

Project-based teaching in physics and its implementation for creating a website

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The report presents a project-based teaching as one of the methods for developing cognitive skills in students in their studies of Physics. What is described is an exemplary application of the method in the 9th grade for building a website dealing with electromagnetic phenomena. There are described all the activities of the students through which a virtual environment has been built, providing access to learning resources and popular science information from the Chapter on Electromagnetic interaction.

Key words: project based teaching in physics, project method, cognitive skills, electromagnetic phenomena, a website, information and communication technologies

CONTEMPORARY DIMENSIONS OF PROJECT-BASED LEARNING ACTIVITIES IN TEACHING PHYSICS

Nature of the project method

Quality teaching is achieved by proper selection of one or another approach, in which students can develop active cognitive skills to learn. Students should be motivated to act as if they were researchers themselves and on their own being able to discover the pathway to knowledge through activities they will conduct – such as reading, thinking, discussing, exploring and so on. That is why a contemporary teacher should be able to create a proper learning environment, in which they can build up knowledge, skills and attitudes through problem solving, discussions and cooperation amongst students. Such an education environment is created with the help of a project-based instruction through applying various methods and implementing different approaches [1].

The term “project” is in the grounds of project-based teaching. The literal translation of the term comes from Latin and means “thrown forward”. It is used in various areas of human life with the meaning of intention or action plan. In didactics the term “project” is understood as research topic in the context of didactic task whose successful development requires theoretical knowledge and practical actions.

The Project Method as part of the interactive approach enables students to develop their cognitive skills. It also simulates their aspiration for a creative self-expression, independent handling of information and critical understanding of reality. Project-based teaching is based both on cooperation among

students, and also between them and the teacher. “Here there is an expression of the synergistic idea of cooperative joint action of all parts in the whole unit, as well as about qualitative changes occurring in the system as a result of self-organization processes taking place in it” [2].

In the implementation of the project work students learn:

- to create, consider and adopt ideas;
- to plan tasks and activities to achieve the objective;
- to calculate out learning resources;
- to allocate positions and responsibilities;
- to present and stand up for their ideas to the class, their teacher or parents;
- to put practice the idea of the project;
- to evaluate the process and outcome.

Didactic characteristics of the project learning activities in physics

School project in Physics enable the teacher to organize the circumstances in which students reveal themselves as researchers. Through this method, they look for and find solutions to specific problems on their own, creating an intellectual product of practical importance.

Work on a project begins by a precise definition of the topic. Then the topic is discussed among the participants, who specify the details and plan the activities. The clearer the concept of the value of the final product is, the more interested students are in the project. In practice this learning activity is a challenge for the manifestation of students’ own strengths and capacities. In order that this activity becomes of systemic nature and to achieve the desired synergetic effect, the Physics teacher should strike a balance be-

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tween traditional and innovative elements in teaching.

Planning of the project activity can be done in class, agreed within the school framework of among several schools. The teacher should focus on the individual elements of the project manager, but further on, when difficulties arise, he/she becomes a consultant and facilitator.

According to the didactic theory, the structure of the learning project involves the following stages:

1. Stage of Searching;
2. Stage of Analysing;
3. Implementation of Planned Activities;
4. Presentation Stage;
5. Evaluation Stage.

The types of projects in Physics are classified according to the following criteria [3]:

- Didactic objectives:
 - to visualize a phenomenon;
 - to consolidate knowledge;
 - for systematization and generalization of knowledge;
 - to develop skills for solving problems;
 - to develop skills for conducting experiments and similar.

Products: computer presentations, virtual demonstration experiments, computer tests, etc., simulation labs, equipment and learning aids.

- Contents of the syllabus:
 - for developing topics related to applying Physics in sports, medicine, technology, etc.;
 - for developing topics where the studied objects and phenomena are difficult to visualize;
 - for presenting and studying a particular phenomenon or object.

Products: a computer presentation, panels, posters, films, simulation labs, equipment and learning aids, tests, assignments, and others.

- Purpose of using physical knowledge:
 - creating a practical relevant product for the man with tailored properties;
 - evaluating or determining the parameters of properties of objects in a certain state;
 - developing a technology (a method) for achieving a practical relevant result;

- establishing causes of phenomena and processes.

Products: dynamic model, static model, mechanism.

- Type of results:
 - aimed at creating objects;
 - aimed at aesthetic, emotional or another type of experience;
 - aimed at solving a problem;
 - aimed at acquiring knowledge, skills.

Products: an article, a report, communication, an appliance, a didactic game, a picture.

- Degree of utilization of information and communication technologies in the educational-cognitive activity of students:
 - web reference;
 - web search;
 - web research;
 - e-mail project;
 - cooperation.

Products: a computer presentation, online tests, a report, a poster etc..

The evaluation can be conducted according to several exemplary criteria [3]:

- relevance and significance of the problem in accordance with a given topic, and how much it is linked to the syllabus;
- properly assigned and used research methods and processing of results;
- activity of each participant according to their individual abilities;
- collective decision making;
- team work;
- using knowledge and skills from other subject areas to complete the project;
- argumentation skills, drawing inferences and making conclusions during the presentation of the final product of the project;
- aesthetic finishing of the designed product.

The project method in terms of the class-lesson system in teaching physics

A trend in the global educational theory and practice is the redistribution of the functions of the class-lesson system and self-study activities of the students. The optimum combination and mutual completion of the class-lesson system and the project method leads to an enrichment of tradition and innovation. As a result, teaching Physics gets individualized; knowledge

and skills from different fields of science get updated and applied into practice. Students learn to plan, observe, experiment, analyze and create. This enhances their motivation and makes knowledge, habits and skills more sound, leading to more effective results in teaching Physics. From a practical point of view, an emphasis is placed on the following key points:

- A self-study cognitive activity in teaching Physics is conducted, through which students solve significant personal problems;
- The Physics teacher takes the role of advisor and partner, guiding students in self-study acquisition of physical knowledge;
- “Teacher - student” relationship is developed based on the constant feedback, which timely enables to identify the positive and negative aspects of the activities in the physical project as well as to overcome any encountered difficulties;
- Self-reflection on the individual cognitive activity of students in teaching Physics is made, which itself is a sign of self-governing development in terms of synergetic ideas for self-organization in complex nonlinear structures.

In the process of implementation of the Project Method in teaching Physics, some controversies ought to be overcome. They are caused by the mutual contradiction of the project activity with the proven class-lesson system. When working out on a school project in Physics, the student searches for a solution of a subjectively significant problem by using various resources. However, this cannot be implemented entirely within the class. Since knowledge and resources from a variety of subjects are applied and quite often the information goes beyond the curriculum, the project activity cannot be always organized within the frame of one lesson. Nevertheless, in pedagogical practice the class-lesson system has long been established to be effective for fundamental acquisition of knowledge, skills and habits. Therefore, the Physics teacher needs to find ways to a measured balance. The teacher should conduct a mutual completion of the two pedagogical phenomena in their teaching practice and thus thoroughly reach the educational goals.

Using information and communication technologies in the implementation of the project method

The educational process in Physics is more effective if the project-based learning is integrated with

Information and Communication Technologies (ICT). According to the European reference framework this is how a certain level of digital competence is accomplished, including free and critical use of these technologies for extracting, assessing, saving, creating, presenting and exchange of information as well as communication, and participation in collaborative networks [4]. Virtual learning environment is extremely popular and can provide access to a variety of learning resources, even outside the school framework. Such an environment is the educational portal through which the student does informal learning outside the classroom. It will be interesting for students if the contents of the site is entertaining, one that makes them share opinions, comment on problems and propose solutions. Thus, a website can be a powerful tool not only for entertainment but also for sharing knowledge and ideas. Therefore, a project activity linked to any virtual environment is particularly effective. Project-based teaching using ICT stimulates students to learn more efficiently and gain more information within a shorter period of time. “Technologies should be used as a tool through which students, thinking on their own, more quickly and easily can get to resolve issues and solve problems that have been assigned to them” [5].

ICT are at the core of electronic learning (e-learning). It is regarded as “a system of methods, techniques and technologies for organizing and presenting different objects through ICT” [6]. Thus, by using different types of educational information technologies, scientific information is visualized, the learning process is automated, the training is more efficient and interesting for students. What matters is the quality and selection of contents, as well as the design of the educational product in order to attract and hold the students’ attention. Both conditions should be observed in the implementation of the project learning activity for creating of an e-content course or an educational internet site.

APPLICATION OF THE PROJECT METHOD TO
CREATE A WEBSITE ABOUT ELECTROMAGNETIC
PHENOMENA STUDIED IN 9th GRADE

The Project Method could be an exemplary embodiment in teaching Physics in the 9th grade by students working out a virtual environment to access information from Chapter on Electromagnetic interaction. The website should contain selected learning resources and interesting popular science audio-visual

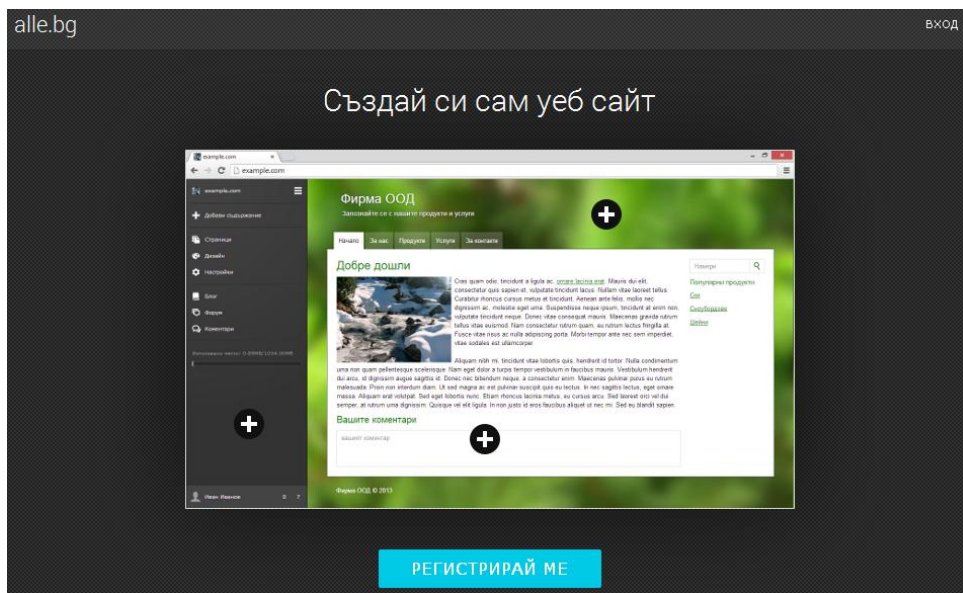


Fig. 1. Exemplary www.alle.bg platform for creating websites.

information about electromagnetic phenomena. Thus, participants in the project from being trainees by teaching their peers turn into trainers. They virtually pass their curiosity to potential web users of the website. Most of them are expected to be peers who are motivated to visit the page, even out of curiosity.

The project objectives are:

- extension and consolidation of students' knowledge on electromagnetism;
- stimulating their creative cognitive activity;
- developing their skills for searching and dealing with information;
- developing their skills for using a computer;
- developing their organizational skills.

Prior to the start of activities, the teacher reports to a chosen by him class the idea of creating a website template on a ready-made platform. The contents of the future virtual environment is subjected to a discussion in class, during which constructive suggestions are noted. Next, the students are informed that the school project will be implemented primarily extracurricular within 3 weeks' time and the website will be promoted in the consolidation section of the lesson. Afterwards, the project will proceed to realization in the following stages:

Stage of searching

According to students' wishes and abilities at the beginning of the first week three groups of 8 people in total are formed to realize the project. Each group elects its leader, and each member undertakes to per-

form a particular activity: The first group (consists of three people) – editors of information about:

- magnetic field and magnetic induction;
- direct current (DC) electromotor;
- the Northern Lights.

The second group (consists of three people) – editors of information about:

- magnetic properties of substances;
- electromagnetic induction;
- generators and power transformers.

The third group (consists of two people) – administrators responsible for:

- graphic design, selection of photos and videos;
- uploading information.

The groups responsible for the information start searching in textbooks, in books and on the internet for a week. During this time administrators review the available in the global network ready-made platforms on which to build the educational website (Fig. 1). The teams work mainly extracurricular, primarily at home, if necessary some of the computer labs at school can be used. In Physics classes teachers consult each group and ideas are shared with the teacher.

Stage of analyzing

At the beginning of the second week the editorial teams through a discussion analyze the information collected in their portfolio, they offer working thematic sections and discuss what to include in it.

The administrators' group give ideas about the website layout and create a gallery of photos and videos.

At a common meeting of all members the structure, the sample design and the chosen platform of the virtual learning environment are approved, of which the teacher is also informed. Then the activities of the three teams are scheduled until the end of the project.

Implementation of planned actions

At the end of the second week the administrators' group makes a registration on the Internet page, whose server will host the school website. An account is created and a web address is given, at which address the website will be accessible in the global network (Fig. 2). This is how the foundations of the virtual environment are laid, which will be uploaded with information (Fig. 3).

The administrator responsible for the design chooses from the available templates the one that is closer to the pre-approved looks. Then the two groups of editors in stages submit to the administrators the

finished text files and audio-visual contents to the website sections (Fig. 4). One administrator uploads information (Fig. 5) and the other selects graphics and videos, and those that are more interesting of them are placed in a gallery (Fig. 6). Furthermore, administrators activate social voting buttons ("like", "do not like") to any material or file including optional comments by readers (most platforms support these features). These features turn the school website into a modern social learning environment.

Presentation stage

At the end of the third week the project is accomplished and the website is completely ready (Fig. 7). Its official presentation is given by all students in a computer lab during the consolidation lesson of the chapter. The authors present their virtual work to the class and explain what it contains. Their peers visit sections in the site out of curiosity, getting to know with the information, looking through the photos and videos, voting for them or commenting on them. As users of the website, they consolidate and extend their knowledge, raise their curiosity and motivation to learn.

Evaluation stage

The teacher comments to the class how the project participants have dealt with the project. He points out the merits and drawbacks of the school website, stimulates original ideas, analyzes the mistakes of some of the groups (if any are made) and sets the assessment. Students do their self-evaluation, also share how they

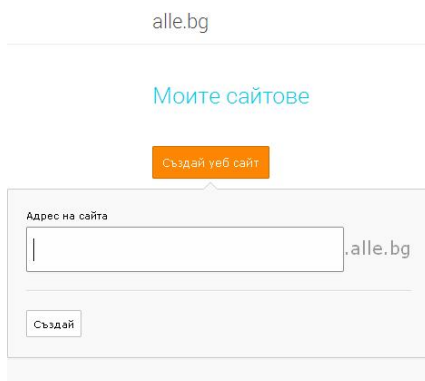


Fig. 2. Registering a web address.

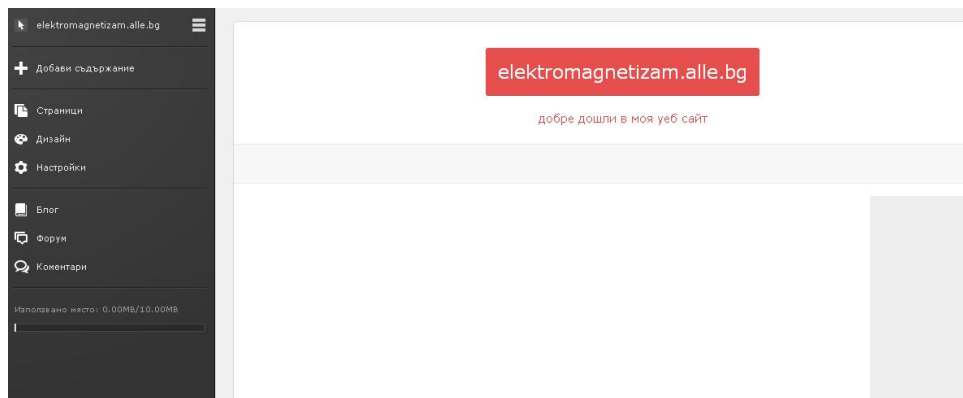


Fig. 3. A blank site with and exemplary title was created: elektromagnetizam.alle.bg

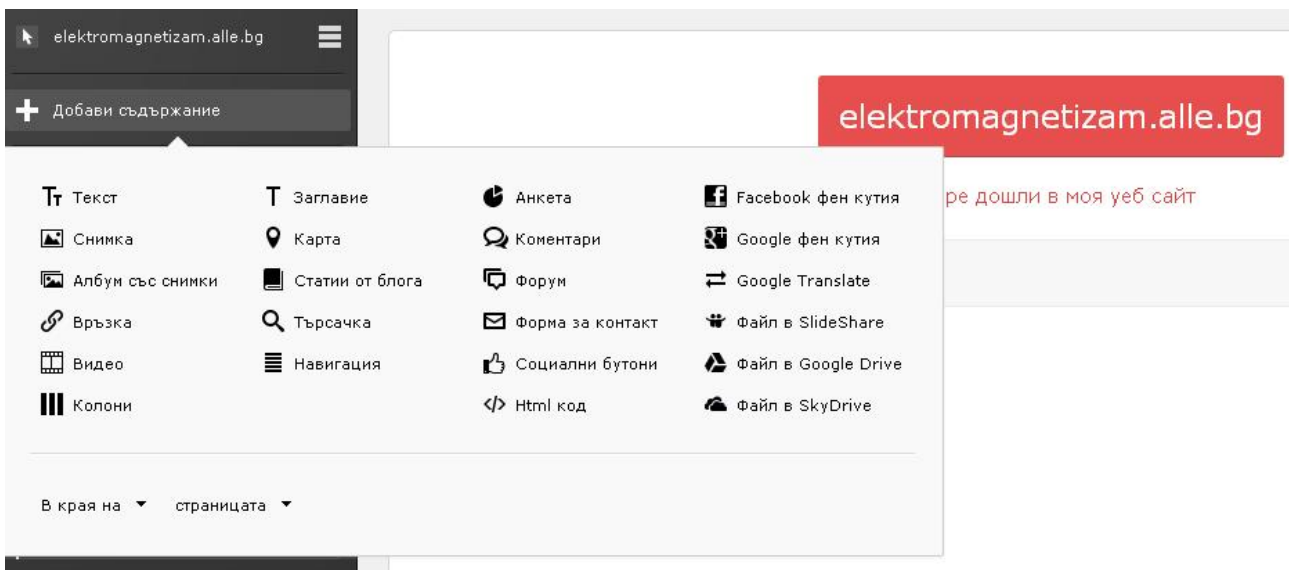


Fig. 4. Menu for uploading contents.

have dealt with encountered difficulties and tell interesting details of the implementation of the learning virtual environment, through which they have attracted the interest of both the other classmates and users in the global network.

SIGNIFICANCE OF PROJECT-BASED TEACHING IN PHYSICS

The school project in Physics is a comprehensive educational and cognitive activity with an objective, a topic, structured actions and a final result. A key role

in the implementation of the Project Methods is the independent work of students. Such training provides an opportunity to leapfrog the limitations of authoritarian and reproductive methods. Through it the educational process turns into a personality-centered, interactive and thoughtful combination of methods and tools.

With the help of project-based teaching in Physics students manage to master new knowledge, which is relevant, of practical value and viability. Moreover, they stock their mind with knowledge and consolidate



Fig. 5. Exemplary uploaded information illustrated with a photo.

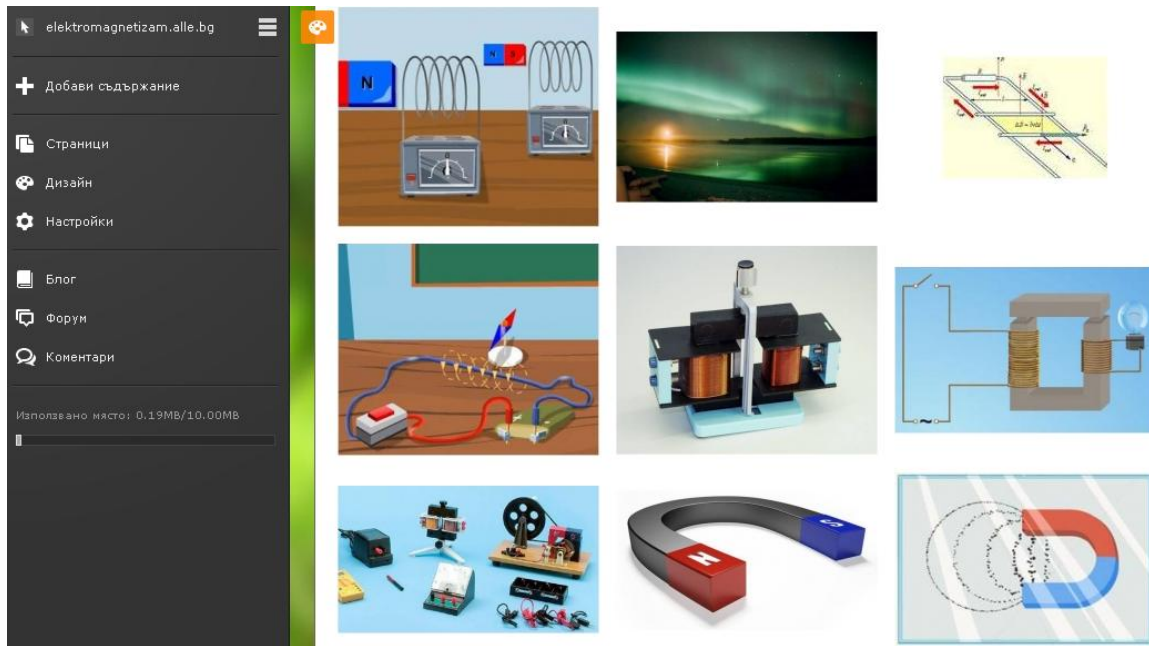


Fig. 6. Exemplary Gallery of Photos.



Fig. 7. Exemplary view of the ready-made website.

it, develop their skills to seek information and handle it. They learn to plan, analyze and create. Thus, students themselves turn into motivated participants in an effective educational process. Their independent cognitive activity enhances the ambition for further improvement of the individual. The accumulation of information on the project provokes new perspectives and generates new ideas, which can be implemented in new activities and projects.

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ПРОЕКТНО-БАЗИРАНОТО ОБУЧЕНИЕ ПО ФИЗИКА
И ПРИЛОЖЕНИЕТО МУ ЗА СЪЗДАВАНЕ НА ИНТЕРНЕТ САЙТ

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(Резюме)

Качествено обучение по физика се постига с правилен избор на подход, в който е заложена активната познавателна дейност на учениците. Те трябва да се мотивират да бъдат изследователи и сами да откриват пътя към знанието чрез дейностите, които ще извършват – да четат, да мислят, да дискутират, да изследват [1]. В тази връзка докладът разглежда проектно-базираното обучение като един от методите на интерактивния подход, с който се развиват познавателните умения у учениците в обучението им по физика. Методът на проектите стимулира техния стремеж за творческа изява, самостоятелно боравене с информация и критично осмисляне на действителността [2].

Констатира се, че образователният процес по физика е по-ефективен, ако проектно-базираното обучение е съчетано с информационни и комуникационни технологии [3]. Според Европейската референтна рамка така се постига определено ниво на дигитална компетентност, включваща свободното и критично използване на технологиите за извличане, оценяване, съхранение, създаване, представяне и обмен на информация, както и комуникация и участие в мрежи за съвместна дейност [4].

В доклада е описано примерно приложение на метода на проектите в 9. клас за създаване на интернет сайт, посветен на електромагнитните явления [5]. Разгледани са всички дейности на учениците, с които се изгражда виртуална среда, осигуряваща достъп до учебни ресурси и научнопопулярна информация от раздел "Електромагнитно взаимодействие". Така се стимулира творческата познавателна активност на деветокласниците и те се улесняват при изучаване на електромагнетизма [6].

Прави се изводът, че с проектно-базираното обучение учениците обогатяват и затвърдяват своите знания, развиват уменията си да търсят информация и да боравят с нея, да планират, да анализират и да творят. Това ги превръща в мотивирани участници в ефективен образователен процес по физика.

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