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PARENTS' PERCEPTIONS OF THE STEM CONCEPT OF LEARNING WITH STUDENTS OF THE FIRST CYCLE OF PRIMARY EDUCATION

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Abstract: This empirical research aims to examine parents' opinions on the STEM concept of learning. The sample included 125 parents of students in the first cycle of primary education. A descriptive method and surveying and scaling techniques were applied. A survey questionnaire with a five-point Likert-type rating scale was used. According to the majority of the parents surveyed, they do not use STEM activities with children and they have never attended any activity or workshop on that topic, because the school has not organized this type of activity; however, they will be happy to participate in these activities if the school organizes them. A large number of surveyed parents believe that it is necessary to take children to science museums, aquariums, workshops on the use of digital tools, or other events related to mathematics, the World Around Us/Nature and Society, and the Digital World since this would be one of the effective ways of encouraging children to develop a positive attitude toward the subjects encompassed by the STEM concept. The results indicate the need to support parents in understanding and applying the STEM learning concept with children, with a focus on the benefits that the application of this learning concept has on children's development, as well as the fact that schools and teachers do not deal, to a sufficient extent, with STEM activities by cooperating with parents. This opens up opportunities for future research on this problem within the first cycle of compulsory education.

Keywords: parents, children, STEM, integrative approach.

INTRODUCTION

STEM (Science, Technology, Engineering, Mathematics) learning concept has become a subject of numerous studies on all levels of education (from preschool to higher education), which indicates manifold advantages and opportunities for implementation, in both curricular and extracurricular activities.

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Ocal and Tuğluk (2023: 550) consider the STEM approach to "go beyond mere memorization of information to create solutions for everyday problems using the obtained information."

The aim of STEM concept is "to find solutions to problems by using scientific methods and giving importance to individual and collaborative studies" (Ceylan, & Akçay Malçok, 2020: 718), and such an approach to science, technology, engineering, and mathematics has an important role in developing skills for the 21st century. İdin & Dönmez (2020) state that STEM education inspires critical thinking, creativity, innovation, and communication. This aligns with the objectives of primary education and cross-curricular competencies in the Republic of Serbia. These include "the development of key competencies for lifelong learning and cross-curricular competencies in accordance with the development of contemporary science and technology; development of creative abilities, critical thinking, motivation for learning, the capability of teamwork, the capability of self-assessment, initiative and expressing one's own opinion" (Law on Primary Education, 2023: 5).

As children from an early age explore, observe, seek solutions and gain their first experience and knowledge about the world surrounding them within the family, "for the success of science education in classroom and out-of-school settings, parents' behaviors related to STEM are of substantial importance" (Šimunović, Reić Ercegovac, & Burušić, 2018:977). "Although parental involvement has been systematically forgotten as a critical factor" (Salvatierra & Cabello, 2022: 218), the results show that STEM activities can promote parental engagement, improve the value parents attribute to STEM, and positively affect STEM learning in preschoolers.

On the importance of including parents in schools, authors Matejević and Jovanović (2017: 14) state that "when the parents are involved, they learn about school programs and educational objectives at school, support their children's learning at home more effectively, and influence future education of their children more adequately." The strategic documents of the Republic of Serbia emphasize the need for and opportunities for parents to be involved in the operation of schools. According to the Law on Primary Education, schools are obligated to include the plan of involving parents or other legal guardians in their Development Plan. The same law states that with the aim of strengthening "educational activities of schools and encouraging individual preferences and interests" (Law on Primary Education, 2023:13), schools are obligated to implement extracurricular activities of the students, including those in the field of science. Through the program of cooperation with the family, the school defines areas, contents, and form of cooperation with parents, which, among other activities, include involvement in both educational and other

school activities. In line with the aforementioned, the school also has the legal capability to implement STEM activities and realize cooperation with the parents. Therefore, it is important for the school to "take initiative for the inclusion of parents into school activities through cherishing different partnership forms of a school and a family" (Matejević & Jovanović, 2017:18) to achieve well-being and support for the holistic development of a student, which is one of the primary objectives of primary education. We are witnessing that there is not enough research "on parent involvement in STEM as an integrated focus" (Thomas et al., 2020: 1). However, in a research conducted by Gülhan by analyzing 24 studies, the results show that there was a certain increase in 2021 and reportedly, "the subject of family participation in the STEM program (parent-child activities) is frequently studied" (2023:7). The researchers believe that "parents have a positive impact on their children's engagement with STEM and consequently on their achievement" (Milner-Bolotin & Marotto, 2018:53) and that "STEM education studies involving family participation is important in terms of bringing a different perspective to STEM education" (Gülhan, 2023:9), but despite the importance of parental involvement in STEM activities, there is still insufficient research in this area. In order for teachers and schools to engage parents in a meaningful way, they need to understand how parents perceive their role in their child's education regarding STEM. This is the subject of our research.

RESEARCH METHODOLOGY

The objective of the research is to examine the opinions of parents whose children attend the first cycle of education about the STEM approach. The following research tasks have been formulated: investigate if the professions/hobbies of parents are related to the STEM field and their awareness of STEM; investigate to what extent parents are engaged in STEM activities at home; determine if the parents need support in preparing and implementing STEM activities and the type of support they need; investigate if the parents have attended the activities, workshops at school and teacher's classes where STEM concept was applied; inquire if children have attended STEM-base activities and workshops outside of school; investigate which methods are efficient for parents to inspire their children to develop a positive attitude toward subjects within the STEM field.

A descriptive method and techniques of surveying and scaling were applied. A questionnaire with a five-point Likert-type evaluation scale was used. The instrument used was developed by combining adopted and modified questions from the instrument (Marotto & Milner-Bolotin, 2018) and questions

formulated based on relevant and tangent literature. In the introductory section of the instrument, besides clear instructions, we also included the link to the STEM education center https://www.stemeksperimenti.com/. Here, the participants could get familiar with the STEM approach to learning. In the first part of the questionnaire, the participants were required to provide basic information (gender of the parent, level of education, age, gender of the child, and grades they attended), while the second part of the instrument contained questions related to the objective of our research. The survey was conducted online, using an electronic questionnaire. The survey was conducted in January 2024. The acquired data were processed using the SPSS program.

The sample of the survey included 125 parents of students in the first cycle of education from different parts of Serbia.

Table 1. Structure of the sample of participants

	f	%
Gender of the parent		
Male	21	16.8
Female	104	83.2
Level of education of the parent		
Primary school	1	0.8
High school	39	31.2
College/University	54	43.2
Master	27	21.6
PHD	4	3.2
Age of the parent		
Younger than 34	16	12.8
From 34 to 37	38	30.4
From 38 to 41	40	32
Older than 41	31	24.8
Gender of the child		
Male	64	51.2
Female	61	48.8
Grade the child attends		
First grade	20	16
Second grade	31	24.8
Third grade	29	23.2
Fourth grade	45	36

RESULTS AND DISCUSSION

The first task to deal with was to determine whether the professions or hobbies of parents were related to any STEM discipline. 33 (26.4%) parents responded that their profession/hobbies were related to a STEM discipline, 28 (22.4%) partially related, and 64 (51.2%) parents responded negatively. Parents who answered with *yes* or *partially* were asked whether they would like their child to follow in their footsteps. 42.4% of the parents stated that they would like their children to continue on their path and get involved in some of the STEM disciplines.

Having in mind that within the group of surveyed parents, there were some who were involved in some of the STEM disciplines and the majority of those who weren't, it was important to examine whether the parents were aware of the STEM concept. The results of our research show that parents responded that they had not heard anything about STEM before to a low extent (M=2.52; SD=1.753) while the results show that "64.51% responded that it was not entirely clear to them what STEM education was about" (Milošević, 2022: 204). Milner-Bolotin & Marotto also state (2018) that the problem with involving parents and their support to the children in STEM activities was that some parents did not have enough information about the STEM concept, while the other problem was a language barrier.

In the following task, we have examined the extent to which parents were dedicated to STEM activities at home. Cronbach's α coefficient for the scale measuring parents' dedication to STEM activities is 0.926, which indicates the reliability of the scale.

Table 2. Responses on the extent of dedication to STEM activities at home

	M	SD
I invent various games in which I apply STEM.	2.66	1.350
I buy various board games which support STEM.	2.92	1.462
I buy various toys which support STEM.	2.83	1.430
While buying board games and toys, I choose those that support STEM.	2.82	1.362
I create toys with my child through STEM.	2.62	1.435
I exchange experiences and ideas about STEM with other parents.	2.10	1.201

The role of families is exceptionally important in different areas and spheres of a child's development, i.e. "parents shape children's interests and self-efficacy about STEM and content application that can favor their children's approach

to STEM" (Salvatierra & Cabello, 2022: 218). The findings presented in *Table 2* testify that the parents are not dedicated to a sufficient extent to STEM activities with children at home. The parents do not buy STEM-oriented games and toys, perhaps, because they require additional financial expenses. However, the findings also indicate that the parents very rarely invent different games and create toys with their children relying on the STEM concept. The lowest rating is recorded for the item stating, "*I exchange experiences and ideas about the STEM concept with other parents*." The results indicate the need to guide and empower parents to implement and use STEM activities and content with children. Although the parents have a positive attitude towards STEM education, they "also needed more training on how to work with their children in STEM activities and scaffold their children' learning" (Wan, Jiang & Zhan, 2021:940). Regarding the question of whether the parents needed support in preparing and implementing STEM activities, the following results were obtained: 79 (63.2%) parents feel that they need support in preparing and implementing STEM activities, 40 (32%) are not sure whether they need support and 6 (4.8%) responded negatively. Since the parents stated they needed support, one of the ways to address the problem is also one of the objectives of the Education Strategy until 2030, i.e. availability and openness of pre-university education which involves "a number of established functional resource centers for additional support to children, students, parents and employees in educational institutions" (*Strategija razvoja obrazovanja i vaspitanja u Republici Srbiji*, 2021:39). Thus schools will have the possibility to provide support for parents in implementing the STEM concept of learning through different forms of cooperation.

The parents who responded that they needed support were asked via an open-ended question to specify what kind of support parents needed. *Table 3* shows some of the parents' answers.

Table 3. Responses and suggestions of parents about the kind of support

"Workshops with children and parents, STEM educational sets and models to follow in working with their children."
"Workshops to demonstrate to parents how to implement STEM activities in everyday play with their children using materials accessible to everyone."
"Parents should get familiar with STEM concept itself and be provided with examples of activities they can use with their children."
"More information from schools and professional teams."
"More education about what STEM represents and what it entails."

"Textbooks could include sections for parents related to preparation and implementation of STEM activities."
"First of all, we need to have an educational workshop at school to get more familiar with the system and be provided with explanations and examples on how to work with children within this framework."
"I don't think that preparation and implementation of STEM activities should be parents' responsibilities. It would demand a certain level and breadth of their education which cannot be expected in a large percentage of our population. Those who already have a certain education and willingness to work with their own children could use educational workshops as the most convenient manner of engagement and learning of busy parents. My opinion is that STEM is primarily an approach that should be implemented at schools."

Types of support that the parents listed and described (*Table 3*) indicate that parents believe it is necessary to explain and present the STEM concept in more concrete terms, conduct workshops for parents and children, present models and examples that could be applied with children at home, provide support from schools and school staff and propose that the textbooks should include sections dedicated to parents with guidelines for STEM activities. The last response in the table represents the opinion that STEM should be nurtured only at schools since its implementation requires a certain education level of the parents. By all means, through education, preparation, and providing guidelines to all interested parents, these barriers in the context of the implementation of STEM activities could be overcome. The family environment is the relevant and the primary environment for a child (Vilotijević, 2002). Therefore, learning based on the popular STEM concept of learning should be nurtured in this crucial environment for a child. *Table 4* shows the responses of the parents on participation in activities and workshops organized by schools on STEM.

Table 4. Parents' responses on participation in STEM activities and workshops at schools

	f	%
Yes	6	4.8
No, because I couldn't attend	16	12.8
No, because the school hasn't organized this kind of activities and workshops	103	82.4
Total	125	100.0

The findings show that 82.4% of the parents state that they haven't attended these kinds of activities and workshops because they haven't been organized at

schools. Reportedly, 74 (59.2%) parents would attend if the school implemented and organized these kind of activities. Statistically significant differences exist between the level of parents' education and their potential attendance of activities and workshops that a school would organize (χ^2=24.969; df=12; p<0.05). There are no statistically significant differences between other sociodemographic variables and parent's responses regarding the attendance of STEM activities and workshops whether they should be organized at schools.

Table 5 shows parents' responses about attending classes where a teacher used STEM.

Table 5. Parents' responses about attending STEM classes.

	f	%
Yes	4	3.2
No, because I couldn't attend	15	12.0
No, because a teacher hasn't organized this kind of work	106	84.8
Total	125	100.0

84.8% of the parents state that they haven't attended this kind of activity because it hasn't been organized by the teacher. However, 62.4% of the parents responded that they would attend an event if organized by the teacher. By all means, the results obtained through our research sample show that schools and teachers are not sufficiently dedicated to collaborating with parents and involving them in STEM activities. However, "students need to be introduced to STEM areas as early as possible in the learning process so they would better accept them" (Puška & Puška, 2022: 123). The application of STEM models and concepts of learning and working with children features numerous benefits such as cooperation, exchange of ideas, work in groups, interaction, and research (Hanh, 2021). In line with the benefits, "STEM follows the principles of universal design for learning according to all three criteria – representation, engagement, and action and expression. Thus, it respects the diversity of all participants in the learning process and leads to better acquisition of knowledge, skills, and attitudes" (Stantić Miljački, 2020: 104). Therefore, we can agree that the school represents a favorable environment for the promotion of STEM activities and that the school practice should more frequently include this kind of work with students but also with their parents. The researchers state that "school-related projects, homework assignments, and visits to science centers open additional opportunities for positive STEM-related interactions between children and family members" (Rodari, 2009; Vartiainen & Aksela, 2013, according to Milner-Bolotin & Marotto, 2018).

31 (24.8%) parents responded positively, while 94 (75.2%) parents stated that their child had not attended STEM-based activities and workshops outside of school. Compared to older parents, younger parents more often indicated that their child had attended STEM activities and workshops outside of school (χ^2=9.389; df=3; p<0.05). Other sociodemographic variables proved not be relevant when it comes to children's prior experiences with STEM activities and workshops outside of school.

Table 6. Correlations between attending STEM activities outside of school and STEM-related professions/hobbies of the parents

		My child has attended STEM activities and workshops outside of school.	My profession/hobby is related to STEM disciplines.
My child has attended STEM activities and workshops outside of school.	r	1	.322
	p		.000
	N	125	125
My profession/hobby is related to STEM disciplines.	r	.322	1
	p	.000	
	N	125	125

Based on the calculated Pearson correlation coefficient, there is a positive and statistically significant correlation (r=0.322; p=0.000). The findings indicate a connection between a profession/hobby of a parent and child's participation in STEM activities and workshops.

The question is: What are the efficient ways for parents to motivate their children to create a positive attitude toward school subjects included in STEM (i.e. mathematics, world around us/science and social studies and digital world)? The parents ranked the suggested means of motivating children to develop a positive attitude towards curricular subjects from STEM field. Among the combination of multiple offered response modalities, the majority of parents primarily choose the modality that describes that it is necessary to *take children to science museums, aquariums, workshops on using digital tools, or other events related to mathematics, World Around Us / Science and Social Studies and Digital World.* The next most frequent choice was the modality which emphasizes that it is necessary *to help children with homework in Mathematics, World Around Us/Science and Social Studies; enroll children in extracurricular activities related to Mathematics, World Around Us/Science and Social Studies and Digital World* and the fewest number of parents choose modality which describes that it is necessary *to point out the role that Mathematics, World Around*

Us/Science and Social Studies and Digital World have in everyday life. "Numerous informal educational contexts such as museums, science centers and camps, botanical gardens, technology parks and facilities, in general spaces that contain and can offer information and insights related to science, technology, and engineering, are becoming important and essential places of learning" (Burušić et al., 2018: 27). The authors state that "out-of-school science clubs and visits to science centers open additional opportunities for positive STEM-related interactions between children and family members" (Milner-Bolotin & Marotto, 2018:53), which implies that these kind of visits should be more prevalent in family activities.

CONCLUSION

It is a fact that "most of the children start losing their interest in science and mathematics during school days" (Qureshi & Qureshi, 2021: 146) which implies the need to change and modernize school practice, educate and prepare parents, and implement STEM activities and workshops with children, focusing on bringing this kind of interactive and interdisciplinary method of work closer to children. Inclusion of parents in educational activities with children is very important for "the development of their competencies and their later achievements" (Đević, Stanišić & Vujačić, 2021:89) and this is why cooperation of a family and a school is essential for student success (Thomas et al., 2020). There are many possibilities for how teachers can include parents in STEM activities and events (Milanović, Miletić & Mijajlović, 2024). According to this survey, we can conclude that parents are not significantly dedicated to STEM activities and that they need support and training on how to implement STEM in family upbringing and free time. As expected, the findings show that there is a positive and statistically significant connection between STEM-related professions/hobbies and child participation in STEM activities and workshops. Based on the obtained results, it is necessary to support parents in the implementation of STEM activities with children and introduce parents whose profession/hobbies are not related to STEM disciplines with this innovative type of learning more thoroughly. Further research could focus more on this topic.

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