain worldview positions and ideas about the modern model of the world are formed in students. Therefore, teachers of natural science subjects face the important task of building a teaching in such a way that it is not limited to the assimilation of theories, laws and regularities, but involves, first of all, the application of the acquired knowledge in practice and awareness of the possibilities of their application in the context of modern technologies. However, the current state of science education in our country is going through a difficult period. Therefore, it is necessary to look for ways to improve this situation with the help of promising teaching methods that can improve students' acquisition of knowledge.

2. Materials and methods

The purpose of the article is a theoretical study based on educational experience and modern challenges of the features of studying natural sciences in schools and to clarify their impact on the quality of the educational process.

Let's consider methodological aspects of the learning activities of science in institutions of general secondary education. The methodological foundations of organizing modern educational training, in particular its regulatory and technological support, are highlighted in the studies of Sadovyi and Tryfonova [1] and Chumak and Zahorodnia [2]. It is known that the system of training future teachers of natural sciences involves mainly traditional approaches to building the structure of a lesson about what happens in the work of Shut et al. [3]. As a result, a young specialist who is starting his professional activity uses a standard method of conducting a lesson when planning a lesson, which includes updating basic knowledge, explaining the educational material in accordance with the content of the textbook, conducting a demonstration experiment if necessary and consolidating the acquired knowledge. At the same time, the organizational and methodological features of implementing modern formats of learning, including distance learning in physics, require a revision of such approaches and adaptation to new educational conditions [4]. But at the same time, not every teacher thinks about the question: Will the knowledge be successfully mastered? Will this approach to building a lesson ensure the achievement of the main learning objectives? As the practice of teaching students shows, this method of conducting the lesson is not effective enough. In order to improve the quality of the lesson and students' assimilation of knowledge, it is necessary to identify and take into account the peculiarities of studying natural sciences, which will allow the introduction of elements of innovation into the educational process, as well as predict its prospects in the direction of achieving the specified learning outcomes.

3. Results and discussion

We specify these features:

The first feature of teaching science students in a modern educational institution is the use of gadgets. The works of Rozlutska et al. [5] and Trach [6] show how digital resources have become an important component of learning in schools and universities. Therefore, a large number of works by scientists are devoted to researching the possibilities of using digital technologies in the educational process. In particular, the use of cloud services, digital platforms, and online tools in Ukrainian educational institutions has proven their practical value for communication, access to materials, and organization of students' independent work [7]. However, it cannot be said that the existing approaches to the use of gadgets during the teaching of sciences make it possible to increase the number of high results in students' mastery of knowledge. Unfortunately, the process of their use is mostly frontal in nature (multimedia demonstrations, presentations, virtual experiments, and simulations). At the same time, the use of gadgets can be more useful if this process is individualized, because each student searches for the information that interests them precisely with

their help. Therefore, the presence of such skills in students should be directed in the right direction and individual work with gadgets should be organized accordingly. This aspect of digital educational technologies is not sufficiently researched. In addition, issues regarding the socio-psychological impact of gadgets on learning activities continue to be debated today. In particular, much is said about their negative impact on the development and formation of youth. Can it be stated unequivocally? The answer to this question is quite difficult to give without having experience in practical pedagogical activities. But our experience as a practicing teacher allows us to evaluate the use of portable devices during the teaching of natural science subjects, so to speak, from the inside.

Modern education is facing a serious challenge: More and more teachers and parents are expressing concern about the impact of gadgets on teaching. They note that students who constantly use mobile devices show a decrease in concentration, an irresponsible attitude to learning and a marked decrease in interest in reading printed books. Indeed, for today's generation of students, virtual entertainment, such as computer games and social networks, often turns out to be more attractive than traditional learning.

This trend has led to an increase in academic failure and a general decline in motivation to study. In response to this, the question of banning the use of gadgets during lessons arose in many educational institutions. However, is such a ban an effective solution? Perhaps a more productive approach would be to transform this challenge into an opportunity by turning students' dependence on digital devices into a tool for effective learning.

It is in this context that the concept of a specially organized informational educational environment—an educational app—becomes particularly relevant. These innovative solutions not only ensure the effectiveness of achieving educational goals, but also ensure the organization of integration of traditional elements of the educational process, the challenges of globalization and modern digital educational technologies. The effectiveness of electronic educational resources in blended and digitally enriched learning environments has also been confirmed in recent pedagogical studies [8].

The mobile application offers a wide range of opportunities for modernizing the learning activities. E-learning technologies make it possible to significantly enrich educational material by presenting it in various formats: Video materials, interactive notes, electronic textbooks, and hyperlinks to additional educational resources. Such a variety of formats corresponds to different learning styles and the success of students in the learning activities.

A particularly important aspect is the availability of educational materials. With the structured placement of the mobile application according to the curriculum, students can access the educational resources at any time and from any place with an Internet connection. This creates opportunities for continuous learning that go beyond the traditional classroom. Such approaches are especially important in the context of Ukrainian education during wartime, when pedagogical science is focused on preserving the continuity and quality of the educational process under crisis conditions [9]. Also, this approach to education makes it possible to continue the

education of students in the conditions of war, when teachers are forced to conduct lessons in bomb shelters during air raids, which is especially important in the context of educational losses caused by martial law [10].

Taking into account students' natural tendency to use smartphones, teachers can direct this habit in a constructive direction by encouraging the search for scientific information and the completion of educational tasks with the help of mobile devices.

Under the conditions of proper organization of work in the educational app, educational institutions get access to the design of selected educational resources: Educational videos, scientific articles, information about modern scientific achievements, online tests and virtual laboratories. This creates a comprehensive educational environment that meets modern educational standards and the needs of students. These changes are consistent with the conceptual foundations of upper secondary education in the New Ukrainian School, which emphasize competence-based learning, flexibility, and the integration of modern educational tools [11].

This approach demonstrates that gadgets can become a powerful tool for ensuring the learning activities both in wartime and under peaceful skies. Instead of banning the use of mobile devices in lessons, their integration into the educational process through an educational mobile application can significantly increase the motivation of students to study the subject and activate their cognitive activity. This creates prerequisites for the formation of a new educational paradigm, where digital technologies become an integral part of effective learning activities.

The second feature of teaching science in schools is related to the unsatisfactory state of technical support of subject classrooms, due to insufficient funding of educational institutions in connection with Ukraine being at war. Current national educational priorities and the prospects for the development of the educational sphere in Ukraine also indicate the need to modernize the material, technological, and methodological support of the educational process [12]. It is no secret that in most cases they are in a neglected state, and a significant percentage of the equipment is significantly outdated. A situation has arisen when, on the one hand, there are not enough devices to ensure the individual work of students, and on the other hand, those devices that are available, due to their antiquity, do not always give the desired result. Under such conditions, it is impossible to perform a demonstration experiment and frontal laboratory and practical work, which negatively affects the formation of experimental skills in students, which are the most important component of their subject competence in science. Thus, students' study of science is reduced to the study of theoretical material. At the same time, it is necessary to remember the significant threat caused by the current state of education in Ukraine, which in the near future will have a negative impact on the scientific and technical development of the country and its formation in the world rankings of developed countries. How to reduce the negative impact of the situation on the technical equipment of physics classrooms? And here again a mobile application comes to the rescue, for example, "Virtual Physics Classroom" and other digital technologies, as discussed in the works of Banak and Yefymenko [13] and Shamshin [14]. In the conditions of its functioning, virtual experiments and simulations can be used for the successful implementation of the

experimental component of training.

The use of virtual experiments and simulations is provided by placement and structuring in an educational app, in which mode students have the opportunity to repeatedly conduct experiments and experiments. At the same time, it is important that working on a mobile application does not cause students to fear damage to their devices or their failure. The best results of such work will be ensured if, after successful completion of the virtual experiment, students try to implement it in real conditions. Of course, this is possible in the presence of appropriate devices, which again brings us back to the need to improve the material and technical support of subject offices. Immersive virtual reality tools have been shown to be effective pedagogical instruments in education, enhancing student engagement and improving learning outcomes [15]. Also, virtual models provide an opportunity to introduce students to various objects, as well as experiments that cannot be reproduced in real conditions, in particular:

- The structure of the Solar System: Using virtual models to demonstrate the orbits of the planets, their interactions, and comparing the sizes of celestial bodies;
- Studying the internal structure of the Earth in physics and natural science classes: Three-dimensional models allow you to visualize the layers of the Earth (crust, mantle, core) and processes such as the movement of tectonic plates or volcanic activity;
- Chemical reactions during practical classes in chemistry: Simulation of the interaction of dangerous or rare chemical substances, for example, reactions of metals with acids or explosions;
- Human anatomy in biology and nature lessons: Virtual simulations make it possible to study the organs and systems of the body, in particular the blood circulation or the nervous system, without real anatomical objects;
- Ecological systems in the lessons of geography, biology, physics and others: Simulation of the impact of various factors on ecosystems, for example, water pollution or deforestation;
- Astronomical phenomena in physics and astronomy classes: Observation of eclipses, comets or supernova explosions, which cannot be seen in real time;
- Climate change processes in geography and ecology lessons: Models of global warming or melting glaciers allow you to visualize the long-term consequences of human activity.

It is obvious that without an understanding of the above educational material, it is impossible to thoroughly master the knowledge of natural sciences, as well as the formation of a scientific picture of the world in the minds of students, and the formation of their worldview, which indicates the relevance of developing methodological approaches to the use of mobile applications.

So, this once again confirms the need to use virtual models and experiments to minimize losses from the ban on the use of physical devices in the educational process and to fully implement the experimental component of education.

The specifics of learning natural science subjects that we have identified require the teacher, accordingly, to have special approaches to the organization and

implementation of the teaching. Working with modern students, whose intellectual characteristics and educational capabilities are significantly different from those of their predecessors, we drew attention to the fact that they need to be provoked into new types of activities. In the context of this, we suggested that students master such an activity as drawing up project notes, a detailed description of which will be covered in other studies. As practice shows, such work is quite interesting for students. We use the project outline for independent work. This is usually a brief description of the relevant section of the natural science subjects. Thus, drawing up a project summary from the physics section "Light phenomena" (grades 9 and 11) has a significant methodological effectiveness, which is explained by the humanistic orientation of the educational material of this section. When performing this type of work, students are required to analyze the educational material and additional information. They must concisely and succinctly systematize the material on the topic, and the level of performance of this task will indicate how thoroughly they have understood and mastered it. The coefficient of usefulness of this type of activity increases significantly when working with an educational app, where students use various sources of information, domestic and foreign Internet resources to search for information, which accustoms students to orientation in the flow of information, and ensures the formation of the informational component of subject competence. Searching, selecting and analyzing educational information, students get acquainted with different points of view, available ways of solving scientific problems and perspectives of scientific research. In the process of this type of activity, students also work on presenting information and presenting their work, thereby demonstrating their communication skills. After processing and presenting information, students defend their work individually or in small groups, presenting their work to their peers and teachers. Thus, the teacher sees the result of the work of each educational participant process and in the process of the conversation can identify possible complications in learning the educational material and outline ways to overcome them, which ensures the implementation of the diagnostic function of the educational process. Therefore, during the defense of the project summary, the analysis and generalization of the learned content are carried out, but the student himself performs this task. It is clear that preparing students for this type of educational activity requires the teacher to spend appropriate time, but the results of such work also have a significant impact on the formation of subject competence in physics. We also offer students the opportunity to exchange their work through the educational mobile application and messengers so that each student can compare the learning results obtained by them with the results of other students, and, therefore, carry out self-analysis and self-evaluation. We have determined the advantages of students' educational activities when developing project notes on physics in the operating mode of the educational app:

- The possibility of searching for information in domestic and foreign sources;
- Submission of completed work in the form of a presentation;
- The possibility of communication in the process of work with other participants of the teaching;

- Familiarization with available approaches to solving educational problems and further prospects of scientific research in this direction by using information from various services;
- Increasing the effectiveness of diagnosing students' knowledge of the topic, timely identification of learning difficulties and determination of ways to eliminate them.

An important feature of teaching natural sciences in schools is also the need to acquaint students with modern achievements in physics. It is clear that this task has always been important. But today it has acquired a special significance, since there is not a single sphere of human activity left in which the achievements of physics are not used. All modern technologies are based on scientific laws and regularities. In order to prove the importance of science, the teacher should show as much as possible the spheres of human application and their influence on the formation of scientific knowledge about the world and its structure, which will make it possible to form in students a materialistic vision of the structure of the world and methods of its cognition. It is well known that each subsequent stage of human development takes place in a shorter period of time. For example, the discovery of electrical phenomena preceded the development of technologies by almost a century (electric motors, electrical appliances); the discovery of nuclear laws made it possible for humanity to obtain a huge amount of energy compared to contemporary sources in less than half a century (nuclear power plants); the construction of the scanning electron microscope and the discovery of nanotechnology enabled the development of even newer technologies in all spheres of human activity in just a few dozen years (the creation of a microcomputer, nanomaterials, etc.). Currently, the new technical revolution is taking place in two different directions. The first is the creation and implementation of artificial intelligence and neural networks based on robots. The second direction is the improvement of technologies for space research and projects, the mission of people to Mars. The use of new technologies and their modernization or replacement with even more promising ones is based on knowledge of science, and a special place is occupied by knowledge of physics, its theoretical and experimental methods. Therefore, a modern student in the context of the development of modern technologies must have a clear vision of the picture of the world structure and an understanding of the world. After all, only such a conscious person can make an important contribution to the development of domestic science and even bring benefit on the world stage. The use of a mobile application provides significant help in solving the task of raising the level of awareness of students in the modern achievements of physics as a science. In this application, the teacher posts information related to the latest research and discoveries in science, and students have the opportunity to find this information and process it. In this way, the teacher provides students with access to the latest information.

Based on the above, it can be concluded that the development of society in the process of its globalization becomes possible thanks to the quality process of learning natural science subjects in institutions of general secondary education, which is also changing significantly in today's conditions. The features that we have highlighted have

a significant impact on the organization and implementation of the educational process and must be taken into account by subject teachers. The main thing is to respond more mobile to modern trends and ensure innovation in the implementation of the goals of teaching natural sciences.

4. Discussion

The conducted analysis shows that teaching natural sciences in modern institutions of general secondary education is taking place under conditions of significant educational and technological change. Digital tools create new opportunities for improving the quality of learning, increasing students' independence and combining traditional teaching methods with innovative educational approaches.

At the same time, the effectiveness of such tools depends on their pedagogically justified use. Gadgets and digital resources should serve not only as demonstration tools, but also as means of organizing active individual work of students. In this regard, the educational mobile application "Virtual physics center" can be considered an effective didactic tool that supports access to educational materials, promotes cognitive activity and helps orient students toward modern scientific knowledge.

Thus, improving the teaching of natural sciences should be based on a balanced combination of traditional didactic principles and modern digital technologies. Further research should focus on expanding the methodological support for the use of educational mobile applications and studying their impact on students' learning outcomes.

5. Conclusion

The article presents a theoretical study of the features of teaching natural sciences in institutions of general secondary education in Ukraine under modern educational challenges. It has been established that the effectiveness of the educational process depends on the integration of digital technologies, the use of electronic educational resources and the creation of an appropriate educational environment.

It has been determined that digital tools are most effective when they support individual educational activity, increase students' motivation and contribute to the practical application of knowledge. In this context, the educational mobile application "Virtual physics center" is an effective means of supporting the educational process in natural science subjects.

The highlighted features should be taken into account by teachers when designing lessons and selecting teaching tools. Further research may be related to the development of methodological recommendations and the study of the influence of mobile applications on the quality of students' knowledge.

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