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Modern educational technologies in physics teaching

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The use of modern educational technologies in the education of natural sciences is one of the current methodological problems. The article presents modern educational technologies which are applicable in the physics teaching in Bulgaria. Innovative technologies based on the use of information and communication technologies in education are considered. Methodological possibilities and perspectives for their use in the educational process in physics are specified. Both advantages and disadvantages of the integration of modern educational technologies in the physics teaching are mentioned. The conducted pedagogical experiment, by using computer educational technologies in the secondary school physics teaching, is at the base of the article. The modern educational technologies reveal new opportunities for organizing physics teaching, for exchanging information in it and for increasing its effectiveness.

Keywords: Modern Educational Technologies, Information and Communication Technologies, Physics Teaching.

INTRODUCTION

The problem of increasing the efficiency of the educational process has existed and will always exist, but the forms, methods and tools will be different depending on the development of science, technics and technologies, and the theory and practice of the education. About 400 years ago Jan Komenský wrote that "should be sought and found a way by which the teachers to teach less and in the same time the students to learn more" [1].

The use of modern educational technologies in the education of natural sciences is one of the current methodological problems. In its solution an objective and reasoned answer to the questions is sought: When, where and how can be used modern educational technologies in the educational process?

The activities of state educational institutions in Bulgaria are aimed at integrating the information and communication technologies in the teaching of school subjects. Examples for this are the developed and realized National strategy for introduction of information and communication technologies in Bulgarian schools (2005–2007), National program "Information and communication technologies in school" (2008–2015) and National program "Information and communication technologies in the system of the pre-school and school education" (2016–2019). At the current moment institutions are working on a Strategy for effective application of information and communication technologies in education and science of Republic of Bulgaria (2014–2020) [2] and a National Program "Providing a modern educational environment" (2018–2019) [3].

The analysis and summary of psychological-pedagogical, didactic and methodological literature shows that educational process using modern educational technologies is being conducted on natural sciences in all degrees of education.

Physics as a learning subject provides opportunities for realization and for verification of the effectiveness of different methodological ideas. This is due to the great variety of forms, methods and tools that can be included in the physics teaching.

The modernization of education, based on information and communication technologies, implies a model of educational activity that is aimed at both students and teachers [4].

At the current moment many teachers in Bulgaria are using the opportunities of modern educational technologies for physics teaching at the secondary school.

Modern educational technologies can be used in the different physics lessons (for new knowledge, for solving physics problems, for summary, for laboratory exercises, for check and assessment of the students' learning achievements) and in the students' extracurricular activity for achieving the purposes of the physics teaching.

The article presents modern educational technologies, which are applicable in the physics teaching in Bulgaria. Innovative technologies based on the use of information and communication technologies in education are considered. Methodological possibilities and perspectives for their use in the educational process in physics are specified. Both advantages and disadvantages of the integration of modern educational technologies in the physics teaching are mentioned.

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The conducted pedagogical experiment, by using computer educational technologies in the secondary school physics teaching, is at the base of the article [5].

METHODOLOGICAL POSSIBILITIES AND PERSPECTIVES FOR USING MODERN EDUCATIONAL TECHNOLOGIES IN PHYSICS TEACHING

In the current article the term *modern educational technologies* is used for educational technologies using information and communication technologies which help, diversify, rationalize and improve the presentation, perception, acquiring and application of the learning content, the check and assessment of the students' learning achievements, their individual learning activity and their extracurricular activity in the physics teaching.

Globally, significant experience has been gained from the use of modern educational technologies in the education of natural sciences, and in particular – in physics teaching. The role and the place of the information and communication technologies in physics teaching and their possibilities as modern educational technologies are presented in detail by different Bulgarian authors [6-16] and many others.

The modern information and communication technologies give opportunities to use in the physics teaching:

- multimedia programs and computer simulations;
- video applications;
- animations;
- electronic visual materials with reference character – hypertext, data tables, graphics, drawings, circuits, formulas, images and more;
- computer presentations;
- computer interactive programs for solving physics problems;
- computer programs for conducting computer (virtual) interactive laboratory exercises in physics;
- computer applications for processing and presentation of the results that are obtained in conducting real and computer interactive physical experiments (demonstration and laboratory);
- computer interactive tests for check and assessment of the students' learning achievements;
- electronic textbooks and aids;
- interactive boards;
- virtual classrooms and laboratories;
- e-learning;
- m-learning;
- cloud technologies;
- social networks;
- educational websites;
- online lessons and electronic consultations;
- and others.

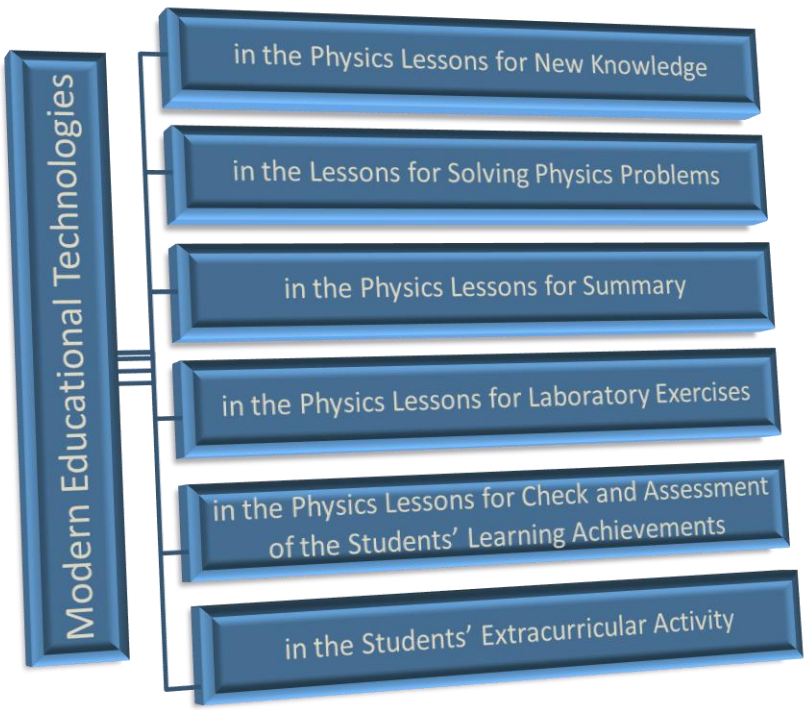

Fig. 1. Modern educational technologies in physics teaching.

In physics teaching modern educational technologies can be used in the different physics lessons and in the students' extracurricular activity (Fig. 1).

For realization of the modern educational technologies in the educational process in physics computer technics and didactic software products are needed.

In the physics lessons for new knowledge modern educational technologies can be used for:

- presentation and visualization of the learning content – through computer demonstration of physical experiments (quantitative and qualitative, which are realized through multimedia programs, video applications, animations etc.), by using electronic visual materials with reference character, through computer presentations and more;
- creating problem situations and solving learning problems;
- introducing new physical terms, physical quantities and measurement units;
- research and establishment of functional relationships between physical quantities;
- disclosure of causal relations;
- formulating regularities and conclusions;
- illustrating the manifestations and applications of the physical knowledge in the nature and the human activity;
- development of the students' creative possibilities and cognitive abilities;
- forming skills and habits for self-contained acquisition of knowledge;
- building a physical style of thinking.

In the physics lessons for solving physics problems modern educational technologies can be used to solve quantitative, graphical, qualitative, experimental, test and other physics problems. The solving of physics problems can be accomplished through different didactic software products: multimedia programs and computer interactive programs for solving physics problems, information from the Internet, etc.

In the physics lessons for summary modern educational technologies can be used with different purposes in their separate, interconnected parts. Depending on the methods of teaching and the form of conducting lessons for summary, a variety of didactic software products can be used: multimedia programs, video applications, animations, electronic visual materials with reference character, computer interactive programs for solving physics problems, information from the Internet etc..

In the physics lessons for laboratory exercises modern educational technologies can be used for:

- conducting computer (virtual) interactive laboratory exercises – physical experiments conducted entirely on a computer and in dialogue with it, by using multimedia programs and more;
- conducting laboratory exercises, assisted by a computer [10];
- computer processing and presentation of the results that are obtained in conducting real and computer interactive physical experiments (for example, by MS Excel, Origin, Maple etc.);
- combining the listed options (for example, conducting a qualitative real experiment and then a virtual experiment with variation of the parameters, etc.).

By using modern educational technologies, the learning experiment in physics (demonstration and laboratory) rises to a qualitatively new level, because it saves time both in conducting the experiments and in processing the obtained experimental results that can be visualized.

In the physics lessons for check and assessment of the students' learning achievements the use of modern educational technologies is associated with the development and implementation of computer tests. The computer tests allow individual check and assessment of the students' learning achievements, automation of the activities related with it (registration of the answers, their processing and making an assessment), minimize the subjective factor and increase the objectivity and effectiveness of control.

Modern educational technologies can also be used in the students' extracurricular activity, because it is a form of learning that gives opportunities to use a variety of methods and tools. The students can use all listed modern information and communication technologies and especially the possibilities of the Internet as a computer educational technology [14] in their extracurricular activity in physics.

The modern educational technologies expand the opportunities for education for students who study on individual learning curricula, for students with special educational needs, for talented or advanced students and others. They also provide opportunities to individualize physics teaching and each student to study at his own pace, at any time and from any place in accordance with his individual interests, abilities, needs and peculiarities.

Some of the main advantages of the modern educational technologies described by pedagogues, psychologists and methodologists are the following:

- the information base of the educational process is significantly expanded;

- the visualization is increased by dynamic presentation of the studied objects, phenomena and processes;
- overcoming the need to remember huge quantities of facts, because the accent is placed on the use of the knowledge to solve specific problems, i.e. on the development of thinking;
- they provide the opportunities for individualisation and differentiation of learning by volume, content, pace, levels of learning, etc.;
- they bring together media that influence different senses in the students;
- they allow a dialogue with the users, that gives opportunities for choice, interruption, repetition;
- the multimedia technologies provide opportunities for complete learning through action;
- they provide opportunities to use various forms and methods to perform systematic, complex and objective check and assessment of the students' learning achievements;
- they can be used in a home-based learning system and they enrich the opportunities for self-education of the personality [5].

Together with the listed advantages, the application of the modern educational technologies in the teaching is accompanied by some problems – the insufficient educational software in Bulgarian; the direct contact of the students with the teacher is sometimes reduced, some standardization of students' thinking is obtained; some authors share their concerns of a negative impact on the students' health. These disadvantages, however, can be minimized by a correct ratio between the traditional lessons and those using modern educational technologies.

Naturally, the question arises: "When to use modern educational technologies in physics teaching?". Above all, in the cases when they have significant advantages compared to the traditional ones. The use of modern educational technologies is expedient when it leads to positive changes in the content, organization and conduction of the educational process in physics, when it facilitates the acquiring of new knowledge and the formation of skills and relations, when it helps to develop the creative possibilities, the cognitive abilities and the thinking of the students and when it relieves the teacher's work.

In the conducted pedagogical research [5] we are guided by the principle that information and communication technologies cannot and will not replace the good physics teacher. The reason is that nothing can replace the human contact and the real communication, the live speech and the careful attitude. In the traditional education the teacher is a major source of knowledge. In the teaching by using information and communication technology he is one of the sources of information that plans the overall activity and the conducting of the educational process. The teachers are the ones who create conditions for students to think and to express their thoughts clearly and accurately. In the physics teaching by using information and communication technologies the role of the teacher is to make a connection with reality, with the real physical objects, phenomena and processes. The modern educational technologies do not replace the teacher in the physics teaching, but they help, rationalize and improve the teacher's creative learning activity with students [4].

CONCLUSIONS

In the article are presented:

- modern educational technologies that can be used in the secondary school physics teaching in Bulgaria;
- methodological possibilities and perspectives for use of modern educational technologies in the different physics lessons and in the students' extracurricular activity for achieving the purposes of physics teaching.

Using the achievements of the modern science, computer technics and technologies is one possible way to improve the physics teaching.

The use of modern educational technologies in the physics teaching diversifies and enriches the methods and tools of learning. The acquiring of knowledge and the formation of skills and relations is so more efficient as much as organized students' learning activities in physics are in a great variety. This activity leads to creation of a cognitive interest in the study of physics and its applications, to achievement of new cognitive results or to improvement of already acquired competences.

The conducted pedagogical experiment in which the developed author's methodological concept for complex and purposeful using of computer educational technologies in the secondary school physics teaching was applied, the statistical processing of the experimental results and the qualitative analysis that are made, showed that the use of the modern educational technologies increases the efficiency of physics teaching.

The modern educational technologies reveal new opportunities for organizing physics teaching, for exchanging information in it and for increasing its effectiveness.

REFERENCES

1. J. Komenský, Great Didactic, University Press "St. Kliment Ohridski", Sofia, 2008.
2. Strategy for Effective Implementation of Information and Communication Technologies in the Education and Science of Republic of Bulgaria (2014–2020), Ministry of Education and Science, Sofia, 2014.
3. National program "Providing a Modern Educational Environment" (2018–2019), Ministry of Education and Science, Sofia, 2018.
4. G. Kalpachka, Teachers in Learning with Using of Information and Communication Technologies, *Chemistry*, **25(6)**, 940 (2016).
5. G. Kalpachka, Methodological Possibilities to Use Computer Educational Technologies in Secondary School Physics Teaching, PhD Thesis, South-West University "Neofit Rilski", Blagoevgrad, 2006.
6. K. Tutulkov, *Chemistry*, **21(1)**, 23 (2012).
7. G. Kalpachka, *Fizika*, **35(6)**, 299 (2010).
8. I. Kotseva, M. Gaydarova, K. Angelov, F. Hoxha, *AIP Conference Proceedings*, **2075**, 180020-1 (2019).
9. G. Kalpachka, *Chemistry*, **25(6)**, 856 (2017).
10. K. Tutulkov, About the Current State of the Computer-aided Experiment, in: Physics and Information and Communication Technologies (Proc. XXXIII National Conference on Physics Education), Varna, 2005, p. 101.
11. G. Kalpachka, Computer-aided Educational Technologies in the Laboratory Exercises in Physics, *Chemistry*, **21(5)**, 700 (2012).
12. S. Shtrakov, G. Kalpachka, A. Stoilov, *Elektrotechnica i Elektronica*, **40(3-4)**, 68 (2005).
13. M. Gaydarova, I. Kotseva, Smartphone Supporting the Education (Summer lectures, 11–15 June 2016), Faculty of Physics, Sofia University "St. Kliment Ohridski", 2016, available at http://www.prirodninauki.bg/wp-content/uploads/2016/07/Lecture12-Mobilni-technologii-obuchenieto-Gaidarova.pdf (2019).
14. G. Kalpachka, *AIP Conference Proceedings*, **2075**, 180015-1 (2019).
15. Z. Raykova, G. Vuldzhev, N. Moneva, *AIP Conference Proceedings*, **2075**, 180017-1 (2019).
16. E. Andreev, M. Nikolova, V. Radeva, G. Bochev, *AIP Conference Proceedings*, **2048**, 020028 (2018).