INNOVATIVE PRACTICES IN TEACHERS' AND STUDENTS' TRAININGS

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Abstract. The present work is dedicated to innovative educational practices, that are based on teaching and learning through the methods of science, technology, engineering and mathematics (STEM), combined with the use of various digital tools. These project activities are suitable for implementation in the learning process both in face-to-face and distance learning. They enable the development of communication and collaboration skills, critical thinking and problem solving, creativity and innovation, as well as the creation of digital content. The described practices and digital tools are used in the preparation of teachers in various qualification courses conducted by the Department for Qualification and Professional Development of Pedagogical Specialists at University of Plovdiv "Paisii Hilendarski". They are used and implemented also in education of students in lower-secondary schools (5th – 7th grade). The teaching practices are based on the results of a three-year study of already trained Bulgarian teachers, who try them daily in the learning process and notice their positive impact on students. The article describes a realized STEM project, named "European countries".

Keywords: STEM; digital tools; interdisciplinary; interactivity; innovative practices

Introduction

In the last two years, for a considerable period, the educational institutions in Bulgaria switched from a face-to-face education to a distance learning. Pedagogical specialists were faced with difficulties related to "mastering" studying and using information and communication technologies. Due to this fact, the need for sharing innovative practices among the teachers themselves has grown, so that they can subsequently apply them in the education of students. By presenting various methods and means of implementing innovations in the educational process, including the teaching and learning through the methods of STEM and the use of various digital tools, a greater number of specialists could present the educational materials in an interesting and attractive way. This method of training provides an opportunity to provide greater activity on the part of the trainees, as the teachers will only be in the role of mentors and, if necessary, they will be involved in

the educational process. It is necessary for the pedagogical specialists to have the necessary knowledge and skills in order to be able to successfully use a wide range of innovations and introduce them into pedagogical practice on a daily basis, and this is done thanks to different types of qualification courses.

For this reason, the present work is dedicated to the presentation of good teaching practices that can be implemented in the educational process. School projects are presented, which are based on teaching and learning through the methods of STEM, combined with the use of different digital tools. These project activities are suitable for implementation in the learning process both in face-to-face and distance learning. They are suitable for application in the learning process at the lower-secondary level of education (depending on the age of the students, there will be differences in the requirements – older ones will use a greater range of digital tools, more information will be presented on the topic concerned and terminology will need to be used).

The described methods and tools are used in the preparation of teachers in various qualification courses conducted by the Department for Qualification and Professional Development of Pedagogical Specialists at University of Plovdiv "Paisii Hilendarski". The teaching practices presented are based on the results of a three-year study of already trained teachers who try the tools and practices out daily in the learning process and notice their positive impact on students. Teachers apply innovations on a daily basis in the learning process for students in lower-secondary stage of education when it is possible and can help for the improvement of the students' achievements. The described innovative practices were applied in the education of students from "Hristo Smirnenski" Primary School, Rakovski and "Dimitar Talev" Primary School, Plovdiv.

Teaching and learning through the methods of science, technology, engineering and mathematics (STEM)

STEM means teaching and learning through the methods of science, technology, engineering and mathematics in an interdisciplinary and applied way (there is also an extended version of STEAM that also includes the Art). It is equally suitable for use in both preschool and school education. In the present work, the emphasize is on the application of STEM in school education (the projects are suitable for implementation at the lower-secondary stage of education) and the opportunities it provides to increase the knowledge, skills and competences of students through contact with real-world situations. The Ministry of Education and Science in Bulgaria also recognizes the importance of STEM for learning, launching a national program "Building a School STEM Environment", which "aims to create school STEM centers that will serve as models of the future learning environment"[1]. In this way, students will work in an innovative environment that will help increase motivation and interest in exploring new things. According to R. Papancheva and L. Dermendzhieva, "the application of the STEM in education comes as a natural step in the course of modernization of Bulgarian education" (Papancheva & Dermendzhieva 2020). A number of authors of scientific publications (Mihov, Stoitsov & Dimitrov 2022; Mihov & Dimitrov 2022;

Stoyanova 2020; Hadzhikolev, Hadzhikoleva, Hristov, Yonchev & Tsvetkov 2021), (Stavrev 2022) also support the idea of implementing innovative methods in school education and some of them also participate in the training of the teachers in the STEM disciplines. STEM is closely related to the 17 global United Nations Sustainable Development, as well as the 21st century learning framework, and more specifically with learning skills (the well-known 4 "C" – creativity, critical thinking, communication, collaboration). More information on the nature and key features of STEM and the development of the approach over the years can be found in (Papancheva & Dermendzhieva 2020).

Digital tools are online-based technologies that could provide opportunity to the teachers to successfully transform a traditional classroom into an innovative one. They are extremely suitable for implementation in the learning process because they are the "key" to the transition from a passive learning model (teachers are more active) to an interactive one (students are more active). The use of digital tools to produce e-learning content is an integral part of the learning process. They are extremely suitable for storing learning materials in one centralized place, presenting additional material related to the different lesson units, completing homework assignments and for presenting the results of larger interdisciplinary projects. For teachers, they are another additional ways of attracting students' attention for a longer period of time and increasing their motivation for better results. There are various digital tools that can be grouped according to the direction they are aimed at: tools for cloud storage of information; video conferencing tools; creating presentations; collecting and providing information; creating digital notebooks; mind mapping tools; website building tools; whiteboard tools; test and survey creation tools; tools related to creativity and more. The implementation of various digital tools in education in Bulgarian schools is a great opportunity to move from a traditional way of teaching to an innovative one.

Technologies in the projects

Makey Makey is a technology by which inanimate objects can be connected to a computer to bring them to life. With the help of a computer program to configure these objects, computer games, music simulators can be controlled, stuffed toys can talk, various musical instruments can be played from fruits and vegetables, or different characters can be written from the keyboard through them, school steps can be turned into a piano and more. Makey develops students' constructive and computational skills, as well as skills related to programming, physics, chemistry and, above all, an interest in information technology. The face of the board consists of six inputs to which cables ("alligator" type) are attached. The pedagogical objectives related to the use of Makey Makey in the projects proposed and implemented below are development of skills related to computer modeling, acquisition of knowledge and skills for working with information and digital devices, creation of animated projects using algorithms with conditions and synchronization of actions of the characters through a visual environment for block programming, mathematical skills, logical thinking and creativity and making interdisciplinary connections.

Mentimeter is an online application for creating interactive computer presentations, which was developed by the Swedish company of the same name. In addition to the typical presentation slides, which include different types of content, the tool allows you to add slides with questions directed at the audience, and the answers are received in real time. One of the question types also allows the audience to ask questions that are directly visualized in the presentation. Thanks to the functionalities included in it, Mentimeter is extremely suitable for implementation in classrooms. It includes innovations that can engage students' attention for a longer period of time. During the lessons, the students have to answer various questions in the form of a discussion, but using this tool, the participation of the more active students is observed. The question-asking functionality provided by Mentimeter is a great alternative to this type of discussion where all students can join in and express their point of view without worry. To be able to send their answers, learners only need a digital device and an access code, which must be provided to them in advance. In addition to engaging students' attention and trying to interact with them, the tool can also be used to create surveys that can collect data and explore opinion on a specific topic.

Alle.bg is a platform for creating websites and thanks to its intuitive interface, this can be easily achieved in a short period of time. It is suitable for use by users who do not have knowledge and skills related to programming, because its functionalities are presented through menus and no code appears. It is extremely suitable for presenting information by teachers and students in an innovative way, thanks to which the attention of the audience can be engaged for a longer period of time. The platform includes three services, in addition to the ability to create a free website with an unlimited number of pages, which may contain various elements (text, images, videos, surveys, maps, etc.), it provides free domain and hosting. The tool offers ready-made templates for websites with different designs and the user can choose a specific design and then he can change.

Padlet – Very often in class, students have to answer various questions in the form of a discussion. In this discussion, however, the participation of the more active students is observed. In order to be able to include everyone with their suggestions, there is an alternative option to collect their responses. Teachers often also need to present information related to a given lesson. This can also be done in an innovative way, as in addition to text, videos, images and different types of files can be included in the form of sticky notes. For this purpose, this digital tool can be used for collecting and providing information and play the role of a virtual blackboard or the so-called digital information board.

Popplet – A suitable method for generating new ideas in a short time that can be implemented in the process of student learning is brainstorming. Generated ideas can be structured and visually presented thanks to digital mind mapping tools. They are a learning aid used for note-taking, project planning, teamwork, solving a specific problem, or organizing information. In addition to the option to create a new mind map, most of the tools also offer ready-made templates that can be directly worked on and replaced with information using their design.

Kahoot – When it comes to conducting a test on a topic or just a competitive game, it has digital tools that offer the ability to create online tests. Kahoot! is a free platform for creating fun quizzes for kids and students. It can be used with any device, in and out of the classroom. The service allows to create games and tests in Bulgarian language and collect answers in real time, using either a computer or a mobile device. After each question there is a leaderboard showing the fastest participants, and finally there are three prizes for the fastest students who answered correctly.

Canva – Canva is a platform that makes it easy to create professional designs as brochures, business cards, cards, presentations, posters, social media posts, logos, and more. Thanks to ready-to-use templates, the creation of the content desired by the user is done in a short period of time and in an easy way. The created materials can be shared on the Internet or printed afterwards.

STEM project "European countries"

In the period 04.06. – 13.06.2021 and 04.06.-11.06.2022, the authors of this paper held a qualification course on the topic "Digital tools and STEM education" lasting 32 academic hours at University of Plovdiv "Paisii Hilendarski". 30 teachers from all over the country participated in the course, who had to acquire knowledge and skills related to the topic. They had different levels of digital competence and learning ability. The implementation of the teaching and learning through the methods of STEM in training aims to achieve results with maximum efficiency in relation to the knowledge and skills related to STEM education and digital tools.

Figure 1. Teachers' training

During the teacher training we have used the basic methodological principles as accessibility; from "simple to complex" clarity; activity. We used the following methods – face-to-face learning, explanation, observation and exercises that help various learning tasks to be solved. We believe that these methodological principles support the usefulness of the described teaching and learning through the methods of STEM and different digital technologies.

After familiarizing the students with the methods and technologies presented in the

article and implementing them in the learning process, they approve of this teaching model. They believe that the inclusion of innovative practices helps the faster perception of new information and the visual presentation of the relationship between theory and practice, giving the opportunity to touch real life situations and express a personal opinion on the discussed issues.

The teachers thinks that thanks to the activities that students carry out, they build additional knowledge, skills and competences related to their communication abilities, teamwork, organizational activity, critical thinking and creativity. Changing the atmosphere in the classroom helps increasing the motivation of learners to achieve better results.

A project based on the principles of STEM is described, with various digital tools being used in the work process. The project is suitable for implementation in the educational process and has already been approved by the trained pedagogical specialists who have passed the qualification courses. The project is the idea of the authors and serves as an example for sharing good practices. Our impression is that, based on this example, teachers who have passed the qualification courses "create" many more and different projects and successfully apply them in the educational process.

STEM project "European countries"

Students from different schools (students from "Hristo Smirnenski" Primary School, Rakovski and "Dimitar Talev" Primary School, Plovdiv), from the lower-secondary stage of education, involved in an extracurricular club, worked in groups and researched what the lifestyle of people from different European countries. Each of the teams had the right to choose independently which country to research. A compulsory element in this assignment was the use of the Makey board – the students had to make a piano out of bananas and play the tune of the European Anthem. Students had the opportunity to use a variety of digital tools to organize and illustrate what they find, compare their data and share it with each other.

This assignment expanded into a STEM project involving the use of various digital tools. The specific example that is described in the following lines is a basic version that presents the way of working in different teams and unites the overall idea of the training by Deyana Peykova and Vera Shopova. Each assignment can be expanded into a STEM project to be developed over a longer period of time, incorporating interdisciplinarity and touching on real-life problems. Teachers teaching different subjects can incorporate new ideas covering different learning areas by conducting studies and experiments related to the topic. In the following lines, a realized STEM project is presented, which can be further developed subsequently. Information about the assignment is presented in separate paragraphs, according to the STEM discipline which it belongs to or according to the specific study subject. The idea is to have greater clarity when implementing the example in the learning process.

Figure 2. Students playing on a banana piano

Information technologies – students have the right to choose the topic of their own project, the Brainstorming method is appropriate as it will allow them to generate ideas related to different project topics, for a short period of time, after which they will choose only one. Thanks to the digital tool Popplet, students create a mind map to visualize, organize and share their ideas. In the center of the mind map is the topic of the project, and on the branches there are categories and subcategories that briefly show what the content will be. This mind map is shared and visualized through an interactive display for better visualization.

During the implementation of various experiments for the purpose of visualization, the experiments were filmed by creating videos. These videos would be helpful in showing how the end result was realized. To attach the videos to a centralized place, it is appropriate to use the Padlet platform, which in this case will serve as a tool to collect information from students.

When presenting the computer presentation to the audience, a suitable digital tool to "check the knowledge" is Kahoot!. After presenting the information about the specific European country, the other students have to answer questions on their mobile devices, and there will be medals awarded for the top three prize places. Some of the teams made medals out of paper, others bought real ones.

Geography – students discuss about the geographical location of the selected European country, the borders of the country, relief, climate, soil, water and natural resources. They comment on the topic of non-renewable energy sources, specifying the types of fossil fuels, the region in which they are located, their main characteristics, etc. Students comment on the topic of crude oil transformation and its application (transformation into a different type of fuel such as gasoline, jet fuel, etc., or transformation into electricity before it is used to power airplanes, cars, or heat a household) .

Physics – touching on the subject of renewable energy, by discussing the types of renewable energy sources students point out the possibilities for the protection of non-renewable energy sources. They comment about Europe's green future, energy efficiency and tackling energy losses.

Biology and health education – students deal with the topic of flora and fauna distributed in the specifically chosen country. They search for information on protected species of plants and animals.

History – information about the historical sights and cultural monuments in the specific European country is studied. There are also photos for each landmark - if there are students from the team who have visited the landmark, they provide photos taken by them personally.

Art and technology – students create an information brochure and a computer presentation, which include an author's design and logo. The logo and individual background elements must be drawn using a graphics tablet (if available) or drawn on paper. In one case, the brochure is created using a digital tool and then printed, and in the other, it will be drawn by the students. A suitable digital tool for creating an information brochure including summary information about the specific European country is Canva. A suitable digital tool for creating an interactive computer presentation is Mentimeter. As an additional task, a website is created, including information on the topic (each team creates a separate site). It is necessary to use a suitable software product or a web-based platform that provides ready-made templates for work. A suitable digital tool is Alle.bg.

Bulgarian/foreign language – in the brochure and on the website, the most important of the collected information should be included, in a synthesized form. In this case, the Bulgarian language subject is involved, and an adequate summary of all the information must be made. This will visualize spelling and punctuation errors, if any. In the event that knowledge related to a foreign language is to be included, teachers can have students produce the brochure and website in a foreign language as well.

Music – students use Makey and learn how to play the European anthem. They work collaboratively – one group search for the text and melody, the other – how to make a piano from bananas, the third – how to play the Anthem on it. As a final event each group present their digital product and they play the anthem together.

Any of the proposed digital tools or platforms can be replaced by another, and the STEM project can be expanded by adding more fields and other subjects. We have a feedback from the teachers we have trained and they shared that they did the banana piano in their classes and the students did it well, with a lot of pleasure and this project motivated them to continue working on STEM projects.

Results of already conducted STEM-related researches

In 2021, D. Kozhuharova and M. Zhelyazkova conducted a survey related to the knowledge of teachers about the specificity of STEM education and their opinion about its application in Bulgarian schools. 156 Bulgarian teachers, teaching at different educational levels and different academic disciplines took part in the survey. From the analysis of the survey, it can be concluded that "teachers consider it appropriate to implement STEM education in classrooms but at this stage they are not well aware of exactly what is behind the term and content of STEM, what they need to implement this type of training, what is

their role and what will be the benefits of implementing it. Of course it should be borne in mind that as with any innovation in education, STEM will meet initial resistance from some teachers who is due to fear of the new. But creating methodological guides, sharing good practices and equipping more STEM classrooms in schools will lead to an increasingly successful implementation of this approach in our educational system" (Kozhuharova & Zhelyazkova 2021). In 2022, M. Zhelyazkova conducts a survey in which 200 Bulgarian teachers teaching at various educational levels and in various disciplines from all over Bulgaria tooκ part. The aim is to study the opinion of educators regarding the STEM approach, its implementation and the competences developed through it. The conclusions drawn are that "only 45 out of the 200 teachers surveyed, (22.5%) teach STEM lessons. For comparison – according to the survey conducted in the previous year (2021), the percentage of teaching through STEM was (22%). From the indicated data, it can be concluded that the STEM approach is implemented at a very slow pace, regardless of the construction of STEM centers in schools (Zhelyazkova 2022).

Conclusion

According to V. Gyurova, "a good teacher today needs modern methodological competence, which implies knowledge and skills for using interactive methods and technologies – both based on modern technical means and interpersonal relations" (Gyurova 2018). We support the opinion of the author, wanting to add that it is extremely important for pedagogical specialists to know the principles of teaching and learning through the methods of STEM and modern digital tools and to implement them more often in the educational process. We believe that the adequate application of innovative practices in the educational process would help students to acquire the necessary knowledge, skills and competences in the relevant fields. Thanks to the already conducted research by D. Kozhuharova and M. Zhelyazkova, we come to the conclusion that pedagogical specialists teaching in Bulgarian schools need requalification in the relevant field. This can be done through various training courses related to STEM and the availability of more training resources and materials. It is extremely important to carry out research on the subject over a period of time and reflection the results through scientific publications, so that they can reach a larger circle of people.

Acknowledgments & Funding

NOTES

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