

TRAINING OF TEACHERS OF NATURAL DISCIPLINES TO CREATE MULTIMEDIA DIDACTIC TOOLS

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Abstract: The article is devoted to the problem of creating multimedia didactic tools by teachers of natural sciences. Based on the analysis of relevant scientific sources and existing pedagogical practice, the author shows that the teacher knows the content of the subject material, has knowledge of its teaching methodology and educational digital technologies, and understands the needs of students, which is crucial for the creation of the aforementioned pedagogical tools. The author considers this problem not as technical, but as pedagogical.

The article presents specific examples of obtaining photo, video, and audio content and its use to create multimedia didactic tools.

Keywords: multimedia teaching tools, content, creation, use, didactics, secondary school, educational process, natural sciences, teacher, training

Introduction. The development of education proceeds through the adjustment of curriculum content, the evolution of teaching methods and organizational approaches to working with students, the creation of appropriate instructional tools, and, of course, the training of teaching staff. It is impossible to single out one of these components as the primary one, as each performs its own specific functions.

Given the rapid integration of digital technologies into the educational process, the use of multimedia didactic tools (hereinafter referred to as MMDTs) for student learning and development is becoming increasingly accessible and effective. Modern students grow up in an environment where video, audio, and other multimedia materials are an integral part of their daily lives. Therefore, the use of these tools in teaching can increase student interest and make the educational process more interesting and attractive.

However, in this article, we propose discussing not the use of existing MMDTs, but rather the issue of preparing teachers for effective pedagogical practice amidst the integration of digital learning technologies into the educational process. To narrow the scope of the issue, it specifically concerns preparing teachers of natural science subjects to create MMDTs.

We maintain that the creation of MMDTs is not merely a technical task but a pedagogical-technological activity requiring the teacher to combine subject-matter, didactic, technological, and design competencies. This aligns with research findings by Désiron et al., which demonstrate that possessing technological skills alone does not guarantee the production of high-quality multimedia learning materials. Simply put, the ability to use digital tools (such as cameras, audio recorders, computers, etc.) does not in itself indicate a teacher's readiness to create pedagogically sound multimedia didactic tools [7]. Therefore, the central concept of our research is the creation of MMDTs as a pedagogically designed digital product, rather than simply the creation of multimedia content.

The object of our research is not the technology of creating multimedia content as such, but the process of pedagogical preparation of a teacher for its didactic design and use. In this study, digital technologies are viewed as tools for achieving pedagogical goals, while the criterion for effectiveness is the level of the teacher's readiness for the corresponding professional activity of creating multimedia didactic learning resources.

Methodology. In the course of studying this problem, we analyzed scientific and scientific-methodological publications, as a result of which we established how interesting it is for scientists

from different countries. At the same time, we determined the level at which this problem has been researched and how the results of this research have been implemented into pedagogical practice.

To reach appropriate conclusions, we also considered the research findings of A. A. Davidenko and P. A. Davidenko, who not only create photo and video content but also develop MMDTs based on it. Furthermore, they have designed original training programs on MMDT creation, which are used to train science teachers at the K. D. Ushynskiy Chernihiv Regional Institute of Postgraduate Pedagogical Education. We also took into account the performance of teachers who studied under these programs in advanced training courses at the above-mentioned institute.

Results and discussion. It is worth noting at the outset that the issue of using multimedia didactic tools (MMDTs) has long attracted the attention of educational researchers. Some of them also draw attention to the need to prepare teachers for their creation, who directly carry out the education and development of students in general education institutions. Who, if not a teacher, feels the lack of such a pedagogical tool for posing a problem in class, for presenting new material, for a student to choose a topic for a future research or creative project, etc.?

Researchers La Torre S., Désiron J. C. analyzed 78 educational videos used by high school teachers, with a significant portion of the materials relating to science subjects. The videos were evaluated through the lens of the principles of the Cognitive Theory of Multimedia Learning. The study revealed that certain multimedia design principles were either violated or entirely absent from the materials. This points to a genuine issue regarding the quality of multimedia materials used in science education. Notably, the researchers found no videos created by the teachers themselves. This again shifts our focus to the need to train teachers not only to use ready-made digital resources, but also to be prepared to create them themselves. Such teacher-developed multimedia materials could be tailored to specific content and instructional contexts. [8].

Désiron, J. C., Schmitz, M.-L., and Petko, D. analyzed the professional practice of 2,247 upper secondary school teachers. They were interested in how often practicing teachers create MMDTs on their own? The study examined factors related to the creation process: technological and pedagogical knowledge, attitudes toward technology, access to tools, and crucially an understanding of the principles governing the use of such materials in the educational process.

The researchers found that when creating multimedia didactic materials, teachers currently prioritize the production of audiovisual content, relying on their technological knowledge and self-assessed competence in both technology and pedagogy, while often overlooking principles of multimedia design. Here they emphasize that the ability to use digital tools is not the same as the teacher's readiness to create pedagogically sound multimedia teaching aids [7].

In his work **Using Multimedia for E-Learning**, R. E. Mayer summarizes 12 research-based principles for designing multimedia instructional materials. These include the principles of coherence, signaling, redundancy, and spatial and temporal contiguity, among others [9].

In his seminal work **Multimedia Learning**, R. E. Mayer explains why the creation of multimedia teaching materials cannot be reduced to the mechanical combination of text, images, sound, animation, and video. Mayer's cognitive theory of multimedia learning is based on three fundamental premises: the existence of two information-processing channels, their limited capacity, and the necessity of active cognitive engagement on the part of the learner. Thus, creating high-quality multimedia educational resources requires an understanding of the principles of multimedia learning. Such knowledge can be obtained during professional teacher training. [10].

One can conclude that a teacher's possession of technological skills does not in itself guarantee the ability to create high-quality multimedia learning materials. Creating MMDTs is not a technical, but a pedagogical-technological activity that requires the teacher to combine subject, didactic, technological, and design competencies.

Research by domestic authors is also devoted to the creation and use of MMDTs in the educational process. For example, one Daviden, A. A., introduced experimental-graphic problems into the physics teaching process, the conditions of which are formulated on the basis of photographs of moments of the course of certain physical phenomena. This is detailed in his Candidate of Sciences

dissertation: "Experimental problems as a means of improving the level and quality of students' knowledge in physics" [1].

The use of audiovisual media has further developed by involving students in research projects. This is reflected in the publication by Pavel Davidenko, "Creation of multimedia didactical tools for the development of students' research abilities" [5].

Davidenko, A. A., & Korshak, Ye. V. suggest that physics teachers use the photographic method in the study of physical phenomena [3].

We find a continuation of this in the well-known manual by Davidenko A. and Bocancea V. "Proiecte STEM/STEAM la fizica". It features photographs capturing physical phenomena in action; viewing these images may prompt students to ask questions and seek answers, potentially leading them to select a topic for a future research project. Some of the photographs are accompanied by relevant explanations. Questions have been formulated regarding the photographs in the other section. All photographs included in the manual can be displayed using a multimedia projector and screen, enabling work with a large group of students in the classroom. The manual provides numerous examples of how STEM/STEAM approaches can be implemented in physics instruction [4].

Our analysis of the sources shows how complex the problem raised is and how specialists in the field of pedagogy, teaching methods, and digitalization of education are solving it. However, in real pedagogical practice, this problem is not yet everywhere and does not always come to the fore. The analysis reveals that a significant number of teachers are satisfied with the status quo; they are content with the didactic tools available at their educational institutions, often without critically evaluating their didactic quality. And this is their attitude not only towards MMDTs, but also towards educational devices. Our observations indicate that few teachers identify the shortcomings of these tools or strive to rectify them, and even fewer create new teaching aids. Yet, if the situation remains unchanged, we will see no progress in education. Therefore, we must prepare teachers in advance for positive changes in education.

And one more detail. In one article, it is not possible to show all the features and currently known technologies for creating MMDTs. Now we will look at how content is created, which subsequently forms the basis for the creation of MMDTs with its subsequent use in the educational process in natural sciences.

There are at least two ways to approach the creation of photographs, videos, and phonograms. In one scenario, a teacher acquires them without a specific, predetermined goal—that is, spontaneously. Yet, as a teacher, they perceive the world through the lens of a specific subject, such as biology, physics, or chemistry. As a specialist possessing specific knowledge, they notice elements in the surrounding world or the laboratory that align with their professional interests. They often capture images or record audio "for future use," anticipating that the material might prove useful to themselves or their colleagues. This process results in the creation of portfolios containing a substantial amount of relevant material. A case in point is the portfolio by A. A. Davidenko titled "STEM, physics, nature and physical experiments [Collection of photographs and videos]" on the Pond5 stock media site [6]. Currently, the portfolio contains over 600 photos and videos, with new content being added continuously. One can only speculate as to the volume of similar materials stored in folders on the creator's personal devices.

In other cases, content is prepared for a specific pedagogical situation. The photograph (Fig. 1) was taken by him in the school physics laboratory for classes on the topic "Electric current in different media". By formulating appropriate questions for its content, we can format it in the form of MMDTs. This can be done using Microsoft Word, PowerPoint, or similar software.

When reviewing material related to the passage of electric current in gases, the teacher can involve students in analyzing the trajectories of spark discharges, which are depicted in the photograph he took. It will be interesting to discuss problems related to the directions of electric

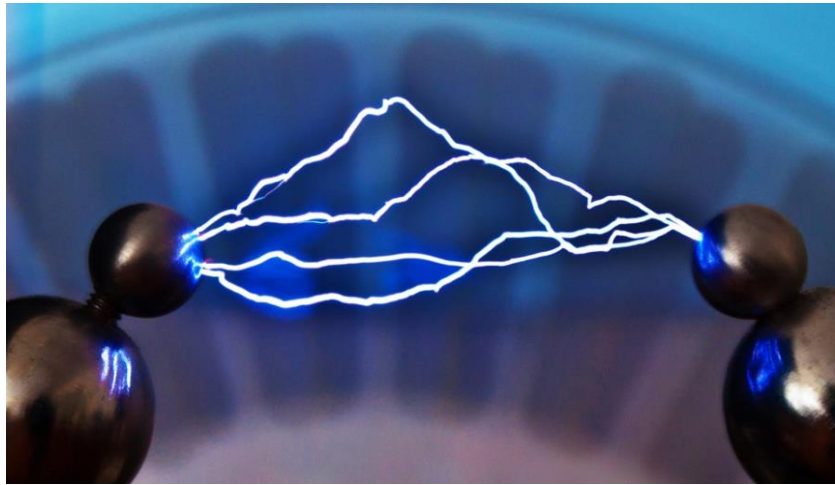


Fig. 1. Series of spark discharges
Photographer – Andrey Davidenko

current flow, trajectory breaks recorded in the image, and so on. Typically, students are interested in how the teacher managed to take such a picture, in particular, obtaining an image of several trajectories in one frame. It is possible that one of the students will express a desire to take such a picture with their own camera.

No less interesting will be a comparison of the depicted trajectories of spark discharges, which are made in laboratory conditions, with the trajectory of a similar physical phenomenon that we can see in nature. Such an image is presented in the next photograph by the same author (Fig. 2).



Fig. 2. Spark discharge in nature (lightning)
Photographer – Andrey Davidenko

Clearly, in some instances, students should be invited to analyze only a photograph—without any accompanying text or audio commentary provided by us. In this way, we foster their ability to see the extraordinary in the ordinary and to notice details that challenge their preconceived notions. It is precisely in such moments that ideas for research or creative projects may emerge.

Let us consider another interesting example. People do not always pay attention to the distribution of colors in the rainbow's arcs (Fig. 3). Yet, they are distributed differently: in the lower arc, the red color is at the top, whereas in the higher arc, it is at the bottom. In this case, there is considerable scope for conducting an investigation. One student might simply observe and describe

the distribution of colors, another might attempt to find an explanation for the phenomenon, while



Fig. 3. Two rainbow arcs
Photographer – Andrey Davidenko

someone else might focus on the brightness distribution of different parts of the sky during the formation of the rainbow, and so on.

So far, we have focused only on physical phenomena, but phenomena observed in other natural sciences—such as biology, chemistry, and astronomy—are no less interesting.

Here is a photograph capturing a bee collecting pollen (Fig. 4). Searching for pollen, the insect "hangs" near the flower. Could this perhaps inspire a topic for a future project? How do its wings move to achieve this "hover"? And here a filmed video will come to the rescue. Frame-by-frame analysis of wing positions may help answer this question... This image is a frame removed from the video.

Biological objects are also always interesting for observation, photography, and video recording. Moreover, if such a scientific and educational photo shoot for physics in a significant number of cases requires laboratory conditions, then in biology everything is simpler, because the plant and animal



Fig. 4. A bee "hanging" near a flower
Photographer – Andrey Davidenko

world is more often located outside the premises.

In our article, we did not address audio content—specifically, recordings of the sounds associated with various natural phenomena and processes. Generally, little attention is paid to such material in the teaching of natural sciences. While this type of content—and the multimedia teaching tools

(MMDTs) based on it—is widely used in music education, imagine how much more engaged students would be in a biology lesson if the classroom were filled with the sounds of various bird calls, followed by a question asking them to identify the species.

The primary objective when creating MMDTs is, of course, obtaining high-quality content. The material must capture a specific moment in the course of a phenomenon or process. During photography or video recording, it is important to highlight details that are not visible to the naked eye. For example, one of the images posted in our article (Fig. 4) is a frame from a video. The video was shot at 30 frames per second and lasted 50 seconds. Therefore, the author of this video was able to select the frame he needed from 1,500 shots. Specific recommendations for obtaining photographs to create MMDTs can be found in the article by A. A. Davidenko, "Training physics teachers to obtain photographs of moments of rapidly occurring natural phenomena" [2].

Our future research will focus on developing a methodology for creating MMDTs.

Conclusions. Multimedia learning technologies play an important role in the educational process for natural science disciplines. They serve not only as traditional visual aids but also as tools for formulating learning tasks, generating ideas, selecting topics for potential student projects, and more.

Any content and the multimedia didactic tools (MMDTs) created from it must not only help students better understand the learning material to ensure its mastery but also foster their research and creative abilities and contribute to their aesthetic development.

Teachers can participate in creating content and MMDTs, but this requires their training within the system of postgraduate pedagogical education.

Creating a multimedia didactic tool is not merely a technical task but a pedagogical-technological activity that requires the teacher to combine subject-matter, didactic, technological, and design competencies..

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