

PRIMARY SCHOOL TEACHERS' PERCEPTIONS AND ATTITUDES TOWARDS THE APPLICATION OF STEM ACTIVITIES IN REGULAR CLASSROOM

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ABSTRACT

STEM education is an educational approach focused on the integration of science, technology, engineering, and mathematics in the creation of student-centered learning environment for the examination of real-life phenomena [1,2]. The benefits of the STEM implementation within school environment are reflected in the increasement of students' creativity, problem-solving skills, communicational skills, and the fostering of knowledge application. In this study we have examined the teachers' attitudes and perceptions towards the application of STEM hands-on activities for the teaching natural science concepts to the students aged 7-10, in the framework of courses named Nature and society and The world around us. To train teachers for the implementation of STEM activities one workshop with carefully designed examples of STEM activities was organized, while the questionnaire was conducted after the teachers have implemented suggested activities in their regular classroom. The obtained data have suggested that teachers showed generally positive attitude toward STEM and high valuation of the skills and competences obtained during workshop training. In addition, the results from questionnaire have indicated that they increased knowledge base for the teaching science concepts, while the students have positively rated learning of natural concepts in this way.

Keywords: STEM, hands-on activities, teachers.

INTRODUCTION

STEM (science, technology, engineering, and mathematics) education and its acronym has been present for more than two decades and was firstly introduced in 2001 by scientific administrators at the U.S. National Science Foundation (Li, Huang, Jiang, & Chang, 2018). The main motive for establishing STEM education was ever growing demand for STEM-related skilled workers as they play a key role in the sustained growth and stability of the 21st century economy. STEM education has a very broad meaning, and many definitions were developed and discovered during the last two decades, but basically it represents an aspect that focuses on solving real problems, which have an interdisciplinary nature at its core. A more modern definition states that STEM education is an interdisciplinary teaching method that integrates science, technology, engineering, mathematics, and other knowledge and skills related to the fields in those disciplines (Baran, Bilici, Mesutoglu, & Ocak, 2016; Koul, Fraser, Maynard, & Tade, 2018; Thibaut et al., 2018). In the modern world, where a new and innovative technologies are being developed every day, STEM education represent essential link to the creation of next generation of innovators through reinforcement of critical thinking, integration of knowledge and skills and basic science literacy. In the coming years, the STEM sector is expected to be one of the largest employers in the world. STEM classrooms typically focus on project-based learning and hands-on activities (Yildirim, & Turk, 2018) with accent on connection of knowledge and skills in order to prepare the students for future job market. In STEM learning activities, soft skills such as problem-solving, higher-order thinking skills, and collaborative work are the main focuses on which students' learning is directed toward (Li et al., 2016; Meyrick, 2011). STEM activities in the classroom

strive to improve the quality of the learning process, as well as learning outcomes (Meyrick, 2011; Cedefop, 2017). One of the advantages of STEM education is that students are taught various skills in STEM domains in a context that helps them realize a connection between the classroom and the world around them.

Research conducted by Honey et al. (Honey, Pearson, & Schweingruber, 2014) have pointed out that in STEM education the integration of knowledge must be explicit both within the disciplines and across the disciplines. Knowing all the benefits of early age implementation, the primary school teachers represent the unique and valuable resource as they have the opportunity to work with youngest students and they teach all the subjects, so have ideal possibility for interdisciplinary learning. STEM education in Serbia isn't systematically introduced into curriculum and is used sporadically, depending on teacher abilities and interests (Maksimović, Osmanović, & Mamutović, 2020). Teachers in Serbia aren't properly trained to implement STEM in their learning environment although it is known that their readiness to integrate STEM depends on possession of specialized knowledge in STEM professional development. An elementary teacher's willingness and competency to integrate STEM goes beyond disciplinary content and pedagogical knowledge (Galanti, & Holincheck, 2022) and teachers' professional education at Universities in Serbia is not designed to meet those specific needs. In order to support the professional development and increase primary school teachers' competencies regarding STEM education, we have designed the teaching workshop for the implementation of STEM hands-on activities for the students aged 7-10, in the framework of courses named *Nature and Society* and *The World Around Us*. Also, in this study we have examined the teachers' attitudes and perceptions towards the application of these activities through the survey conducted after the implementation of proposed activities.

MATERIALS AND METHODS

General background

The research was conducted during the year 2019. The study included 17 primary school teachers with teaching experience ranging from 5 to 21 years. All teachers were female and working in public schools from the territory of city of Kragujevac (Serbia).

Sampling

The teachers who participated in the study willingly applied to the workshop where all teachers had the equal opportunity to apply. Teachers who participated in the study taught the students aged 7-10 in courses *Nature and Society* and *The World Around Us*.

Instrument and procedures

The training workshop was design after a detailed review of the curriculum of subjects *Nature and Society* and *The World Around Us* in areas related to natural sciences. The series of experiments were designed for each chapter, in order to implement various hands-on activities on the principal of STEM education requirements in regular classroom settings. Experiments were created to meet the needs of a standard classroom, so all required materials, equipment and compounds were cheap and available in regular shops. During the workshop, the teachers were introduced to all experiments and were given detailed instructions on procedures, materials and methods, along with the outcomes and questions related to the experiments. Some experiments had the possibility of variations that could give the teachers an opportunity to adapt the experiment to meet the specific needs and to build teachers' confidence to apply the knowledge acquired during the workshop in their classrooms. After the workshop the teachers were given the freedom to apply as many experiments as they find convenient in their learning environment.

Table 1. Questionnaire used in this study to examine primary school teachers' perception and attitudes towards application of STEM activities in a regular classroom.

Usefulness and motivation	Q1	The proposed activities are clearly presented and understandable.
	Q3	I had the opportunity to perform a number of proposed activities in this school year.
	Q5	Students were more motivated to participate in the class during activities.
	Q6	Students were more motivated to state their observations and comments during activities.
	Q8	Students were more motivated to present their results to the class during activities.
	Q11	I think that the proposed activities have had a positive impact on the teaching process and I plan to use them in the coming years.
Content and learning	Q12	I think that the proposed activities had a positive effect on my own motivation for teaching.
	Q2	The proposed activities are in line with the contents of the subjects World Around Us and Knowledge of Nature and Society.
	Q4	The performed activities were beneficial for the easier students' learning and understanding of intended materials.
	Q9	I noticed that the knowledge gained by performing the proposed activities is more permanent.
Difficulties in implementation and comments	Q10	I think that the activities I performed helped the students to connect the adopted material with the concepts of everyday life.
	Q7	It was easy to maintain discipline during the activities.
	Q13	List the difficulties you encountered in preparing activities
	Q14	Comments

To test the usefulness of the training workshop, the survey was conducted after the implementation of proposed activities in regular classroom settings. The main goal of the survey was to examine the participants perception on (1) usefulness of proposed activities and motivation of children regarding the learning process and active participation, as well as teachers' motivation for implementation of STEM activities; (2) whether the content of the activities was in accordance with the curriculum and whether it had a positive impact on learning process compared to the standard teaching plan; (3) whether teachers had any difficulties implementing the proposed activities or had any remarks, advices or solutions on its usability or to point out to some overlooked faults.

The questionnaire consisted of twelve closed questions with responses based on the 5-point Likert scale – 5 (strongly agree); 4 (agree); 3 (somewhat agree); 2 (disagree) and 1 (strongly disagree). Last two questions, on eventual difficulties that teachers encounter with, were open-ended. The questions used in the survey are presented in the Table 1, where they are divided into the three groups depending on research goal: (1) Usefulness and motivation; (2) Content and learning; and (3) Difficulties in implementation and comments. For data analysis the descriptive statistics was used, and results were given in percentages.

RESULTS AND DISCUSSION

The results of this study are presented in the Figure 1. Generally speaking, teachers who participated in the survey have positively evaluated presented activities and their impact on the learning process in regular classroom.

The data analysis on perception of participants about usefulness and motivation regarding proposed activities have shown that the 76% of teachers strongly agree, and 18% agree that the implementation of STEM education in regular classroom have a positive impact on teachers' and students' motivation and that they are applicable in given settings. The lowest percentage of agreeance in this cluster of questions is on question 3 regarding the opportunity to perform proposed activities: somewhat agree 29% (5); agree 53% (9); strongly agree 18% (3). In open-ended questions 13 and 14 teachers listed that a reason for this can be sought in the facts that most of activities are time consuming and they can represent a challenge as they are not predicted by the

curriculum. Some teachers found a solution in conducting some of activities as extracurricular such as project in which the parent guidance was required. The Lesseig (Lesseig, Slavit, Nelson, & Seidel, 2016) have found that teacher who use STEM education in their practice have noticed increased motivation and engagement in students while reporting the challenges associated with pedagogy, curriculum, and school structures.

By examining the questions regarding the second cluster, whether the content of the activities was in accordance with the curriculum and if it had a positive impact on learning process compared to the standard teaching plan, the 71% of participants strongly agreed and 24% agreed on its merits. The question nine, concerning permanence of knowledge gained by proposed activities in contrast to standard learning process, gave the lowest percentage of agreeance: disagree 6% (1); somewhat agree 29% (5); agree 53% (9); strongly agree 12% (2). Not any teacher gave the comment regarding this question. Although the percentages were the lowest, most teachers (65%) answered positively on this question. This impact was expected as recent research has shown that teaching based on STEM pedagogy, which relays on project-based approach that requires students to apply content knowledge to solve problems and where the students learn by doing and are encouraged to develop new understandings, leads to higher levels of cognition (Margot, & Lettler, 2019; Bruce-Davis et al. 2014).

The third cluster of questions are designed to reveal the difficulties that teachers are accounted with during the implementation of STEM activities. The question regarding the maintenance of discipline during the activities gave the following results: disagree 6% (1); somehow agree 6% (1); agree 59% (10); strongly agree 29% (5). The results have shown that considering the low age of students (7-10) it would be expected to have some difficulties in the class due to the lack of long-term attention, required skills and independence in work, but perhaps due to the higher motivation and engagement of students, the discipline didn't present a problem.

In concern to the open-ended questions, the teachers' experience in implementation of activities have denoted the lack of resources as the main obstacle. Also, the research by Johnson (2006) reported that many teachers denoted the lack of resources as a significant problem which impeded effective implementation of inquiry-based learning experiences for their students.

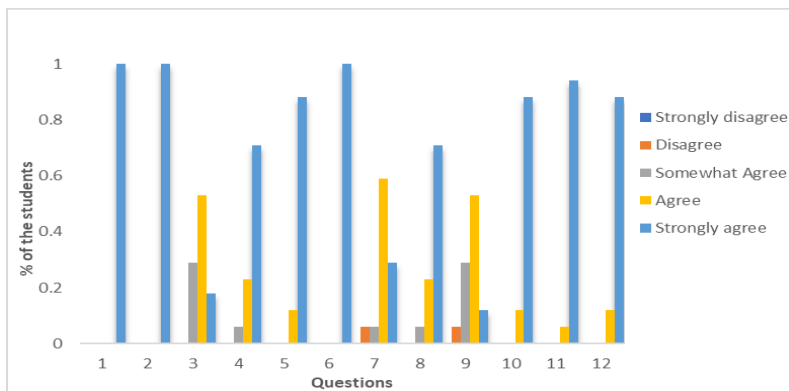


Figure 1. Survey questionnaire results.

CONCLUSIONS

The main value of this research is reflected in the fact that the designed STEM activities were applicable in the current Serbian educational system, and that they could improve teachers' professional development, skill and efficacy related to STEM integration. It is known that student's learning is limited when teachers' knowledge and understanding is deficient (McMullin, & Reeve, 2014), so teachers who have limited knowledge in this area are less likely to apply STEM activities, while teacher who have the confidence, knowledge and skill sets to implement STEM activities often and have a high self-efficacy toward this type of learning.

The data gained from the survey have shown that teachers appear to value STEM education and believe it enhances student-learning outcomes while preparing students for their future. While the results have shown the need to adapt the curriculum that integrates knowledge and skills through learning platform that is largely based on real-world applications, they also reviled other possible difficulties regarding the successful implementation of STEM education, such as, limited fundings and teacher's incompetence to guide and create learning environment towards STEM educational concept. These types of research studies in Serbia are still rare but their merit could reflect in improvement of educational system in Serbia.

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