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PRE-SERVICE TEACHERS' KNOWLEDGE AND OPINION ABOUT STEM EDUCATION IN PRESCHOOL

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ABSTRACT. In recent years, the focus of many researches has been on STEM activities and their application possibilities. The current research examines the opinion and experience of 85 Primary and Preschool Pedagogy specializations students regarding the use of STEM activities in kindergarten. The research tool was a questionnaire that included 18 questions: 5 questions with demographic data, 3 questions on how to integrate different experiential fields in pre-school activities, and 10 questions related to students' knowledge and experience about STEM activities.
The results show that students integrate different experiential fields. More than half of the respondents are unfamiliar with the term STEM and don't have any personal experiences with STEM. These results highlight the necessity of integrating STEM Education in pre-service and in-service teachers training. The results also present students' opinion about the essence and opportunities of STEM Education, and the cognitive, emotional, social, and physical skills/abilities most developed by STEM.

Keywords: *pre-service teachers, preschool, STEM education.*

INTRODUCTION

Science, mathematics, technology and engineering provide knowledge, skills and tools for solving problems from everyday life, for improving life quality. It is very important that members of the society, and especially young people, have the right level of scientific and technological literacy, which competencies are useful both at workspace and everyday life. (English 2016, NGSS Lead States, 2013, National Research Council, 2014,).

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What does the concept of STEM activities mean? STEM is an acronym of the first letter of four words, which means the combination of science, technology, mathematics and engineering. STEM activities have become the focus of national academies, as research has shown that fourth-year children who did not encounter STEM activities in their early years lacked math and science key/basic skills. Furthermore, Chesloff (2013) found that curiosity, creativity, collaboration, and critical thinking are among the central concepts of STEM activities, and therefore the application of these activities should be initiated/applied in preschoolers. Lippard, Lamm, and Tank (2019) emphasize that children's early positive STEM experiences are key to addressing the challenges of the modern world.

Young children are basically characterized by a natural curiosity and enthusiasm for exploring the world around them, for these children science means the knowledge they discover (Conezio and French, 2002). Research results, highlighted by the National Association of Educators of Young Children (NAEYC) have shown that the earlier we support and guide children to marvel at the outside world, the more successful they will be later in all areas of learning (Pawilen and Yuzon, 2019). From science, young children learn important concepts and facts related to their experiences of everyday life (Carale and Campo, 2003; Conezio and French, 2002; Tolman, 1995) which is why interest in science can be easily introduced from an early age. Gaining scientific experience in children also develops many of their cognitive skills. They learn and acquire important skills such as the processing skills, critical thinking, and life experience they need to cope with their everyday tasks (Chaille and Britain, 2002). At the same time, science is a collaborative relationship where working together and discussing ideas are important for practice (Worth, 2010). Technological education of young children is about developing, inventing, and creating new ideas that are actually related to engineering science. Providing young children with access to technological knowledge allows them to look at how certain tools work, how to further develop objects/tools to meet a need or solve a problem, and develops curiosity, creativity in by discovering new things (Pawilen and Yuzon, 2019). Engineering education allows young children to apply their math and science knowledge in order to develop, model, and evaluate something, and to find solutions to problems that arise. At the same time, the engineering creation process, which involves identifying the problem, evaluating the options, and optimizing the solutions, is very important in a wide variety of problem solving. Therefore, preschool teachers can use kindergarten children's favorite play activities (such as building from blocks or rocks or sand) to develop young children's engineering and design skills (Meeteren and Zan, 2010). Mathematics is an

important subject in the curriculum which develop skills useful in everyday life, as counting, calculating, measuring, estimating, comparing, classifying, grouping, etc. At the same time, mathematics develops problem solving and logical thinking, which are also important to thrive at work and in everyday life (Pawilen and Manzano, 2007).

Numerous studies demonstrate (for example, Watts et al. 2014) that early childhood scientific, mathematical, engineering, and technological knowledge and experience significantly influence school performance. In order for preschool children to have adequate knowledge of STEM, the kindergarten teachers who educate them must have the appropriate level of knowledge and experience. In Romania, the current Curriculum focuses on the holistic development of children, taking into account several areas of development, while supporting a balance between the harmonious development of learning and personality. Kindergarten activities are organized on the basis of the principle of integration, where the learning process is realized by connecting several experiential fields (Ministerul Educației Naționale, 2019). However, this does not yet mean the integration of STEM activities into the Curriculum. Moreover, the acquisition of the planning/application of STEM activities is not implemented in the Romanian teacher training either. In Romania future primary and preschool teachers are not trained in the Engineering and Technology domains, thus they usually exclude the Engineering and Technology domains from their teaching activities. The Science, Mathematics, Arts and Reading domains are quite frequently integrated in their teaching activities (Zsoldos and Ciascai, 2019).

In this paper a research is presented about Primary and Preschool Pedagogy specialization (PPP) students' opinion and practice on the specifics of STEM activities in preschool, based on their experiences gained during pedagogical practice.

METHODOLOGY

This survey was conducted in the first semester of the 2021-2022 academic year. The aim of the research was to map preschool and primary school pedagogy specialization students' opinions and experiences regarding the use of STEM activities in kindergarten.

Research questions:

This research tries to find the answers for the following questions:

Q.1. What are the areas which students can successfully integrate into the planning of preschool activities?

Q.2. Are students familiar with the term STEM and its meaning?

Q.3. In students' opinion, what are the essence of STEM activities in education and what cognitive, social, physical, emotional skills/abilities do STEM activities develop?

Q. 4. What personal experience did students gain in applying STEM activities during their pedagogical practice?

Q. 5. In students' opinion, how can the more frequent use of these activities be encouraged?

Participants

The participants of this study were 85 Primary and Preschool Pedagogy specializations students from Babes-Bolyai University: 51 second-year students and 34 third-year students. In terms of gender distribution, 1 (1,2 %) of the respondents was male, this under representativeness of male students is typical for PPP student population.

Instrument

In the research an online questionnaire edited in Google Forms was used which included 18 questions: 5 questions regarding demographic data, 3 questions about how to integrate different experiential fields in pre-school activities, and 10 questions related to respondents' knowledge and experience in STEM activities. Questions about STEM activities were adapted from a questionnaire developed for early childhood education teachers, as well as student teachers, used in several countries as part of the "Kitchen Lab for Kids" Erasmus+ project, coordinated by the University of Catalunya (K4K, 2020).

RESULTS

Q.1.: The experiential fields which can be successfully integrated in students' opinion

95.3% of respondents integrate different experiential fields. This explains the validity of the principle set out in the Curriculum as a recommendation (Ministerul Educaţiei Naţionale, 2019). In the second question respondents had to indicate which experiential fields could be optimally integrated. In accordance with the current Romanian Curriculum regulations, the following experiential fields are included in kindergarten: environmental education,

mathematics, mother language, Romanian language, physical education, handicrafts, fine arts education, singing music, and moral/household education. In the questionnaire a table which contains the names of the experiential fields both in the rows and the columns was included. Respondents had to mark in each row of the table the experiential fields which can be integrated with the experiential field given in that row. The number of occurrence of each experiential field pair which can be integrated was counted. The results have shown that environmental education was most often associated with mathematics (40) and mother language (17) by both second- and third-year students, and mathematics was also most often associated with environmental education (38). In the case of mathematics, the activities chosen in addition to environmental education differed between second- and third-year students: second-year students would prefer to integrate it with fine arts education (8) and handicrafts (6), and third-year students would integrate it with mother language (4) and physical education (4). Mother language activities are combined with singing-music (25), environmental education (14) and fine arts education (16) in both groups, in different proportions. Romanian language (which is the official language of the state but taught as a foreign language), was most frequently integrated with singing and music education (28) from both groups, as well as fine arts education (17). To integrate singing and music activities, second year students preferred physical education (16) and third year students preferred fine art education (12), but physical education was also the second most common answer (9). Fine arts education would be linked to the same activities by members of both groups, only in different proportions: while second year students would add to their knowledge of the environment (16), third-year students chose the mother language activity (15) in greater numbers. Moral/household activities were most often integrated with mother language activities (39) in both group of students. The biggest discrepancy was observed for handicraft activities, with the two groups choosing completely different experiential fields for association: second-year students tended to associate them with environmental knowledge (12) and mathematics (9), while third-year students integrated them with mother language (11) and singing-music activities (5). With physical education activities, both groups linked singing/music (37).

Q. 2. Students' knowledge about the STEM term and its meaning

67.4% of the respondents are unfamiliar with the term STEM: 64.7% of second-year students and 73.52% of third-year students did not know the acronym STEM. It is surprising that the result is worst in the third-year group, this shows that the subjects learnt during university studies didn't help them

to familiarize with STEM education. Comparing this result with those from other countries, seems that the familiarity with STEM of pre-service or in-service preschool teachers is different from country to country and even depends on the higher education institution where the participants are studying. For example, in the study of Karademir and Yıldırım (2021), pre-service preschool teachers in their last year of study could give a definition for STEM education, while in the research of Baltsavias and Kyridis (2020) in-service preschool teachers are not so familiar with STEM education or in the experimental research of Aleksieva, Mirtschewa, & Radeva, (2021) participating preschool teachers were unfamiliar with STEM before the intervention. These results suggest that teachers' familiarity with STEM education depends on the pre-service or in-service teacher training curriculum.

After some description what STEM education is, students were asked to give the logical value of some affirmations about STEM education, affirmations from which three were false. The first false statement was that STEM activities are included in the current Preschool Education Curriculum in Romania. 4 (7.84%) second-year students thought this statement to be true, and none of third-year students marked it as true. The other false affirmation was that STEM activities could only be applied successfully at school. In this respect, 6 (11.76%) second-year students considered the statement to be true, and 2 (5.88%) third-year students chose it as true. The third false statement was that STEM activities always require digital tools. 11 (21.56%) second-year students and 5 (14.7%) third-year students considered this affirmation to be true. It is interesting to observe, that despite the fact, that third-year students were less familiar with STEM education, after a short explanation they were more able to understand what STEM Education is. Maybe they have already had some knowledge about STEM education, they only have never met the acronym STEM.

Q. 3.: Students' knowledge about the essence of STEM education and the cognitive, social, physical, emotional skills/abilities developed by STEM

To find out student's opinion about the essence of STEM Education in preschool and the opportunities it gives, two set of affirmations measured on a 5-leve Likert scale were formulated. For comparing the answers given by the two groups two-sample t-test was used in case of each statement (Table 1). There are small differences between means in case of some affirmations, but no statistically significant difference was found for any of the statements. Second-year students have higher mean in case of 5 statement out of 7 as regarding the essence of STEM Education and 6 statement out of 8 as regarding the opportunities of STEM Education. The most agreed statement describing the essence of STEM Education

is that it encourages children to think creatively in science areas. Creative thinking appeared the most important benefit of STEM education also in other research (Karademir & Yıldırım, 2021). The most agreed opportunities of STEM education are building children's knowledge about the social, natural, and technical world; having practical experiences; and awakening positive emotions and motivation to learning in the sciences.

Table 1. Comparison of the answers given by the second- and third-year students about the essence and opportunities of STEM Education in preschool

Statement	2nd year		3rd year		p	t
	Mean	**Var.**	**Mean**	**Var.**		
Essence of STEM Education						
1. Encouraging children to learn through direct and personal experiences	4.24	0.66	4.26	1.11	0.890	0.138
2. Encouraging children to think creatively in science areas	4.55	0.49	4.32	0.77	0.215	-1.254
3. Developing an active process of learning – teaching	4.16	0.69	4.24	0.91	0.698	0.390
4. Identifying and solving problems in natural everyday situations	4.12	0.83	3.94	1.33	0.456	-0.750
5. Building an integrated, holistic world view in the child's mind	3.94	0.74	3.91	1.05	0.891	-0.138
6. Supporting the child's holistic development	4.02	0.62	3.85	0.86	0.392	-0.862
7. Developing the process of learning– teaching, incorporating at least two of the STEM areas	4.16	0.77	4.00	1.09	0.473	-0.721
Opportunities of STEM Education						
1.Building a positive self-image	3.61	0.92	3.59	1.16	0.932	-0.086
2.Awakening positive emotions and motivation to learning in the sciences	4.53	0.41	4.38	0.55	0.348	-0.946
3.Building children's knowledge about the social, natural and technical world	4.63	0.32	4.38	0.55	0.106	-1.641
4.Self-directed and independent learning	4.04	0.80	4.18	0.82	0.493	0.690
5.Collaborative learning	3.90	0.93	4.03	0.70	0.519	0.648
6.Having practical experience	4.59	0.33	4.47	0.68	0.472	-0.723
7.Encouraging children to learn by playing	4.47	0.61	4.29	0.88	0.368	-0.906
8.Asking questions and searching for answers by doing experiments	4.41	0.73	4.35	0.72	0.756	-0.312

The next four questions tried to find out what cognitive, emotional, social, and physical skills/abilities the STEM activities develop according to students. In the field of cognitive skills, the majority of respondents 56 (75.6 %) say that exploratory and creative thinking can be developed most through the use of STEM activities in early childhood. This result is the same as that obtained in the partner countries of the K4K Erasmus+ project (K4K, 2020). Also Turkish preschool teacher candidates consider STEM activities as helpful for developing children's creativity (Ültey & Ültey, 2020; Karademir & Yıldırım, 2021). 70% of the respondents (81.4%) thought that STEM activities are the best way to develop teamwork among social skills / abilities, which confirms previous research results (K4K, 2020; Karademir & Yıldırım, 2021). Regarding the emotional skills/abilities, most respondents 59 (68.6%) said that STEM activities develop independence the most. This answer ranked second among the results of the research used for developing the questionnaire (K4K, 2020). According to students, the following two physical skills and abilities are most developed in STEM activities: experiencing the world through the senses (52 responses, 60.5%) and fine and great motor skills (51 responses, 59.3%), which results are similar to those obtained by the K4K team (2020).

Q. 4.: Students' personal experience with STEM activities

52 (60.5 %) of the respondents said they had no experience in this area (see Table 2). This result is thought-provoking because in the K4K project most respondents, who were early childhood education teachers or student teachers, already had some personal experience in applying STEM activities. The most frequently selected (by 18 students) type of experience is conducting science observations and experiments.

Table 2. Respondents' personal experience with STEM activities

Type of experience	2nd year students (frequency)	3rd year students (frequency)	Total (frequency)
1. Conducting science observations and experiments	11	7	18
2. Researching physical characteristics of the world	8	3	11
3. Workshops in the area of Informatics	5	0	5
4. Interdisciplinary projects integrating at least 2 different areas of STEM education	1	3	4
5. Fieldtrips and workshops (in the wood, at the meadow, etc)	7	3	10
6. Excursions to science centers/university laboratories or workshops	8	3	11
7. I do not have any STEM experience in early childhood education.	29	23	52

Q. 5.: Ideas for making STEM activities more often used in kindergarten

Respondents think that in order to make STEM activities more often used in kindergarten, the knowledge of kindergarten teachers about STEM contents and methodological aspects related with these activities should be increased (56 responses, 64%). Training in STEM education and support for the trainees in implementation of STEM activities in their preschool groups is an efficient way to increase teachers confident in their STEM knowledge and to change their attitude towards STEM activities (Aleksieva, Mirtschewa, & Radeva, 2021; Fridberg, Redfors, Greca, & García Terceño, 2022). STEM education related disciplines should be included also in prospective preschool teachers' academic training. Even one STEM education discipline could have a significant impact on prospective preschool teachers' tendencies about integrated STEM activities (Uğraş & Genç, 2018). There is also a need for long term professional support in STEM implementation. Those professional development programs in STEM education which includes practicum with the guidance of a mentor offer STEM teaching experiences and are more efficient (Chen, Huang, & Wu, 2021). 11,6% of the respondents consider that changing preschool teachers' motivation regarding STEM activities would also help improving the situation. Research show that motivation for teaching STEM increases as confident in STEM content related and methodological knowledge increases (Aleksieva, Mirtschewa, & Radeva, 2021), thus teacher training would be the solution also for this suggestion. 9,3% of the respondents consider that providing preschools with the necessary STEM tools would also contribute to the increasing frequency of the STEM activities. The lack of the necessary tools is considered one of the main obstacles for implementing STEM in preschool (Ültey & Ültey, 2020).

CONCLUSION

The aim of the research was to map students' opinions and experiences regarding the use of STEM activities in kindergarten. The results show the following:

Primary and Preschool Pedagogy specializations students integrate different experiential fields, this is in accordance with the current Romanian Curriculum regulations. The results show that the most often associated experiential fields are environmental knowledge and mathematics. This can be a starting point for understanding the importance of implementing STEM activities, as these activities include mathematics and science. Unfortunately,

more than half of the respondents are unfamiliar with the term STEM. It is surprising that the result is worst in the third-year group, this shows that the subjects learnt during university studied didn't help them to familiarize with STEM education. More than half of the respondents have no personal experience with STEM. The most agreed statement describing the essence of STEM Education is that it encourages children to think creatively in science areas. The most agreed opportunities of STEM Education are building children's knowledge about the social, natural, and technical world; having practical experiences; and awakening positive emotions and motivation to learning in the sciences. The cognitive, emotional, social, and physical skills/abilities most developed by STEM activities, in the view of the respondents, are exploratory and creative thinking, independence, teamwork, respectively experiencing the world through the senses and fine and great motor skills.

The results of the study show that there is a need for change at several levels: at the curriculum level the teaching of STEM activities should be included, and at the pre-service and in-service teacher training level preparation for teaching STEM activities should be included.

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