

## Multimedia technologies in physics teaching

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The use of multimedia technologies in the secondary school physics teaching is a new, relevant and significant trend in Bulgarian modern education. In the article are presented main methodological possibilities for using multimedia technologies in the educational process in physics in the secondary school. The article gives specific, objective and reasoned answers to the methodological questions: When, where and how can be used multimedia technologies in the physics teaching. The multimedia technologies are innovative educational resources. The use of multimedia technologies complements, expands and diversifies the traditional methods and tools of physics teaching. Their application is related and aimed to increasing the effectiveness of the secondary school physics teaching.

**Keywords:** Multimedia Technologies, Physics Teaching, Secondary School.

### INTRODUCTION

The continuous search for new, non-traditional methods and tools of physics teaching makes the topic of this article current and debatable. On the other hand, the relevance of the article is related to contemporary trends and modernization of the school education in Bulgaria.

Different, but close in meaning definitions of the concept of multimedia technologies are used in the specialised literature. According to the definition formulated in 1988 by the European Commission, which deals with the problems of implementation and use of new technologies, the multimedia technologies have a purpose of creating a product that contains a collection of images, texts and data that are accompanied by sound, video, animation and other visual effects (simulations), which include an interactive interface and other control mechanisms [1]. Over the years, the definition of multimedia technology has evolved, but its meaning remains the same.

The most characteristic feature of multimedia technologies is their interactivity.

The multimedia technologies have applications in various fields of the human activity. They are increasingly used in the education of students in learning the different school subjects.

The use of multimedia technologies in the secondary school physics teaching is a new, relevant and significant trend in Bulgarian modern education.

In the second part of the article are presented the main methodological possibilities for using multimedia technologies in the educational process in physics in the secondary school. They are concretized by the authors of the article on the basis

of the theoretical research in the field of multimedia technologies, the types of multimedia technologies and others. Specific, objective and reasoned answers to the methodological questions When, where and how can be used multimedia technologies in the physics teaching are given in this part of the article.

The main formulated conclusions on the topic are presented in the last part of the article.

### MULTIMEDIA TECHNOLOGIES IN THE SECONDARY SCHOOL PHYSICS TEACHING

In the secondary school physics teaching, multimedia 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), in the students' extracurricular activity, in conducting e-learning (synchronous and asynchronous), etc.

Various multimedia technologies can be used successfully in the secondary school physics teaching, such as multimedia programs, virtual physics laboratories, electronic multimedia textbooks and aids, multimedia computer presentations and more.

#### *Multimedia programs*

Multimedia programs are didactic software products that represent computer models of real physics objects, phenomena or processes, reproducing the real conditions of conducting physics experiments [2].

They provide a qualitatively new type of visualization, because they allow to recreate physics phenomena or processes through computer animation, sound, text, graphics, diagrams,

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numerical values and others and they give opportunities for active intervention in their course by changing the parameters and conditions of the experiments and obtaining concrete results [2].

Multimedia programs can be used in the different physics lessons, in the students' extracurricular activity, in conducting e-learning, etc.

They also can be used when updating, presenting and consolidating the learning content in physics, in checking and assessing of the students' learning achievements, in their independent learning work, in considering the applications of physics knowledge and more.

In the educational process in physics, multimedia programs can be used to:

- illustrate the learning content;
- conduct computer (virtual) interactive physical experiments (demonstration and laboratory, quantitative and qualitative);
- create problem situations and solve learning problems;
- introduce new physical concepts, quantities and units of measurements;
- study and discover causal relationships;
- study and establish functional relationships between physical quantities;
- formulate physical laws;
- solve different types of physical problems (quantitative, graphical, qualitative, experimental, etc.), etc.

Multimedia programs can be used in physics education to:

- create positive motivation in students to learn;
- increase their interest in studying physics;
- form skills and habits for self-acquisition of knowledge;
- diversify traditional teaching aids and methods;

The use of multimedia programs in physics teaching is methodologically appropriate, as everything can be seen at a glance and stimulates the implementation of mental operations - analysis, synthesis, comparison, abstraction, summary and more.

Multimedia physics teaching programs allow conduction of physical experiments that cannot be directly observed or are difficult to perform under natural conditions (experiments at the atomic-molecular level or at the macro level), which are dangerous to the health of students and teachers, but create cognitive interest, which requires a long time or specific and expensive equipment, etc. Through the use of multimedia programs various applications of

physical knowledge in nature, life and human activity can be illustrated.

Multimedia programs are the most commonly used didactic software products in physics teaching in high school, as they provide innovative opportunities to illustrate the studied physical objects, phenomena or processes and to present the learning content in a new, more interesting and attractive way.

Multimedia programs are the basis of virtual physics laboratories, which are also multimedia technologies and are increasingly used in high school physics teaching.

At the moment, a great variety of multimedia physics programs that can be used to study the curriculum in high school, are developed.

When using multimedia programs in physics teaching, students see in practice some of the modern methods and tools (computer modelling and simulation), that are used in science physics to research and study physical objects, phenomena and processes.

#### *Multimedia computer presentations*

Multimedia physics teaching programs allow conduction of physical experiments that cannot be directly observed or are difficult to perform under natural conditions (experiments at the atomic-molecular level or at the macro level), which are dangerous to the health of students and teachers, but create cognitive interest, which requires a long time or specific and expensive equipment, etc.

Multimedia computer presentations are modern learning tools that provide innovative opportunities for teaching and learning physics.

They are usually created by using the program MS PowerPoint and they are a series of slides that can include various objects: text, dynamic and static images, sound, etc., as well as animation effects on the objects of a slide or when switching from one slide to another.

They are also a convenient methodological tool for structured presentation of a certain learning content or a certain information in an appropriate and understandable way for students. They can be used in all types of physics lessons, e-learning and more.

Multimedia computer presentations, which are used in physics education in high school, are most often created by teachers in accordance with their views on the structure and content of each lesson. Each presentation usually includes: lesson topic, lesson plan, links to the used didactic software products, control questions and tasks, topics for project work and preparation of messages, reports,

etc. from students in their extracurricular activities, addresses of sites on the Internet with educational resources in physics, etc.

The use of multimedia computer presentations in physics teaching improves the visibility and accessibility of the studied curriculum, attracts the attention of students, creates cognitive interest and positive motivation in them to acquire knowledge in physics.

In multimedia computer presentations, the curriculum in physics can be structured in different ways. They can include a variety of didactic software products such as multimedia programs, video applications, computer animations, electronic visual materials of reference nature, computer interactive programs for solving physics problems and much more. Computer presentations provide opportunities for dosing the amount of information, for its change and repetition according to the interests and abilities of students, available study time and more.

Multimedia computer presentations as innovative learning tools can be used to support one of the most effective methods of teaching physics - problem-based learning. Through the didactic software products included in them, problem situations can be created and learning problems in physics can be solved.

When presenting the curriculum in physics through multimedia computer presentations, the lessons become more various and interesting, the learning process is intensified, the teaching time is reduced, which in turn allows in the lessons to consider more examples and applications, to solve a large number of tasks, to clarify in more detail various theoretical issues and problems, to make discussions, etc.

High school students have sufficient knowledge and skills in information technologies, which can be used to present through multimedia computer presentations with MS PowerPoint prepared by them messages, reports, etc. on certain topics for participation in discussions, seminars, student conferences, various educational programs, competitions, contests, project work, etc.

In the Bulgarian pedagogical literature it is recommended that the duration of a computer presentation should not exceed 25–35 minutes per school hour for students from VII to XI grade.

The use of multimedia computer presentations complements and expands the means and methods of teaching physics, as they allow the learning content to be presented and illustrated in an innovative and different way.

### *Electronic multimedia textbooks and aids*

Electronic multimedia textbooks and aids are modern computer tools for teaching the different subjects studied at school. They are considered in the methodological literature as a new generation of textbooks and aids after the printed ones [3].

Electronic multimedia (interactive) textbooks and aids are structured on the basis of printed, but also include additional educational resources such as multimedia programs, video applications, computer animations, audio recordings, computer interactive tasks and tests, hypertext, dictionaries and many other didactic software products. In addition, a variety of educational and methodological materials for teachers are attached to them.

Electronic multimedia textbooks and aids can be used in physics lessons in high school, in extracurricular activities of students, for e-learning, self-study and more.

The learning content in them is very well illustrated and is accessible for study by students. The way of its presentation provides opportunities for flexibility and variability, for creating problem situations and solving learning problems, for connecting theory with practice, etc.

Electronic multimedia textbooks and aids allow individualization and differentiation of physics education. They are suitable for learning work with students with special educational needs, with students who study according to individual curricula, with outstanding, talented or advanced students, etc.

In electronic multimedia textbooks and aids, the teaching content of physics can be on different levels of difficulty and can be studied in different ways determined by teachers or students.

Electronic multimedia textbooks and aids can be used through various devices (computers, laptops, tablets, smartphones, etc.) both online and offline. Working with them is easy for students and can be done at any time and from any place.

The learning content in the electronic multimedia textbooks and aids can be much easier edited, added and updated, compared to the printed ones.

On the pages of electronic multimedia textbooks and aids you can write, draw, etc., which is not recommended to do when using printed textbooks and aids. The additions and changes made to the electronic versions can be saved or deleted according to user wishes.

In physics teaching, electronic multimedia textbooks and aids can be used to improve visibility, to present and study in dynamics physical objects, phenomena or processes from the micro and macro world, to conduct experiments that require specific

or expensive equipment, to consider various applications of physical knowledge, etc.

The interactive electronic textbooks of the Prosveta publishing group [4] are digital versions of the printed textbooks and are made in the form of FlipBook - leafing books. They are enriched with multimedia materials - tasks, exercises, illustrations, tests, music, videos and more. They fully cover the curriculum of printed textbooks approved by the Ministry of Education and Science. E-textbooks are interactive, entertaining, easy and convenient to work with. Additional interactive resources support the exercises and can be in the form of games, audio, video, 3D visualizations, 360° panoramic images, files, presentations and more [4].

The electronic textbooks of the publishing groups Anubis and Bulvest 2000 [5, 6] are digitized versions of the printed textbooks, enriched with various multimedia educational resources such as: interactive tasks, audio recordings, videos, images, animations, 3D visualizations, virtual simulations, tests, dictionaries, links to specific web pages and online resources, links to .pdf, .doc, .ppt, .pg, .png documents and those created by the platform itself. They allow flexible, interactive and adaptive learning without time, place and access restrictions [5, 6].

Electronic multimedia physics textbooks and aids provide new learning opportunities for students and are increasingly and successfully used in the learning process in high school.

In addition to the presented examples of multimedia technologies applicable in high school physics education, others exist and are used. However, they are not presented due to the limited volume of the article.

The integration of multimedia technologies in the physics teaching in secondary school requires both technical equipment and professional computer and methodological skills of teachers for their use. In traditional (real) physics teaching, the technical equipment includes at least one computer and a multimedia projector or interactive whiteboard for each physics classroom.

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.

## CONCLUSION

The development of science, technology and engineering causes changes in the methods and tools of physics teaching in high school.

Multimedia technologies are innovative educational resources that have a real application in the physics teaching in high school.

In the article are presented examples of multimedia technologies and basic methodological opportunities for their use in the physics teaching process in high school.

The theoretical research on the topic of the article and on the presented methodological possibilities for the application of multimedia technologies in the physics teaching in secondary school show that:

multimedia technologies can be used in various physics lessons, in extracurricular activities of students, to conduct e-learning (synchronous and asynchronous) and others.

many of the problems of physics teaching can be solved in an innovative way through the use of multimedia technologies;

the use of multimedia technologies leads to diversification and enrichment of traditional teaching methods and tools;

multimedia technologies support, rationalize and improve the creative learning activities of teachers with students.

From a methodological point of view, multimedia technologies have a place in every structural part of physics lessons - updating, presenting and consolidating the curriculum in physics, in checking and assessing the learning achievements of students, etc. The use of multimedia technologies expands the methodological opportunities for presentation and visualization, for perception, comprehension, assimilation and application of the curriculum in physics and of the additional information on the topics studied in high school.

The learning content in physics, presented through the use of multimedia technologies, affects various human senses. On this basis, it can be assumed that it is perceived and assimilated more easily by students.

The use of multimedia technologies in the physics teaching in high school contributes to the implementation of interdisciplinary links with the subjects Informatics and Information Technologies, for the acquisition and formation of generalized knowledge, skills and attitudes.

The use of multimedia technologies is one possible methodological option for improving the secondary school physics teaching and for increasing its efficiency.

#### REFERENCES

1. H. Tuzharov, Multimedia technologies, ,.
2. <http://tu.asenevtsi.com/Media/M28.htm>.
3. G. Kalpachka, Modern educational technologies in physics teaching, Blagoevgrad, University Publishing House Neofit Rilski , 2021, p. 128, ISBN 978-954-00-0261-3.
4. S. Georgieva-Lazarova, Preparation of didactic materials in modern education, 2011, <https://ournals.uni-vt.bg/getarticle.aspx?aid=1017> type .pdf.
5. <https://www.prosveta.bg/>.
6. <https://www.anubis.bg>.
7. <https://www.bulvest.com>.