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OUTSIDE-OF-THE-BOX STEM TEACHING FOR PRIMARY SCHOOL CHILDREN IN SERBIA ON TOPIC DIVERSITY OF NATURE - WATER

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ABSTRACT:

It is well known that STEM education and its early implementation has great benefits for the development of thinking and reasoning skills in younger children, and that early and appropriate experiences can influence and foster interest in STEM. Also, advantages of STEM education are reflected in interdisciplinarity and connection to real life experiences [1,2]. In this study we conducted (2nd grade students, N=29, Primary school “Moma Stanojlovic”, Kragujevac, Serbia) some hands-on activities that mimicked certain real-life scenarios in order to evaluate their impact on student motivation, perception and acquired knowledge. Faculty staff took the role of “STEM ambassadors” and with the help of teacher the experiments involving water cycle in nature, surface tension, capillary force, reflection, reaction medium and heat capacity were conducted through various game-like hands-on activities and demonstrations. The concept of inquiry-based teaching was used, and children were encouraged to ask questions, make suggestions and draw conclusions. Due to the young age of participants, the appropriate data were collected by the teacher through the interview. The results have shown that children gained more lasting knowledge and were highly collaborative and motivated to participate in all activities. It was noticed that the practical nature of proposed activities gave children the feeling of participating in a game or a free activity, so they were more engaged in their learning process, and it was perceived that hands-on activities better match the energy levels of children of that age and the need for a diversity of sensory stimuli.

Keywords: STEM, Chemistry, Primary school education

INTRODUCTION

The basic principle of science relies on foundational concepts of exploring, questioning, speculating and learning about the world through observation, listening, and recording. Children are by their nature full of wonder, curious and are constantly investigating the world that surrounds them in pursuit of new experiences and knowledge in order to better fathom and understand their environment. The educational concept that can nurture these innate characteristics of children and intertwine them with science and knowledge seeking culture can help children to develop skills that have become imperative in the technologically oriented 21st century.

STEM (science, technology, engineering, and mathematics) education which is conducted through the lens of inquiry-based learning approach could be an efficient way of introducing young children to problem-solving interdisciplinary teaching method which is focused more on applying knowledge rather than remembering knowledge [1-5]. This type of learning strategy is favoring student-centered learning environment through the examination of real-life phenomena where students' creativity, problem-solving skills, critical thinking, self-directed learning and communicational skills are nurtured [6]. Also, positive aspect of STEM education is that it is interdisciplinary in its nature and can make connections between school and community and in that way creating a broad mix of skills and interdisciplinary knowledge in students [7]. Cultivating STEM skills in the early years can help building metacognitive skills and foster positive learning dispositions in their future school years.

The majority of STEM education activities are hands-on activities where the student is in the central position, often in co-constructed learning environments where emphasis is on collaborative or partnership working. This helps children cultivate responsibility, independence, self-confidence, resilience and social flexibility which is especially important in younger students.

In order to successfully implement STEM education, teacher should adjust the theme to the children's interests and needs through observing and listening to children in their everyday activities. Following children's interests is crucial in building motivation to embark on a scientific exploration.

Gamification, incorporation of game elements in learning environment, has become an increasingly popular motivational and productivity tool in education [8]. Another advantage of STEM education is in its ability to set the problem-solving ambience into competing, experimenting, hypothesizing, making predictions and wondering setting and enable the student sense that are participating in a game or competition rather than learning.

In this research we designed a series of STEM-based activities within the subject *The World Around Us* on topic diversity of nature – water. Faculty staff took the role of “STEM ambassadors” and with the help of teacher the experiments involving water cycle in nature, surface tension, capillary force, reflection, reaction medium and heat capacity were conducted through various game-like hands-on activities and demonstrations, all in order to evaluate their impact on student motivation, perception and acquired knowledge. Also, this research should provide better insight into sustainability of proposed activities

and possibility of their permanent incorporation in teachers' curriculum and STEM education becoming a standard practice in evolving education curriculums.

General background and sampling

The research was conducted during the year 2023. Students included in the research (sample N=29) were 2nd grade (age 8-9) primary school students (both female and male) from Primary school "Moma Stanojlovic", Kragujevac, Serbia. The students were selected by random cluster sampling method i.e. all were from the same class.

Instrument and procedures

The activities designed for this study are within a subject *The World Around Us* on topic diversity of nature – water. Activities were held with the help of a teacher in a various forms: game-like hands-on activities and demonstrations. The experiments covered the following topics: water cycle in nature, surface tension, capillary force, reflection, reaction medium and heat capacity. All activities were prepared on the principles of STEM education requirements in a regular classroom setting. 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.

Children had the opportunity to get familiar with the topic *water cycle in nature* by experiment *Claud in the jar*. The experiment was first demonstrated by the teacher, and then the children, divided into small groups, were asked to repeat it. The topic *surface tension* was done through two game-like activities both set as competitions between two previously formed groups. In the first activity, a small glass of water was filled to maximum, and then teams were asked to alternately insert small nails to the glass. The team which first spilled the water loses. In the second activity, the teams were competing in whose fish travels further. Foam-paper fish-like cutout with V-shaped flipper is placed in the bowl filled with water. Q-tip is dipped in dishwashing soap and the area behind V-shaped flipper is touched. By breaking the surface tension, paper fish moves forward. The *capillary forces* were examined by hands-on activities by inserting young leaves of lettuce into the food coloring concentrated solution and *heat capacity* by examining which objects heat up quicker; empty or filled with water. The experiments based on *reflection* were conducted by creating a rainbow and drawing an arrow which inverts by placing it behind the glass filled with water. The children also addressed the property of water as a solvent and reaction medium.

To evaluate the outcome of the study two interviews were conducted. The first interview was conducted by the teacher on students. Due to the young age of participants, the data were collected by the teacher through the semi-structured interview which is flexible and open-ended in its nature. This type of interview is selected as an exploratory tool where students' answers could guide interviewer to future research questions that can help gain better insight into the outcomes of research and develop a more robust

knowledge base for future research. The questions were grouped in three clusters: (a) motivation, readiness and attitude; (b) personal experience; (c) obtained knowledge.

The second interview was conducted by the researchers with a teacher to examine: (1) usefulness and sustainability of proposed activities and possibility of their permanent incorporation in teachers' curriculum; (2) their accordance with the curriculum and whether they had a positive impact on learning process compared to the standard teaching plan; (3) possible difficulties of implementation of the proposed activities.

Results and discussion

The first part of the study is the implementation of prepared activities on the subject Water. Carefully designed experiments, which are in accordance with the curriculum, abilities and age of students, were conducted as described in the previous section.

During or after each activity, instead of presenting the answer and revealing the explanation of the observed activity, teacher was prompting the conversation with a range of proposed scenarios and questions for students in order to help them to uncover and construct meaning from their explorations. Also, questions were designed to prompt children to think about what they already know, what they expect might happen during activities and encourage children to try different ideas.

The data analysis of the first interview, conducted by the teacher on the students, revealed that the children were highly motivated and eager to participate in all activities, especially in those which included competition between the groups. All children were included in all activities and tasks were distributed among the members of the group by mutual agreement or sometimes by teacher. In the interview the students indicated that there were some problems in mutual communication, collaboration and work within some groups. It has been shown that in children this young, suitable division into groups represents one of the most important factors for students' positive personal experiences in group work. Therefore, teachers could be advised to pay more attention to this part when preparing for group activities. Generally, most of the children had a feeling that they had participated in a play and not to be involved in the learning process. The children who are known to be more introvert and shy showed more confidence and were more eager to participate than in regular classroom activities. After the activities all children expressed increased interest in the natural phenomena that surround them and showed intrinsic motivation in exploring them. Short quiz questions have shown that children obtained more lasting knowledge on a subject.

The data analysis in the second interview, conducted by the researchers with a teacher, have shown the applicability of proposed activities and its beneficial outcomes on students and obtained knowledge. The teacher pointed out as a possible downfold of these activities the time consumption and some problems with keeping the discipline and focus during some activities.

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