CHAPTER IV: ICT TOOLS – EFFECTIVE USE IN EDUCATION

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INTRODUCING THE YOUNGEST TO STEM EDUCATION IN TEACHERS' EXPERIENCES: ´KITCHEN LAB FOR KIDS´ PROJECT

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Abstract: *The article presents the results of research conducted with pre-school teachers as part of the international research project ´Kitchen Lab for Kids´ carried out within the framework of Erasmus+. The aim of the interviews was to find out if the teachers know what STEM education is and what skills develop in their pupils, how teachers develop STEM skills in their work, what conditions are needed to develop STEM competences in early childhood education, and what are the opportunities to develop scientific knowledge and skills through activity (learning) based on food/cooking in the early years.*

Keywords: STEM**,** preschool**,** preschool teachers**,** kitchen as a laboratory, KLab4Kids

INTRODUCTION

The modern world is changing very dynamically. This world requires teachers, including preschool teachers, to adapt the educational offer to the standards of the 21st century. We are currently observing that the demand for STEM (Science, Technology, Engineering, Mathematics) skills is still growing. Such education instils in the pupils a passion for exact sciences showing them that STEM is a fantastic adventure, giving them a chance for a good start in adult life.

James J. Heckman - Nobel laureate in economics in his works clearly stresses the importance of education from the first years of life:

"Early childhood development drives success in school and life. A critical time to shape productivity is from birth to age five, when the brain develops rapidly to build the foundation of cognitive and character skills necessary for success in school, health, career and life. Early childhood education fosters cognitive skills along with attentiveness, motivation, self-control and sociability—the character skills that turn knowledge into know-how and people into productive citizens." (Heckman, 2013)

1. STEM CONCEPT APPLIED IN PRE-SCHOOL EDUCATION

The notion of STEM gained popularity at the beginning of the 21st. century. The acronym was coined by the U.S. National Science Foundation (NSF) and the term has been commonly used to denote common teaching areas. According to a definition proposed in a 2012 report: *Science, Technology, Engineering, and Mathematics (STEM) Education: A Primer* 'STEM Education' means "teaching and learning in the fields of science, technology, engineering, and mathematics. It typically includes educational activities across all grade levels - from pre-school to post-doctorate - in both formal (e.g., classrooms) and informal (e.g., afterschool specific for programmes) settings." (Gonzalez, Kuenzi, 2012, p. 1).

All disciplines constituting STEM – that is: science, technology, engineering and mathematics - are closely and intricately interconnected. Despite their distinctiveness, the well-defined scope of knowledge they individually represent and the characteristic features each of these disciplines, they all share one common set of basic processes and practices, which can constitute an attractive area for a vast array of educational activities. It is the possibility of integrating various disciplines within STEM that should be seen as a crucial advantage of the concept. This approach helps to greatly enhance the educational process and make it become closer to the life and individual experience of a particular person.

The idea of education based on the STEM model supports defining and solving problems while promoting critical thinking. However, the core value of the approach consists in asking questions in combination with exploration and experimentation. STEM as an educational strategy is in keeping with the current trend promoting interdisciplinary and life-long learning. In addition, the concept is close to everyday life and its various situations and problems. STEM-based education, by developing interests and passions already in very young children, attempts to prepare the young generation to start their future jobs in the area. The STEM model increases learners' motivation to study and promotes the feeling of agency in a person (Plebańska, Trojańska, p. 19).

The skills promoted by STEM Education are becoming an increasingly relevant component of the set of competences necessary for effectively functioning in the contemporary world – digitised and permeated with technology. They are already defined as fundamental skills, alongside the traditional ones – such as reading and writing. The literature on the subject has recently recognised a newly-coined term 'STEM-literacy'. The concept, interestingly, does not mean achieving proficiency in the scope of the four STEM disciplines that could simply be the sum of its constituents, but, instead, refers to competence synergy (Zollman, 2012).

The intertwining of individual disciplines may progress in a number of different ways. Children, when working on projects, gradually and systematically build up their knowledge about a specific topic in a given subject. According to some researchers, the most successful 'integration' occurs in a situation when a project is centered on one, dominant discipline, which is strongly emphasised. It should be, however, accompanied by problems and issues coming from other – background – disciplines (*Early STEM Matters. Providing High-Quality STEM Experiences* …, 2017, p. 7).

It should be noted that the majority of analyses and discussions focusing on STEM education traditionally referred to secondary or tertiary education. It is only recently that its importance has been properly recognised already in the early stages of pre-school education. Special emphasis is currently being placed on introducing children to science and technology from the earliest possible age, which should be accompanied by the development of openness and curiosity about the world.

Teachers and adults that support children in their development play an important role in the successful implementation of STEM education. This will become particularly obvious after reading the following guiding principles formulated by the authors of the 2017 report: *Early STEM Matters. Providing High-Quality STEM Experiences for All Young Learners*:

"1. Children need adults to develop their "natural" STEM inclinations.

2. Representation and communication are central to STEM learning.

3. Adults' beliefs and attitudes about STEM affect children's beliefs and attitudes about STEM.

4. STEM education is not culturally neutral." (*Early STEM Matters. Providing High-Quality STEM Experiences* …, 2017, p. 7).

In the context of this paper one should perhaps stress the relevance of the first two principles. Children may be willing to explore the surrounding world on their own, but they tend to quickly lose interest, grow impatient or show little enthusiasm when seeking answers to the problems they encounter. They easily give up efforts if the first one or two attempts at solving the problem fail. It is important that -

when confronted with such challenges – the child is accompanied by another person, who can help sustain their cognitive activity by defining the problem, directing the child toward the right answers, encourage persistence as well as supply valuable teaching aids and materials. Then, there is the commonly-held opinion that aptitude for such disciplines as, for example, mathematics or other sciences is inborn. Such views expressed by adults – whether teachers or parents – may create barriers that will impede the child's development and produce unfavourable learning conditions. A new outlook on this issue may bring enormous benefits as it will prevent the negative attitudes and beliefs that impose self-limitations on children. Therefore, the quality of STEM education may be improved through proper teacher training that will equip teachers and educators with all necessary knowledge and skills as well as provision of support and guidance in their teaching activity.

In addition, the authors of the above-mentioned report observe that: "Early childhood educators too frequently lack access to high-quality STEM education resources, lack guidance about what makes STEM resources high quality, and lack support for using available resources effectively. Educators need clear and concise information about what constitutes a high-quality STEM resource, and they need access to and support for implementing existing and newly-developed high-quality resources" (*Providing High-Quality STEM Experiences …,* 2017, p. 28).

2. RATIONALE AND AIMS OF THE 'KITCHEN LAB FOR KIDS' PROJECT

The KITCHEN LAB FOR KIDS (KLab4Kids) Project, developed since 2018 under the ERASMUS+ programme, aims to collect and analyse issues related to STEM education at the pre-school level. The primary goal of the project is to facilitate the exchange of experiences and good practice in the scope of promoting active learning of STEM education (Science, Technology, Engineering and Mathematics) in European countries. The project outcomes should also stimulate and encourage teachers to explore modern interactive methods of teaching and learning that would support education within various STEM domains. Other important goals of the project include key issues related to methodological aspects and solutions, including pre-school level STEM education that would be both effective and attractive for children. In the times of an unprecedented technological development, one must not waste children's enormous potential. Small children, with their naturally curious predisposition, are eager to engage in exploration of the surrounding world. They experience it directly as well as through observation of adults attending to their daily routines. Thus, it seems reasonable to see the kitchen as an 'in-house' scientific laboratory, in which children will be introduced to the world of knowledge in an interesting and accessible manner.

The KLab4Kids Project is an initiative of 5 academic institutions from Poland, Italy, Ireland and Spain: Jesuit University of Philosophy and Education "Ignatianum", Libera Universita Maria SS Assunta, Fondazione Politecnico Di Milano, Universitat Internacional De Catalunya and Dublin City University. The project is coordinated by the Jesuit University of Philosophy and Education "Ignatianum" in Cracow.

The project is primarily addressed to pre-school teachers as well as pedagogy students and parents.

KLab4Kids aims to engage teachers and parents in assisting small children aged 3-6 in integrating knowledge from various areas as well as help to relate teaching and learning to the external world and individual interests and ambitions of every child. The project, which falls into the category of edutainment, seeks to combine preparation of meals, cooking and exploring various alimentary products with the acquisition of scientific knowledge. Alimentary products used for cooking as well as processes and phenomena taking place while performing various kitchen tasks are perceived as objects of research and child analyses. Also, one of the project aims has been defined as raising children's awareness of hazards which they can encounter in the kitchen environment.

The outcomes of the KLab4Kids Project will include diagnosis and description of teachers' needs in the scope of STEM education in participating countries as well as the development of a Teaching Set. The set will contain a theoretical overview of problems of early STEM education, guidelines for the organisation of teacher training in STEM, search of supplementary materials and use of online resources, a detailed description of basic skills and key competences developed through STEM education and, finally, a range of typical teaching techniques and good practice, including games and experiments ready to use in pre-school classes. The set of tools and papers for teacher use will be provided as guidelines and recommendations for pre-school STEM education. The project will spin off KLab4Kids practitioner community – a platform for sharing knowledge and experience related to STEM.

Full description of the project is available on: http://kitchenlab4kids.eu/.

3. METHODOLOGICAL FRAMEWORK OF THE PILOT STUDY

A general principle to be followed with qualitative – i.e. questionnaire-based – research requires that the actual study is preceded by some kind of preliminary review. The literature on the subject distinguishes three types of preliminary studies. Even if the actual terms denoting them may vary, they have recently been referred to as reconnaissance, pilot study or pretest and trial test.
In view of the assumed goals of the extended pilot study, the test of research tool (in this case – questionnaire) was to determine whether the questions included in the questionnaire yield relevant responses – that is: whether they produce

specific information sought by the research team. Can one trust the obtained results as true, that is: are the responses not only relevant, but also accurate? (Grzeszkiewicz-Radulska, 2012, p. 117).

The pretest (pilot) study provided the research team with preliminary information concerning the validity of the research procedure adopted. The interviews were conducted on a small (10 persons) non-random sample. The sample was selected using purposive sampling according to criteria proposed by the researchers and adjusted to the specific character of the project. The studies were conducted in all countries participating in the project. This paper presents the findings of preliminary studies conducted in Poland. The results of pilot studies in other partner countries will be presented as part of other publications created as part of the project.

The study aimed to offer the research team an insight into pre-school teachers' opinions on STEM education. The main problem posed in the study has been defined as follows: What is the level of knowledge about STEM education among pre-school teachers? Specific problems have been formulated as follows:

- What are STEM skills?
- How do pre-school teachers develop STEM skills in their pupils?
- What scientific content and skills can be developed through food/cooking-based activity (learning) at an early age?
- What are the necessary conditions for developing children's STEM competences in early education?

The main research method used for the purpose of the study was the interview-based diagnostic survey, which was later used to develop the proper tool to be used in the actual study – survey questionnaire.

4. PRESENTATION AND DESCRIPTION OF THE STUDY FINDINGS

Initially, respondents were unable to explain the term STEM education. Once the notion had been defined by the researcher, they would describe STEM as the ability to integrate various scientific domains. This would be the process of teaching and learning which combines natural sciences with mathematics, technology and engineering both in pre-school and adult education, in formal and informal contexts. It is a blend of play, active participation, modern technology, mathematics and engineering. STEM education builds children's knowledge about the world in its social, natural and technological dimensions. Children are not fed with knowledge, they actively acquire it.

Respondents were further asked to clarify what they understood by STEM skills. The notion was mainly interpreted as a set of so called key competences,

which are currently given strong emphasis. Other responses have been shown in Figure 1 below.

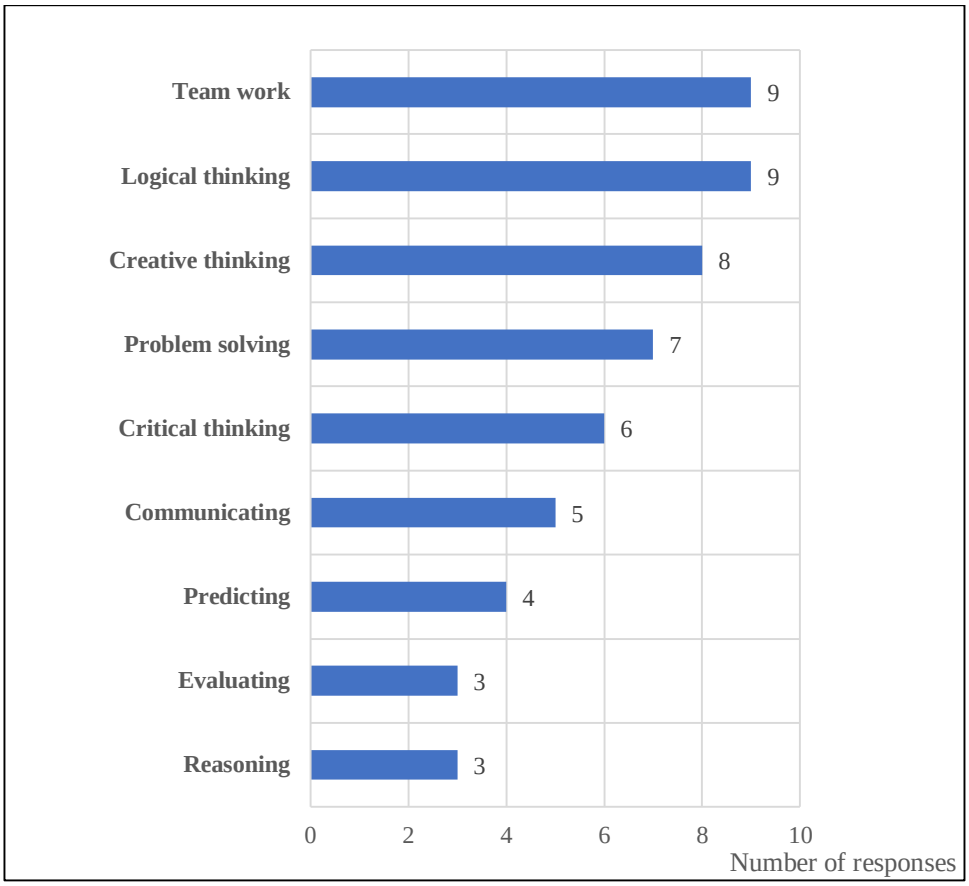

Figure 1. STEM skills in the opinion of the respondents
Source: Own work

All respondents, when asked whether developing STEM skills from an early age is important, answered in the affirmative. 'Children are by nature curious and genuinely interested in how the world and its processes work'. 'Equipping children with STEM skills encourages them to think 'beyond here and now' and thus develops them into more creative and abstract thinkers, helping them to take a more active approach to lifelong learning'. This will be of importance for them in their future lives. The introduction of STEM skills development offers a great advantage as children, from the very early age, develop creative and logical thinking; they acquire autonomy in practical activity as well as cooperative efforts. This approach to teaching engages the child, promotes 'investigating', critical and creative thinking, drawing conclusions and overcoming difficulties. Children are permanently engaged in activities, trying to address various problems in order to understand the world around them. The teacher can manage this natural

curiosity and creativity, encourage asking questions and seeking answers. Social competences are of great importance too as children are encouraged to share ideas, they start getting ready for adult life, work and proper functioning in the society, in line with 'new standards'. All of this boosts their commitment and motivation to act.

According to the respondents, as STEM skills are useful in everyday life, everyone should be equipped with at least basic level of STEM competences. This entails enhanced employability, better career prospects, the ability to cooperate in varied environments as well as the willingness to work toward common good and the ability to solve problems of daily life.

When asked how teachers in pre-school education develop STEM skills as part of their job, the majority of respondents answered that they involved children in the process of problem solving, that enables them to make use of various experiences and create their image of the world. 'Children are small explorers... they have thousands of questions to ask, they never stop asking: 'Why?'". Teachers arrange inspiring situations that lead to new experiences which challenge children to come up with effective surprise, reflection, curiosity, cognitive conflict or motivation to verify knowledge through critical examination. Teachers also provide children with opportunities to undertake research activities, they make use of a host of learning methods to stimulate day-to-day peer work. Additionally, they create conditions conducive to the development of imagination and spatial thinking by, among other things, drawing, painting, creating and constructing. Teachers encourage the youngest children to design and build simple tools and devices and to create visual models (maps, charts and diagrams, layouts: parts of a room, complete room, house, nursery school, garden, playground); they devise a setting for discovering the natural reality through observation, experimentation and exploration. During the classes they use numerous materials and resources that require children to rely on their problem-solving skills and creativity. Equally importantly, children are exposed to the natural environment, stay in contact with nature, where they can get involved in research-type play, conduct observations and their own experiments. In their teaching and educational activity, teachers apply the method developed by Maria Montessori as it integrates various domains of science and approaches specific problems assuming various aspects and perspectives. In addition, the Montessori environment is supported by comprehensive materials, which enable children to develop their knowledge in the scope of mathematics, technology and daily life. 'We run classes using sensoplast products. Children explore the world using their various senses'. Last, but not least, teachers embark on European projects, which integrate knowledge from various areas covered by the eTwinning programme, they develop pedagogical innovations.

Teachers, when asked to give examples of good practice in the scope of teaching/acquiring STEM skills at the pre-school level in children's direct environment, reported weekly buffet breakfast events, where children select

ingredients for sandwiches to be added to the menu. Children set up herbal mini-gardens in ‘nature corners’ or grow vegetables – later used for various meals - in nursery school gardens. Some schools organise monthly culinary workshops, during which children prepare dishes according to recipes contributed by the children themselves and their parents. ‘We are doing a project on “Culinary travels around Europe”. ‘Once a year we arrange visits to a restaurant kitchen to see professional cooking equipment’. ‘On sunny days we organise picnic parties and eat food we have prepared in the garden’. ‘We ask children to bring simple kitchen equipment and together we learn how to use it’. ‘We invite various professionals who tell us about their work: preparation of food (chefs), healthy food (dieticians)’, etc.

The next question asked respondents about skills that are developed in children when conducting research related to food, nutrition and/or cooking. Respondents reported that children are introduced to nutritional values of various food products (including new flavours) and that they are given an opportunity to compose dishes (juices, salads, sandwiches, cupcakes) on their own. They reinforce ‘positive’ eating habits, overcome dislike for some healthy foods as ‘meals you have prepared yourself bring more satisfaction and almost always taste better’. They explore the world around them from the kitchen perspective, through a host of various experiences. During group cooking sessions, children discover new interesting facts related to dishes and culinary traditions, they find out how to lay a table, what is used for eating, how one should eat and how to prepare food to make it safe, healthy, clean and tasty. Besides, they enjoy it a lot... they can pour, add, mix, blend and sprinkle things and do much much more. They learn to plan the next steps to be taken. They expand their range of vocabulary (children learn names of particular foodstuffs as well as the terminology related to food preparation). Children are given a boost of creativity (they can combine various products and are given space for experimenting, they learn that trying out new solutions is something positive).

Feedback on knowledge and science-related skills, which can be developed through active participation (learning) based on food and food preparation at an early age, has been graphically summarised below:

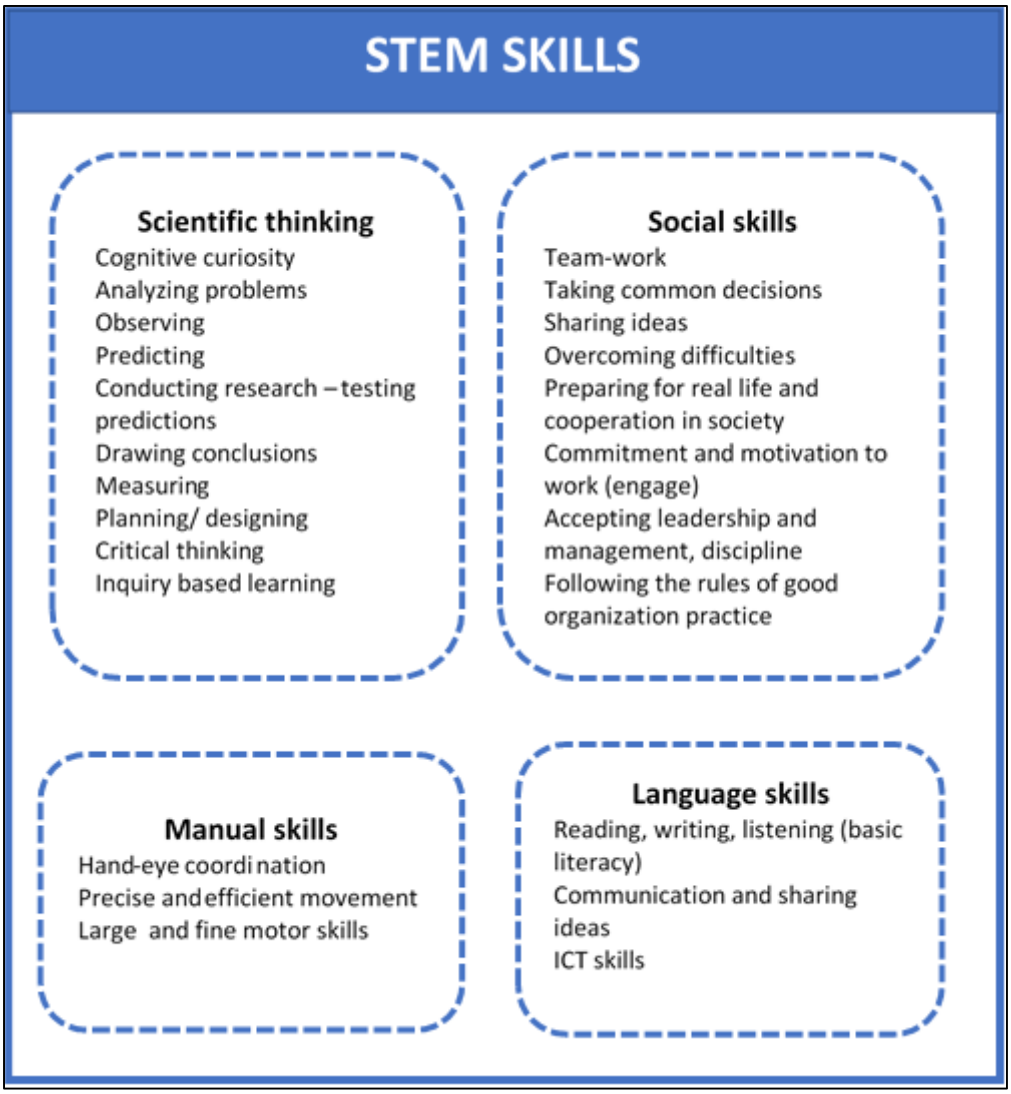

Figure 2. STEM Skills
Source: Own work

When asked about conditions necessary for successful development of STEM competences in early childhood education respondents mentioned several aspects:

- equipment available on site: teaching aids, materials and equipment, modern technologies, additional rooms for food preparation, easy and permanent access to kitchen equipment, kitchen utensils, recipes and ingredients, aprons for children;
- methodological background of teachers delivering such classes: 'innovative approach', methodological competences;

- organisation: small group size;
- cooperation with external contributors: parents, institutions, other teachers and nursery school personnel;
- safety: compliance with special safety procedures with regard to the use of the equipment, clothing, conduct etc.
- manners and behaviour: children are used to being given things 'here and now', without personal initiative (a habit to be modified).

The graph below shows respondents' answers related to challenges (barriers) affecting the development of scientific knowledge and skills through food/ cooking-based learning.

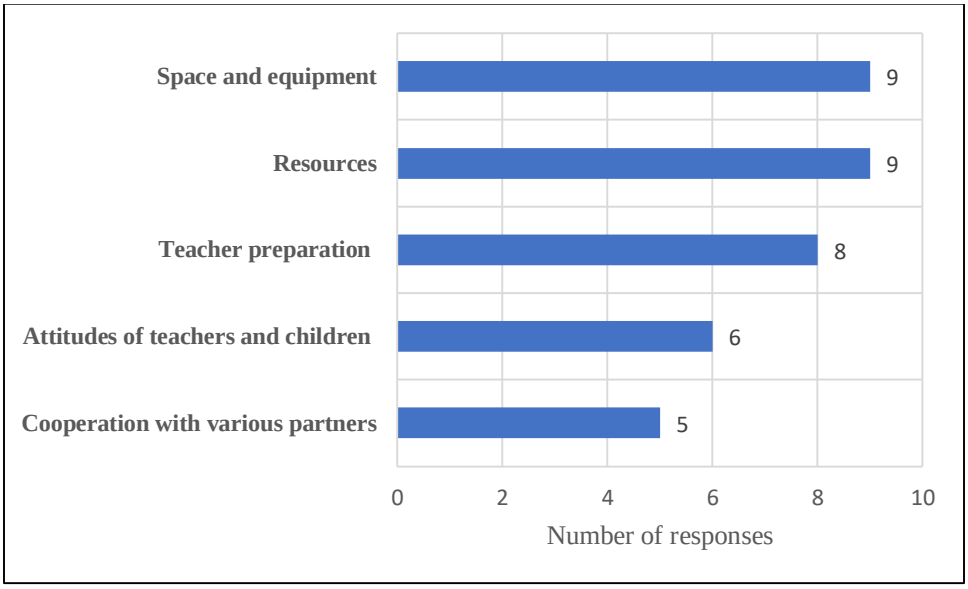

Figure 3. Challenges - to the development of scientific knowledge and skills through food/cooking-based learning

Source: Own work

The implementation of STEM is not easy. Obviously, lack of guidelines or methodological support for teachers interested in implementing STEM may complicate delivery of STEM-based classes. However, of equal importance is the right attitude, freedom given to children and their intrinsic motivation that comes with it as well as the enthusiastic teacher ready to undertake such duties with passion and commitment. Proper context must be set for children to experience such education in the first place. Then, it should be carefully adjusted to the child's age and potential to properly attend to the child's individual development.

The majority of teachers stated that when pursuing their degree programmes they had not been provided with any instruction regarding developing STEM skills in pre-school children. ‘When I studied, we focused more on theory and practice-oriented classes were only occasional’. In addition, any information on new forms and methods of teaching – named as ‘modern teaching’ – was very scarce. Besides, the current choice of training courses, seminars and conferences has little to offer in the scope of STEM education.

CONCLUSION

As suggested by the findings of the pilot study, teachers were initially unable to define what STEM education is. It was not until the researchers defined the notion that the respondents were able to indicate the meaning of the term as proficiency in solving problems, proposing unconventional solutions and responses, the ability to discover as well as give some deeper sense to what one wishes to express, the ability to develop interpersonal relations. In addition, STEM education fosters creativity, arouses curiosity, encourages active pursuit of knowledge and since learning is merged with play, it makes the learning process even more effective. During classes, pupils develop skills in critical thinking, thinking ‘outside the box’, making and testing hypotheses through experimenting. It also develops children’s manual skills, sense of space and time and workplace management. Teachers observe that developing these very skills is one of the main challenges to be addressed already at the pre-school stage. Delivery of the ‘Kitchen Lab for Kids’ Project constitutes can be an ideal way of learning as children acquire numerous skills they may rely on throughout their future lives. For this reason, the kitchen may become a home-lab, in which children may be introduced to the world of knowledge in an interesting and accessible manner. As it was stressed by the surveyed teachers, implementation of STEM is not problem-free. The scarcity of available methodological guidance or teaching programmes focused on STEM may constitute an obstacle when providing the course in a pre-school establishment. However, despite certain difficulties, teachers, in their day-to-day work with children, deliver a number of activities combining food preparation, cooking and exploring various foodstuffs with the acquisition of scientific knowledge.

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