Teachers about STEM Education on the Preschool Level

Comparative analysis

K4K


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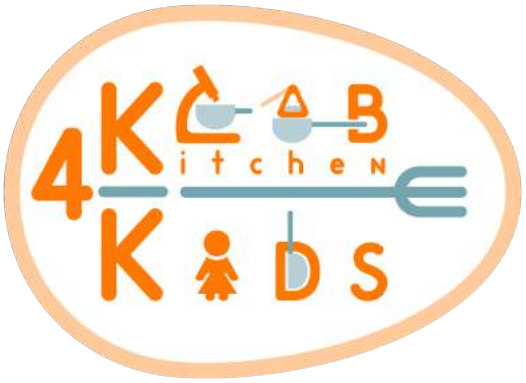

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1. Introduction

Maria Cinque, Nicoletta Rosati (LUMSA, Italy)

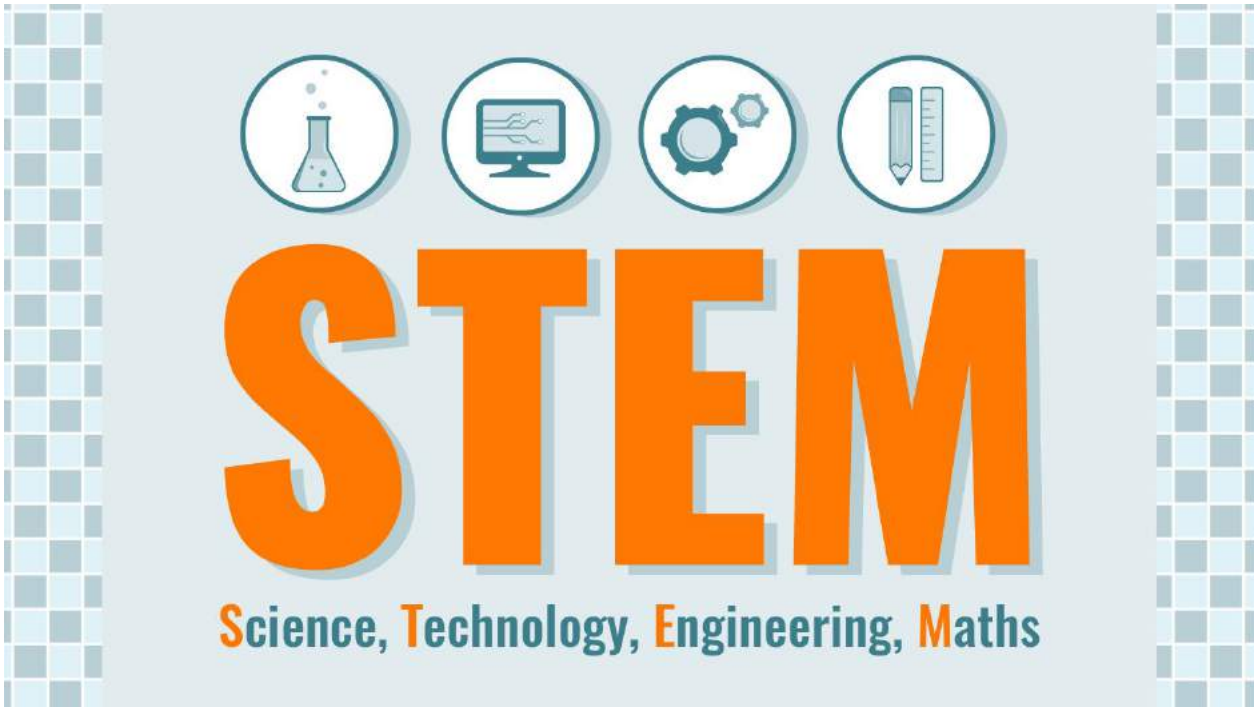
A Recommendation issued in 2019 by the European Council 2019 highlights that "education and care from the earliest stages has an essential role to play in learning to live together in heterogeneous societies […] *since* children at their early years of life shape the basis and ability to learn for all their lives" (Council of the European Union, 2019).

Nobel-prize winner James Heckman uses the expression "skill begets skill" to describe the long-running functional relationship between an early development of skills and later an increase in educational achievement and use of skills throughout the course of a lifetime (Heckman, 2011). In particular, **skills promoted by STEM education (science, technology, engineering and maths) are becoming an increasingly important in society today**. Governments and policy-makers around the world are recognising the importance of STEM education, especially in early years contexts. The STEM economic policy agenda is largely driven by the need to lift the general quality of the supply of human capital as well as enlarge the high-skill group capable in research, commercialisable innovation and effective response to technological change. STEM qualifications – in general science in all countries, and in engineering in some countries – prepare graduates for a broad range of occupations, including management (Marginson et al., 2013).

A recent study (Freeman, Marginson & Tytler, 2019) investigated STEM policies and programs from an international perspective extending from the Anglosphere, East Asia, Western Europe and Latin America to the Middle East. The authors identify discernible trends and parallels regarding government STEM policy and structural responses, school and tertiary level STEM education participation, comparative performance measured by international assessments such as PISA and TIMMS, STEM research and innovation, and issues concerning gender and under-represented groups.

Previous research indicated that **the development of science talent begins in the early years** and as such, the aptitude for science in children can be nurtured through an inquiry-based learning approach in the classroom (Brandwein, 1995). Keeley (2009) lends further credence by stressing the importance of science in the early grades to maximize the cumulative learning processes involved in developing a flair for science. She further argues that if children are not given an early exposure to science instruction, their ability to be successful at science and conceptual understanding will be subsequently adversely affected. Meanwhile, Pratt (2007) builds on this claiming that the curiosity and enthusiasm for science among children may continually diminish if not fostered in the early grades.

Research shows that young learners can understand relatively advanced concepts in STEM and enjoy learning experiences that explore such subjects. In ways that have yet to be fully understood, early development of STEM skills seems to support learning later in life, in STEM and other areas such as developing reading and language skills.



One problem is that science, technology, engineering, and math (STEM) education research is a field of wide variety and unclear parameters. **The many different definitions of STEM education goes to prove the disparity that exists of this sector.** Sanders (2009) suggests, "STEM education includes approaches that explore teaching and learning among any two or more of the STEM subject areas, and/or between a STEM subject and one or more other school subjects".

Kitchen Lab for Kids is an international project, funded by the European Union within the Programme Erasmus+ Action 2. School education – strategic partnerships for school education (KA 201). The project is carried out by the research teams from Poland – Jesuit University Ignatianum in Krakow, Italy - Fondazione Politecnico di Milano and Libera Universitá Maria SS. Assunta di Roma, Ireland - Dublin City University, and Spain - Universitat Internacional de Catalunya.

KLab4Kids is aimed at investigating the best pedagogical methods and exploring existing projects within STEM teaching and learning in Early Childhood Education across Europe.The purpose is to promote an international exchange of best practices and experiences to foster active learning of sciences in ECEC, as well as stimulating and encouraging teachers to find new, modern and interactive methods to effectively teach science. In keeping with the EU strategies for 2020 and the need for a systemic and integrated approach to Early Childhood Education and Care, the project will identify key issues and questions for an effective teaching of STEM at preschool level, collecting and producing resources (science activities and games with food) for pre-primary school teachers. The project will address these issues in an integrative way by combining state-of-the-art knowledge of factors determining personal, social and economic benefits of ECEC with knowledge of the mechanisms determining access to and use of ECEC.

The role of science in basic education – particularly in pre-primary and primary schools – has changed in the course of the last years: in the last two decades, scientific disciplines have assumed a fundamental role in comprehensive training of children, but few projects investigated on how to improve the quality of science learning in Early Childhood Education and, furthermore, on how to prepare pre-school teachers to teach science at early stages of development. Young children actively engage with their environment to develop fundamental understandings of the phenomena they are observing and experiencing. These basic scientific concepts and science process skills begin to develop as early as infancy, with the sophistication of children's competency developing with age (Piaget & Inhelder, 2000).

The results of the research carried out in the USA amongst 8642 early education children (Sackes et al., 2011) indicate that scientific experiments in preschools influence the development of scientific knowledge and skills of school children. Therefore, STEM education should be implemented as early as possible, because it helps the children to develop scientific knowledge and it shapes their scientific attitude, i.e. it develops their critical thinking. It is important to introduce exact sciences into the learning process in a way that matches the children's level of development. Such a learning process should be based on acting, providing adequate contents, reinforcing sensory impressions, creativity, experimenting, as well as problem solving by children.

According to the research, this period of their lives shows that, "they have the capacity for conceptual learning and the ability to the skills of reasoning and inquiry as they investigate how the world works" (McClure et al., 2017, 15). As a result of these assumptions we have seen it important to prepare a programme for young children aimed at developing their scientific thinking while experimenting in the kitchen.

Kitchen Lab for Kids is one of the projects which, first of all, takes into account the EU recommendations for promoting STEM education; secondly it assumes increasing the quality of teaching scientific skills to preschool children with the use of a kitchen as a laboratory; and thirdly it facilitates the international exchange of experiences and good practices in the society of pedagogy students and teachers.

2. Methodology of research

Yvonne Crotty, Margaret Farren, Fiona Maguire (DCU, Ireland)

2.1 Introduction

In this research study a **mixed methods approach** was undertaken to analyse the state of the art of teachers' training for STEM teaching. This approach drew on both qualitative and quantitative data, **to systematically investigate teachers' and student teachers' knowledge, opinions and experience of STEM and cooking in early childhood education**. This research study was carried out in Ireland, Italy, Poland and Spain.

As this research sought to understand the practitioners' views of STEM and cooking in teaching and learning in early childhood education across all four participant countries, it was essential to undertake a cross-institutional desktop analysis of STEM teaching at early childhood education level by examining literature, national and international policies, scientific reports, projects and open educational resources concerning STEM teaching and/or learning at early childhood education level.

Qualitative and quantitative data collection tools were then employed to identify how early childhood education practitioners promote "working scientifically" within their contexts; the values perceived in developing process skills through food related scientific inquiry; the benefits and potential barriers to the development of scientific knowledge and skills through food related learning; and the links between best practice in early childhood education and initial teacher training. Qualitative data was gathered by undertaking focus groups and semi-structured interviews with teachers and student teachers. Comparison analysis of the collected data generated emergent data which informed the design of an online questionnaire, gathering quantitative data. **This data was analysed to provide a clear overview of the state of the art of teachers' training for STEM teaching in each country where the research was undertaken.**

2.2 Research Design

2.2.1 Mixed Methods Approach

A Mixed Methods approach was undertaken in this research to gather and integrate both qualitative and quantitative data in seeking deeper understanding of teachers' and student teachers' knowledge, opinions and experience of STEM and cooking in teaching and learning at early childhood education level (Creswell, 2015). This approach was beneficial in gaining deeper insight into the research problem, rather than that which would have been provided by either form of data collection in isolation (Creswell, 2015; Hennink, 2007). **Qualitative data was gathered in the first and second phase of research to gain a deep insight into participants' opinions and experience.** The data collected then informed the third phase of research which employed a quantitative data collection method to gather data from a larger

population sample, to provide a comprehensive analysis of state of the art of teachers' training for STEM teaching.

As this research study was centred on the mixed method analysis of both qualitative and quantitative data, it was crucial to identify the types of qualitative and quantitative data collection which would be undertaken (Creswell, 2015). This was explored at the early stages of the research process, outlining the data collection methods and identifying for each method, the participants (Table 1).

Table 1. *Klab4Kids* State of the Art Analyses (October, 2018)

TOOLS		
Focus groups in each country 	**40 Interviews** 	**Surveys** 
Qualitative data Script to start and close session	Qualitative data Semi-structured interview	Quantitative data Categorical System
2 (UIC) 2 (AIK) 2 (DCU) 2 (LUMSA)	10 (UIC) 10 (AIK) 10 (DCU) 10 (LUMSA)	100 (UIC) 100 (AIK) 100 (DCU) 100 (LUMSA)

The range of methods and combination of qualitative and quantitative data collection, was employed to provide triangulation and ensure credibility of the data collected (Cohen, Manion & Morrison, 2011). Participants in this research were teachers at early childhood education level and student teachers in Ireland, Italy, Poland and Spain. Qualitative data collection was carried out through focus groups and semi-structured interviews, while quantitative data collection was gathered through an online questionnaire.

2.3 Data Collection Methods

2.3.1 Qualitative Data Collection

Focus Groups

In the first phase of research, focus groups were employed **to gather data on teachers' and student teachers' knowledge, opinions and experience of STEM and cooking in teaching and learning and to provide a collective insight into STEM in early childhood education** (Cohen, Manion & Morrison, 2011). However, as this study aimed to gain understanding into the teachers' and student teachers' opinions and experience, it was important to gather experiential information. Undertaking focus groups provided this opportunity to glean a deeper understanding by encouraging the participants to explore topics of importance to them, in their own words (Kitzinger, 1995). While some researchers highlight the limitations of focus groups in their small sample size not being representative of a larger population or to yield data which can be generalised (Cohen, Manion & Morrison, 2011), as this study also employed a further stage of qualitative data collection through semi-structured interviews and it integrated quantitative data collection, this issue is addressed.

There was cross-institutional design of the focus group, so that all focus groups would include the same categories and follow the same structure, in order to assure comparability of data. **Eight focus groups were carried out with each participating country undertaking two focus groups – a focus group for teachers and a focus group for student teachers.** Participants were asked a set of general open- ended questions regarding STEM and cooking in teaching and learning at early childhood education level. These questions focused on opinions, personal experience, STEM and cooking skills, challenges, requirements and STEM activities. The data was collected in the form of text and informed the development of the semi-structured interview questions and structure.

Semi-structured Interviews

In the second research phase, semi-structured interviews were carried out – **ten interviews were undertaken within each of the four participant countries.** A set of predetermined questions were developed cross-institutionally to facilitate comparability of the participant responses (Cohen, Manion & Morrison, 2011). While the use of standardised questions can potentially constrain the natural flow of conversation, it was important within this study which was undertaken across four countries, to have a set of standardised questions to address the possibility of interview bias (Cohen, Manion & Morrison, 2011). As with the focus groups, the data was collected in the form of text.

2.3.2 Quantitative Data Collection

Questionnaire

In the third research phase, a survey was carried out through an **online questionnaire**, the design of which was informed by the qualitative data gathered through focus groups and semi-structured interviews. This quantitative data collection method was employed **to enable the collection of a large and focused data set**. While the collection of data from a large number of respondents is one of the main benefits to carrying out surveys, there is an inherent expectation that all respondents should understand the questions in the same way (Scott & Usher, 2011). As this research study was undertaken across four European countries it was crucial that this limitation was addressed. In this regard, a collaborative process of questionnaire design was undertaken by all researchers. The questionnaire was developed in the medium of English for this purpose. **Survey questions were examined in terms of sequencing, semantics and cultural understanding**. The survey was tested with three teachers from each participant country to validate the structure and ensure cultural understanding. The final draft of the online questionnaire was translated into three other languages – Italian, Polish, Spanish.

The sampling technique employed in this survey was simple random sampling, whereby a sample of teachers and student teachers within each participant country were randomly selected to complete the online questionnaire (Scott & Usher, 2011). This technique was employed to provide opportunity for representation of the larger population.

The questionnaire was administered using Google Forms as it is easy to use from a design, circulation, collection, analysis and confidentiality perspective. It was advantageous for this research study as it facilitated easy circulation across the four participant countries and allowed for instantaneous collection of responses from participants. **The questionnaire employed Likert Scales, multiple choice questions and optional open ended questions for comments.** Likert scales and multiple choice was used as they are effective methods when analysis is needed (Munn & Drever, 1990). The questionnaire was designed in three sections with regard to the following topics:

- Section 1 - **Teacher background** information to provide context.
- Section 2 - **STEM in teaching and learning**.
- Section 3 - **Cooking in teaching and learning**.

Google forms allowed for data collection in two formats – individual responses and group summary. Responses to the questionnaire were accepted from June 7th to September 15th 2019, at which point analysis began.

2.4 Data Analysis

2.4.1 Qualitative Data Analysis

Focus Group

Focus group data was analysed through comparative analysis. Results were first summarised and exact answers driven from the transcript were quoted, as an efficient means of presenting participants' key points (Barbour, 2013). **A summary was undertaken by researchers in each participant country**, following the categories which had been outlined within the design of the focus group. Thematic analysis of the data within these categories across all four participant countries was undertaken. **Mind-mapping** was also undertaken as a visual presentation of emergent data from the focus groups and as a means of further thematic analysis. These were undertaken by researches in each participant country in order **to identify similarities or differences between cultures**. Tag clouding was also employed in each participant country, as a means of identifying high frequency words. Data which emerged from mind-mapping and tag clouding was analysed across all participant countries. The data generated from comparative analysis of the focus groups informed the development of themes for the second phase of research – semi-structured interviews.

Semi-structured Interviews

Data gathered through semi-structured interviews was also analysed through comparative analysis, so that data could be comparable and integrated to ensure a more robust design of the quantitative phase of research. This **data was grouped and coded** to draw out themes and enable the integration of the qualitative data into the development of a questionnaire for the collection of quantitative data (Bryman, 2006; Creswell, 2015). **Results were summarised at National level** and as with focus groups, exact individual responses were quoted, with results being categorised according to themes identified in the semi-structure interview design. Thematic analysis was then undertaken across all participant countries. **Mind-mapping and tag clouding was employed in the same manner as with the focus groups, analysed at both National level, as well as across all participant countries.** The results from the qualitative analysis phase generated a hypothesis which was then tested through the quantitative approach with a wider population sample.

2.4.2 Quantitative Data Analysis

Questionnaire

The questionnaire data was gathered through Google Forms, which facilitated data collection in terms of individual responses and as a group summary. The individual responses were exported to an Excel spreadsheet, where a breakdown of individual responses to each question allowed for cross comparison analysis. The group summary presented information on group patterns through pie-charts and bar charts. **The data from each participant country was exported to an Excel spreadsheet where numerical**

values for questions were presented through pie-charts and bar charts identifying group patterns across all four participating countries. This facilitated the analysis of patterns of responses for each question. The results of the survey informed an overview of the state of the art of teachers' training for STEM teaching in Ireland, Italy, Poland and Spain.

2.5 Participants

This research took place over a thirteen-month period, across four European countries – Ireland, Italy, Poland and Spain. Participants in the study included early childhood education teachers, as well as student teachers.

Two focus groups were undertaken in each participating country. One focus group included eight early childhood education teachers and the other was comprised of eight student teachers. A total of sixty-four participants took part in the focus groups: thirty-two teachers and thirty-two students teachers. **Participants were asked to discuss STEM and cooking in terms of their opinions, personal experience, STEM and cooking skills, challenges, requirements and STEM activities.**

A semi-structured interview was undertaken in each participating country. Each interview included ten participants. A total of forty participants took part in the semi-structured interviews. Participants were asked to discuss the following:

- Their **understanding of STEM** in education and STEM skills
- The **importance of teaching STEM in early childhood**.
- How **working and thinking scientifically** is promoted within their own contexts.
- **Values and skills** which can be developed through STEM and cooking.
- Their **personal experience** of teaching STEM.
- **Requirements** for developing STEM skills in early childhood education.
- **Challenges** to the to the development of scientific knowledge and skills through food/cooking-based learning.
- Stem skills in **daily life**.

Surveys were administered in each country, with a target of one hundred respondents within each participant country. There was a total of 340 responses. The number of respondents from each country was as follows:

- Ireland - 90
- Italy - 55
- Poland - 149
- Spain - 46

Participants were asked questions for context regarding their number of years teaching experience and the type of school in which they were teaching. Participants were provided with a video to support them if they required support in terms of understanding the concept of STEM. They were then directed to answer questions on STEM and cooking in teaching and learning in early childhood education.

2.6 Conclusion

This research study, undertaken in four countries - Ireland, Italy, Poland and Spain, employed a mixed methods approach, drawing on qualitative and quantitative data, to systematically and rigorously investigate teachers' and student teachers' knowledge, opinions and experience of STEM and cooking in early childhood education, to analyse the state of the art of teachers' training for STEM teaching.

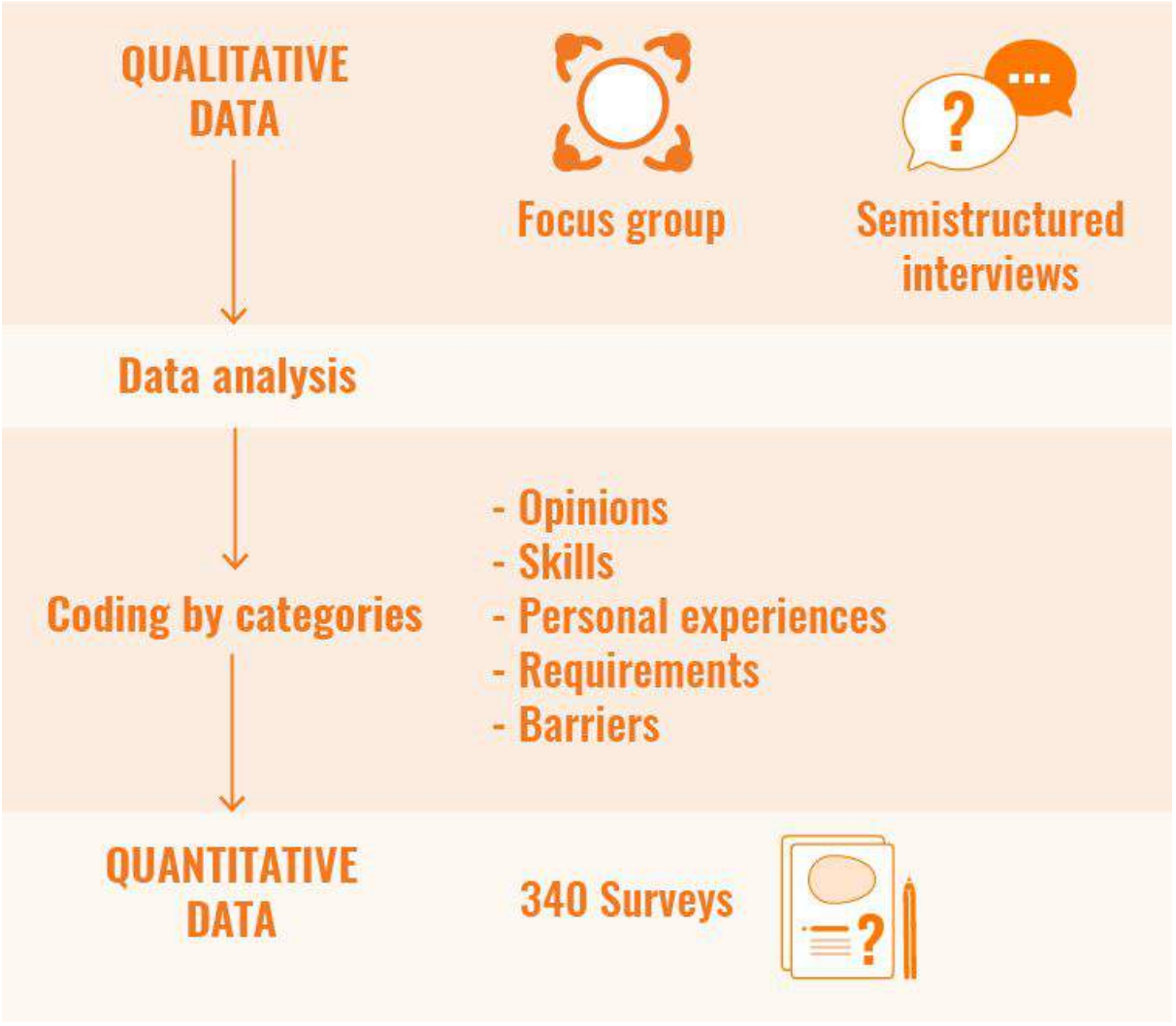
This approach, drawing first on qualitative data collected through focus groups and semi-structured interviews, enabled researchers to gain deep insight into the research topic. The collection of qualitative data in the initial research phases was beneficial to the research process, in terms of gathering data which upon analysis, generated emergent data which informed the development of the quantitative data collection tool – an online questionnaire. The quantitative data was analysed and presented individually for cross comparison analysis and also as a group summary through pie-charts and bar charts which facilitated the analysis of patterns of responses for questions. **The results of the qualitative and quantitative data analysis informed an overview of the state of the art of teachers' training for STEM teaching in Ireland, Italy, Poland and Spain.**

3. Research Results

Maria T. Fuertes, Mariana Fuentes, Mónica Fernández Morilla, Silvia Albareda Tiana (UIC, Spain)

The global goal of our research is to write an empirical report to describe the needs of teachers in the area of STEM education: their knowledge of educational methods and strategies used in science education, the quality of their own pre-service training in that area, their hidden assumptions, opinions concerning perceived values, shortcomings, skills and existing barriers in STEM education in four countries. The process followed to obtain the data is set out below (Fig.1).

Figure 1: Schema of the data collection process



The overall objective of our research is to provide information related to questions such as "What? What did we find? What were the results?" in the analysis of the survey's results shown below. The maximum scores of the global average have been highlighted in red in the different graphs.

3.1 Quantitative Analysis

The comparative analysis of the qualitative data collected in the focus groups and semi-structured interviews (first and second research phase) generated emerging data for the design of an online questionnaire. This questionnaire allowed us to collect the quantitative data described below:

The twenty-four questions of the survey are analysed in a descriptive manner. In some cases, this description is accompanied by graphs that show average scores (globally and country per country).

3.2 Descriptive analysis of the quantitative data of the survey

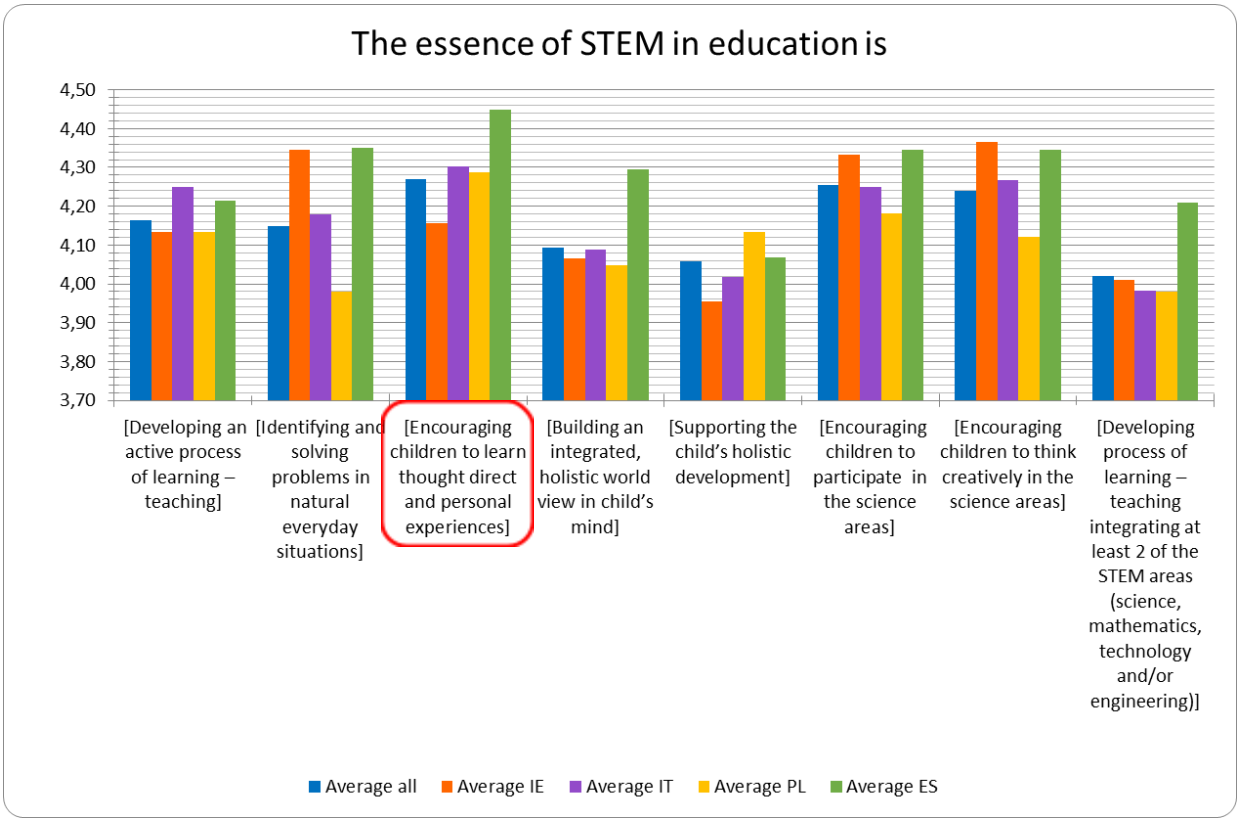
Q1. **The composition of the sample** (nt = 340) differs markedly from one country to another, . While in Spain 97% of respondents are active teachers (82% of whom are Early Childhood Education teachers), in Poland and Italy, only approximately 60% and 70% respectively, are currently working teachers. In Ireland, the percentage of active teachers in the sample is similar to that of Spain (95%), but the difference is that 89% of them are Primary Education teachers.

Q2. **Regarding the experience of the sample** (nt = 340), more than 36% said that they had more than ten years of experience and 16% between three and ten years. This means that, approximately half of the sample either has no real professional experience or their experience is less than three years. When analysed per country, the highest level of experience is found in Ireland and Spain, where approximately 60% of the teachers have over ten years of professional practice.

Q3. **They know what STEM skills are**: compared to the total sample, 68.6% of the respondents know what they are. This means there is a fairly high percentage (around 33%) of teachers and future teachers who are not familiar with the term. If we break the percentage down by country, Ireland tops the list with 93% of the respondents who know it, followed by Spain (67%), Poland (61%) and Italy 50%).

Q4. **The essence of STEM education is**: In the total sample, the average value assigned to the different indicators (Fig. 2) are (in descending order): "**Encouraging children to learn through direct and personal experiences**" (4.27), "Encouraging children to participate in science areas" (4.26), "Encouraging children to think creatively in science areas" (4.24), "Developing an active process of learning – teaching" (4.16), "Identifying and solving problems in natural everyday situations" (4.15), "Building an integrated, holistic world view in the child's mind" (4.09), "Supporting the child's holistic development" (4.06) and "Developing the process of learning – teaching, incorporating at least two of the STEM areas (science, mathematics, technology and/ or engineering) (4.6).

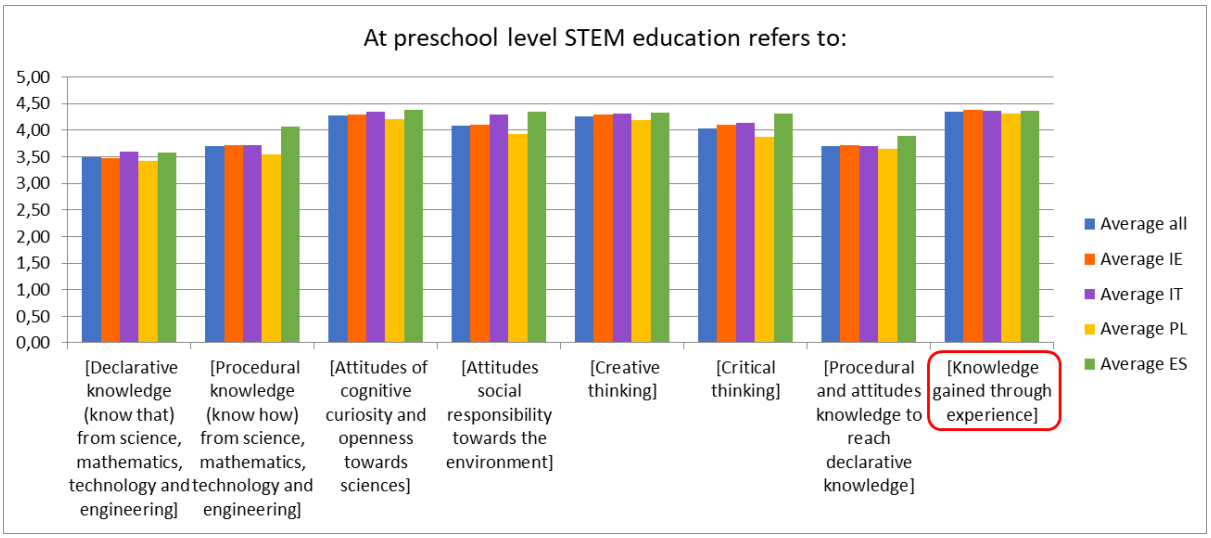
Figure 2. Results of he answers to the question: what do you think the essence of STEM education is?



However, when the analysis is carried out by countries, in Poland, Italy and Spain the first position remains with respect to the global sample. In Ireland, the highest value is given to "Encouraging children to think creatively in science areas" (4.37) (the third position in the global sample).

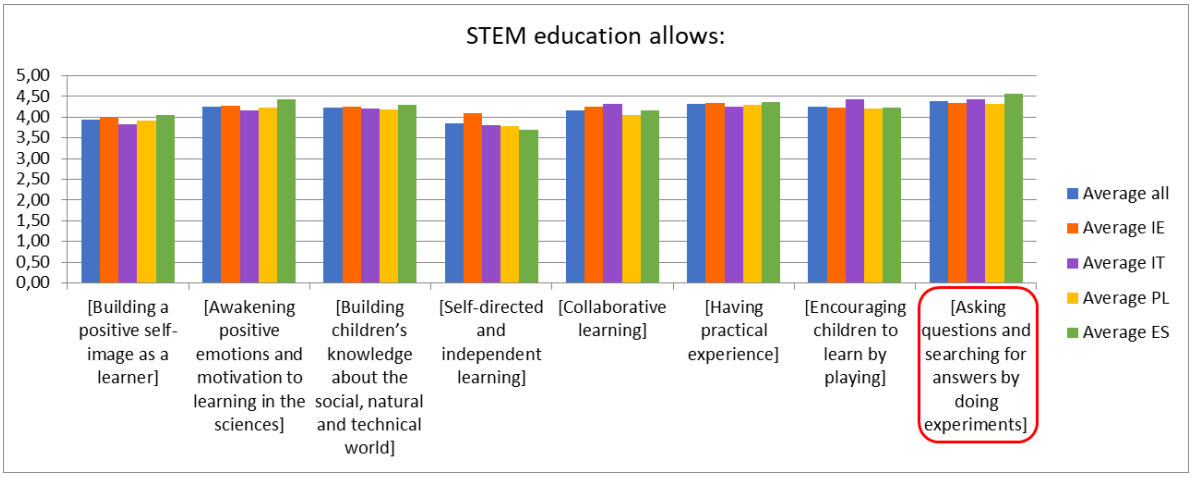
Q5. **At preschool level, STEM education refers to**: In this case, both in the global sample, and in the analysis per country (Fig. 3), the highest average value (between "agree" and "strongly agree") is given to "**Knowledge gained through experience**" (global: 4.34; Ireland: 4.39; Italy: 4.36; Poland: 4.30; Spain: 4.37) and the lowest value, and, therefore, of minor importance (between "neutral" and "agree") is granted globally (3.48) and per country (Ireland: 3.48; Italy: 3.59; Poland: 3.42; Spain: 3.58) to "Declarative knowledge (know that) from science, mathematics, technology and engineering".

Figure 3. Results of the answers to the question: what do you think STEM education refers to a preschool level?



Q6. **STEM education allows**: As can be seen in Figure 4, the respondents in the global sample believe that STEM education especially enables "**Asking questions and searching for answers by doing experiments**", since they assign the highest average value to values between "agree" and "strongly agree" (4, 38).

Figure 4. Results of the answers to the question: what do you think STEM education allows?



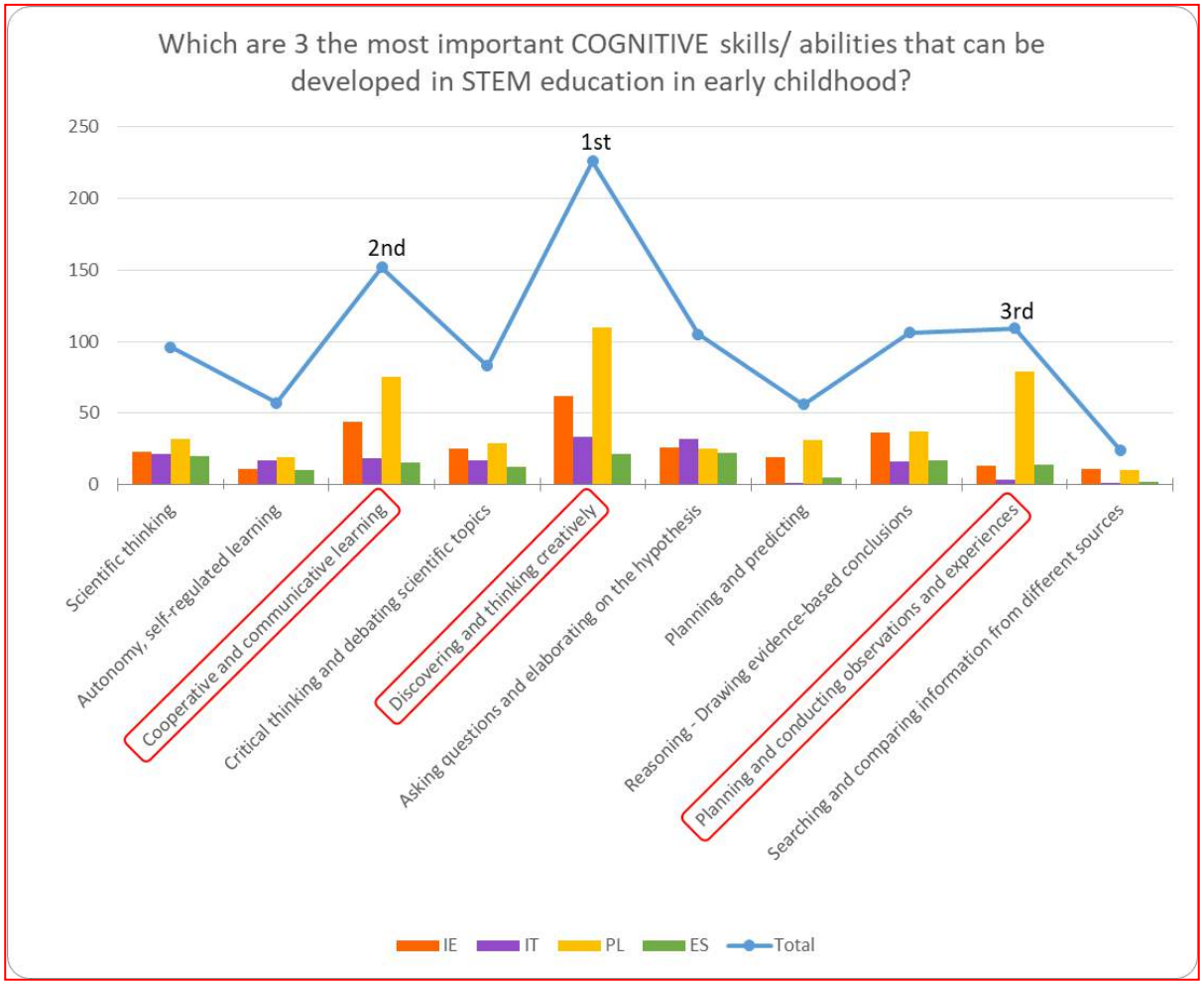
If we analyse each country separately, in Spain this indicator reaches the greatest difference with respect to the rest of the indicators, while, in the other countries it is followed very closely by or at the same level as, "Encouraging children to learn by playing" (Italy) and "Having practical experience (Ireland and Poland)".

The 3 most important COGNITIVE skills/ abilities that can be developed in STEM education in early childhood are: In the global sample, the three most represented skills were:

- 1st "Discovering and thinking creatively"
- 2nd "Cooperative and communicative learning"
- 3rd "Planning and conducting observations and experiences"

Coinciding with the majority of the opinions of the Polish (because of their larger presence in the total sample). However, small differences are observed in the analysis per country. In Italy, these skills are maintained in the first three positions, although the second and third positions are inverted. In Ireland and Spain, although the first two remain (with inverted positions in Spain), the third position is occupied by "Reasoning - Drawing evidence-based conclusions" (Fig. 5).

Figure 5. Results of the answers to the question: which are the 3 most important cognitive skills/ abilities that can be developed in STEM education in early childhood?

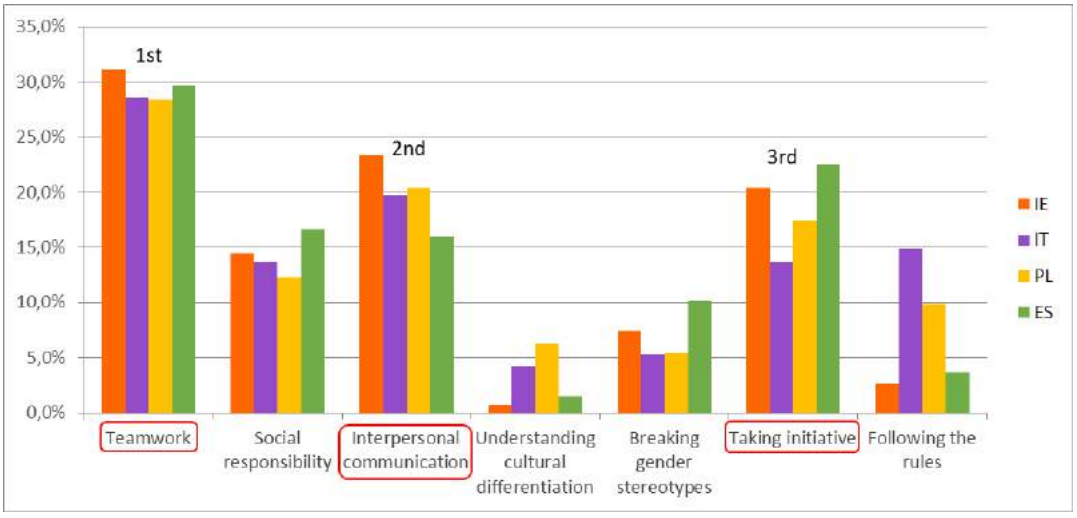


Q8. **The 3 most important SOCIAL skills/ abilities that can be developed in STEM education in early childhood are**: In the global sample the three most represented skills were:

- 1st "Teamwork"
- 2nd "Interpersonal communication"
- 3rd "Taking initiative"

Coinciding with the majority of the opinions of the Polish, Irish and Italians. Nevertheless, in Spain, the first two positions were maintained, but "Social responsibility" came third, slightly ahead of "Taking initiative" (Fig. 6).

Figure 6. Results of the answers to the question: which are the 3 most important social skills/abilities that can be developed in STEM education in early childhood?

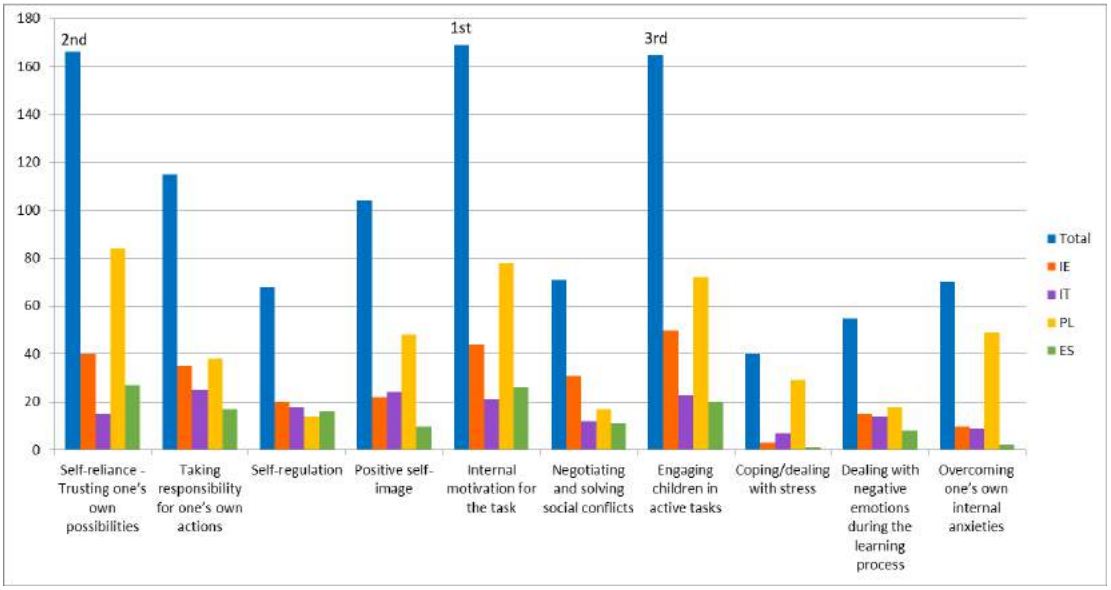


Q9. **The 3 most important EMOTIONAL skills/ abilities that can be developed in STEM education in early childhood are**: In the global sample the three most represented skills were: (Fig. 7),

- 1st "Internal motivation for the task"
- 2nd "Self-reliance - Trusting one's own possibilities"
- 3rd "Engaging children in active tasks"

These positions differed in the countries analysed. Although in Spain, Poland and Ireland, these three skills are the most represented ones, they appeared in a different order. In Italy, only "Engaging children in active tasks" appeared in the first three positions, moving from the third to the first place. The other two were "Taking responsibility for one's own actions" and "Positive self-image".

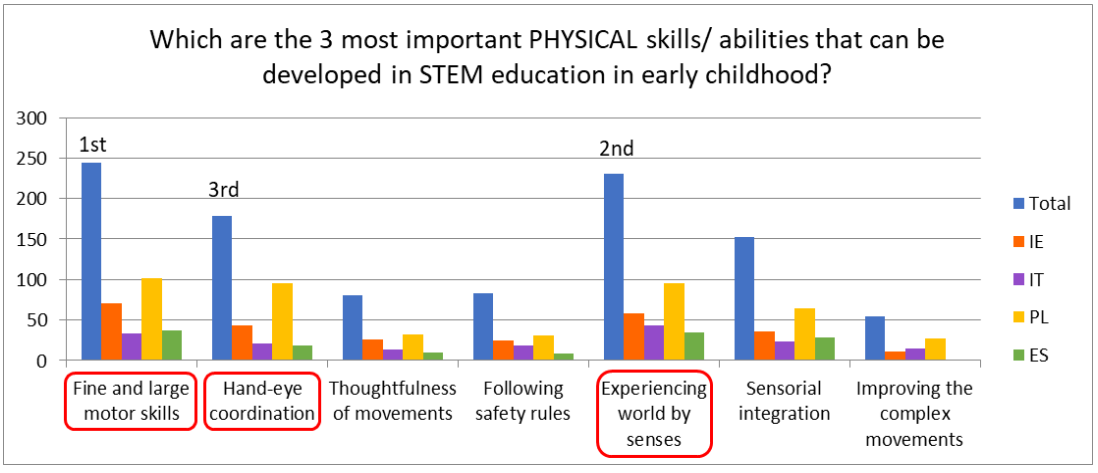
Figure 7. Results of the answers to the question: which are the 3 most important emotional skills/ abilities that can be developed in STEM education in early childhood?



Q10. **Which are the 3 most important PHYSICAL skills/ abilities that can be developed in STEM education in early childhood?** In the global sample, the three most represented skills were (Fig. 8):

- 1st "Fine and large motor skills"
- 2nd "Experiencing world by senses"
- 3rd "Hand-eye coordination"

Figure 8. Results of the answers to the question: which are the 3 most important physical skills/ abilities that can be developed in STEM education in early childhood?



These results coincide with the majority of the opinions of the Irish and Polish participants (although in this case, the third one slightly exceeds the second one). However, these three most represented skills did not exactly match the answers of the Spanish and Italian respondents who, in the global sample,

chose the first and the second one (with inverted positions in Italy), but not in the third position, where they answered, "Sensorial integration".

Q11. **My personal experiences in STEM education in Early Childhood Education include**:

As can be seen in Table 1 the most repeated experience in the global sample was "Conducting science observations and experiments" followed by "Games and experimental plays in mathematics" and "Fieldtrips and workshops (in the woods, at the meadow etc.)". The high number of teachers/ future teachers who have never had STEM experiences in Early Childhood Education is worth noting. The largest number of answers indicating that no previous STEM experiences existed was in Poland, which is also the country where there is a higher percentage of future teachers and non-active teachers (see Q1 results).

Table 1. Results concerning personal experiences in STEM education of the teachers and students of the global sample and the analysis per country

My personal experiences in STEM education in Early Childhood Education include (choose what you did):	IE	IT	PL	ES	Total	
Conducting science observations and experiments	64	20	67	29	180	(1st)
Researching physical characteristics of the world	41	10	52	12	115	
Games and experimental plays in mathematics	63	18	63	29	173	(2nd)
Workshops in the area of informatics (coding, robotics etc.)	23	7	13	11	54	
Interdisciplinary projects integrating at least 2 different areas of STEM education	24	8	7	17	56	
Fieldtrips and workshops (in the woods, at the meadow etc.)	51	20	66	26	163	(3rd)
Excursions to science centers/, university laboratories or workshops	22	4	26	10	62	
I DO NOT have any STEM experience in the Early Childhood Education	14	29	58	10	111	
Others	1	1	4	3	9	

Q12. **My STEM training in Early Childhood Education**

The lowest average values (in the global sample) between "disagreement" (2) and "neutral" (3) are obtained for indicators such as **my training was very satisfactory and my presently in-service training is satisfactory**, which indicates that the respondents do not have a good level of satisfaction regarding their prior or current training, Spain is the country where the level of satisfaction seems to be the highest (Table 2).

Table 2. Results concerning STEM training in Early Childhood Education.

My STEM training in in Early Childhood Education	Average all	Average IE	Average IT	Average PL	Average ES
Was very satisfactory	2,93	2,91	2,54	2,97	3,31
Presently in-service training is satisfactory	2,66	2,58	2,38	2,71	3,05
Was very theoretically oriented	3,12	3,03	3,30	3,11	3,12
Did not have practical training	3,28	3,09	3,48	3,26	3,52
Presently in-service training is lacking	3,43	3,54	3,48	3,33	3,49
Did not have technological training	3,44	3,42	3,43	3,42	3,59
Did not have a very integrated approach	3,08	3,20	3,38	2,90	3,09
Did not focus on younger children (3-6)	3,00	3,31	3,02	2,73	3,29

Q13. Open answer to complete Q12 (optional)

Do you have any other comment about your training in STEM in Early Childhood Education?

13.2% of the respondents in the total sample add comments related to their STEM training in Early Childhood Education. In Ireland, the respondents consider, in general, that their **STEM training in Early Childhood Education "did not exist or was not enough".** They also think that STEM is a "new topic of vital importance that appeared recently" and for this reason, they do not feel "they have enough training" and "teachers need to be trained to deliver it confidently and competently." Some teachers say that they "have learned on their own because of their interest in the subject" and that is why they currently consider their training satisfactory. In one of the cases, the importance of continuing teacher training through PDST (Professional Development Service for Teachers) courses is mentioned. It is the largest single support service in Ireland offering professional learning opportunities to teachers and school leaders in a range of pedagogical, curricular and educational areas.

In Italy, 12.7% of the participants answered this optional question. They consider that their training in STEM "did not exist or, if it did, it was insufficient and only those specialized in the subjects involved received some training in this regard".

In Poland, 8% of the participants answered this optional question. One of them prefers not to comment on the matter and the rest consider that "there was no training either due to a lack of tradition, or due to a lack of funding". Four of the respondents mentioned their "interest" in continuing education and training that "comes intuitively from practice".

In Spain, 19.6% of the total number of participants answered the optional question. Most of them, except for two cases, consider that they "have not received any specific training regarding the subject". The rest were "trained later or received training through practice".

The global results of the different countries to the open question *Do you have any other comment about your STEM training in Early Childhood Education?* show that **there is a lack of specific initial teacher training in STEM skills. Experience and interest stand out as key factors for teachers to keep on learning through continuous education. In some cases, they point out that this training is not possible due to a lack of tradition or a lack of funding.**

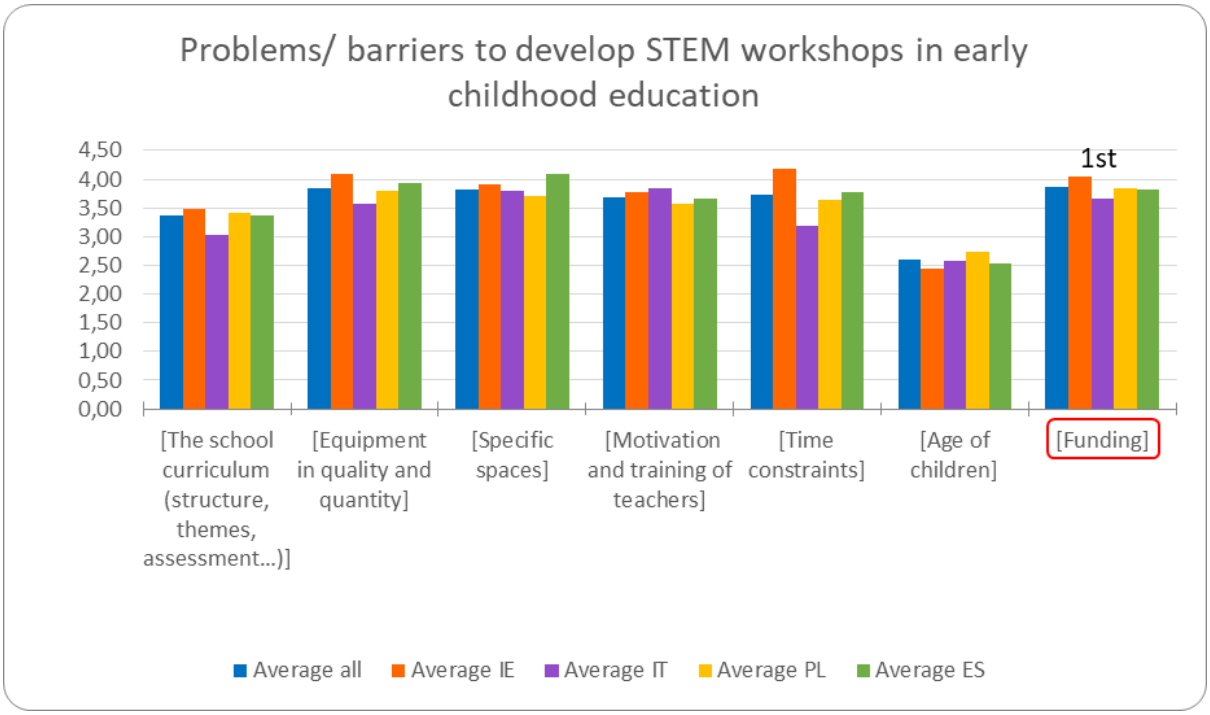
Q14. **Problems/ barriers to develop STEM workshops in Early Childhood Education**

Regarding problems or barriers to develop STEM workshops in Early Childhood Education, the global sample of the different countries reveals that the main problems highlighted in the survey, in order of importance, are: "**funding**" (3.86), investment in quality and quantity (3.85), specific spaces (3.82), time constraints (3.73), motivation and training teachers (3.68), the school curriculum (3.36) and finally, the age of the children (2.61) (Figure 9).

In the analysis per country, the highest value in Ireland was "time constraints" (4.18) and the lowest one "the age of the children" (2.44). In Italy, the main problem is considered to be the "motivation and training of teachers" (3.84) and the least influential barrier is, like in Ireland, "the age of the children" (2.57). In Poland, the maximum value was "funding" (3.84) and the minimum one "the age of the children" (2.74). In Spain, teachers consider that not having "specific spaces" is the main barrier (4.09) and "the age of the children" has the least influence (2.52).

As shown in Figure 9, all the countries agree the age of the children is not a determining factor to develop STEM workshops in Early Childhood Education.

Figure 9. Results of the answers to the question: problems and barriers to develop STEM workshops in Early Childhood Education



Q15. Open answer to complete Q14 (optional)

Do you have any other comment about problems/ barriers to develop STEM workshops in Early Childhood Education?

8% of the total sample provided observations about this question. In Ireland, 11% of the participants in the total sample answered this question. The observations of the respondents concerned the following barriers: **"the curriculum, the resources and the attitude of the teaching staff and the management of the institution**." They consider that the curriculum is "full of content that does not allow innovations to be incorporated" and add the "fragmented approach of STEM subjects.". **Financial resources such as "materials" and "appropriate human resources for the number of students per class" are also considered**. In some cases, teachers consider that the obstacle is "the lack of motivation, of availability of teachers or of guidelines provided by the school management."

In Italy, 3.6% of the respondents added comments regarding: "the lack of teacher training" and "the lack of teachers in each class."

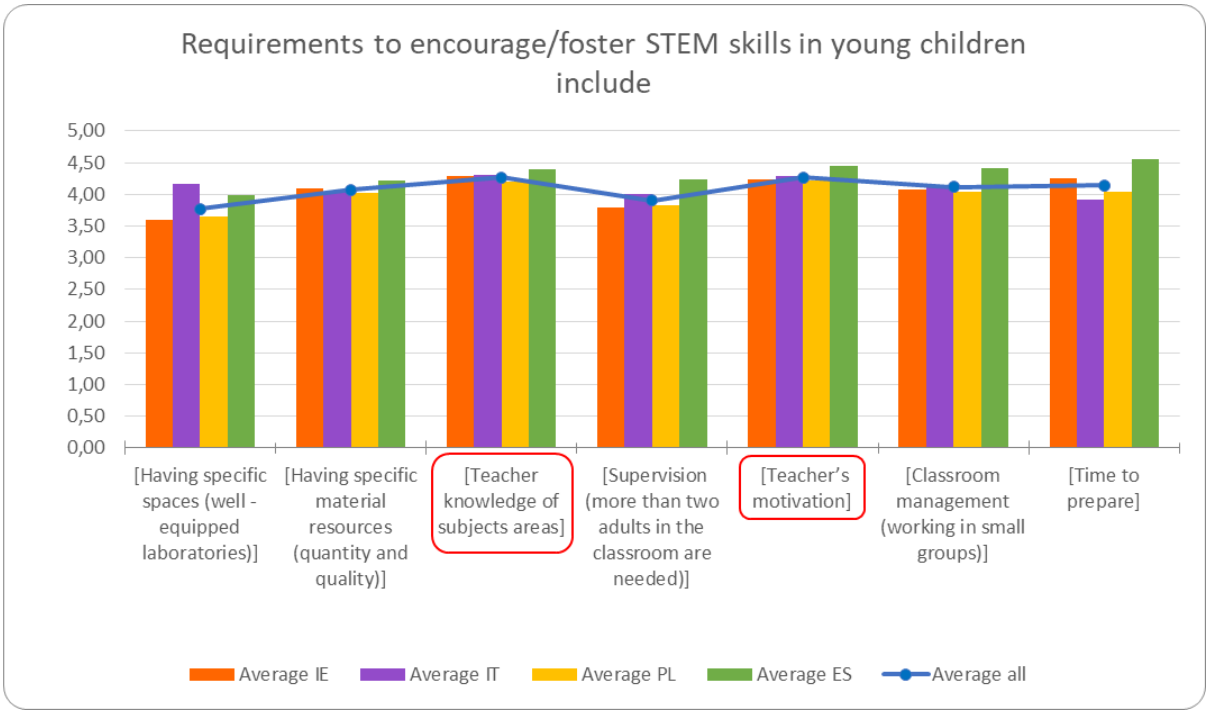
In Poland, 8.8% of the participants made observations. The major barriers reported to conducting workshops in Early Childhood Education were: "the lack of motivation, of experience and/ or of cooperation among teachers, methodological stereotypes and the lack of implementing a flexible curriculum."

In Spain, 6.5% of the respondents provided comments. “The lack of motivation of the teachers and the lack of financial resources" for the necessary material and human resources” were the main obstacles mentioned.

Q16. **The requirements to encourage/foster STEM skills in young children include**:

The question regarding the requirements mentioned in the survey to encourage/foster STEM skills in young children at a global level in all the participating countries, in order of importance, are: “**teacher knowledge of subject areas**?” and “**teacher motivation**” (both 4.27), “time to prepare” (4.14), “classroom management - working in small groups” (4.12), “having specific material resources” (4.07), “supervision-more than two adults in the classroom” (3.91) and “having specific spaces-laboratories” (3.77).

Figure 10. Results of the answers to the question: requirements to encourage/ foster STEM skills in young children include…



In Ireland, the maximum value was “teacher knowledge of subject areas” and the lowest one “having specific spaces (well-equipped laboratories).”

In Italy, the main requirement is “teacher knowledge of subject areas” (4.3) and “time to prepare” is the least valued.

In Poland and Spain, “teacher motivation” (4.22 and 4.46 respectively) is considered the main requirement and, “having specific spaces (well-equipped laboratories)” (3.65 and 3.99) is not deemed essential.

Q17. Open answer to complete Q16 (optional)

Do you have any other comment about the requirements to encourage/ foster STEM skills in young children?

The observations concerning Q16 represent 4% of the total sample. 4% of the participants in Ireland provided comments considering that "environmental challenges may be a source of interest and motivation" and that "teacher training and specific spaces are necessary." In Italy, 3.6% of the respondents provided comments about "the need of teachers" and proposing activities that foster the development of STEM skills in young children", considering them the main elements to promote these abilities.

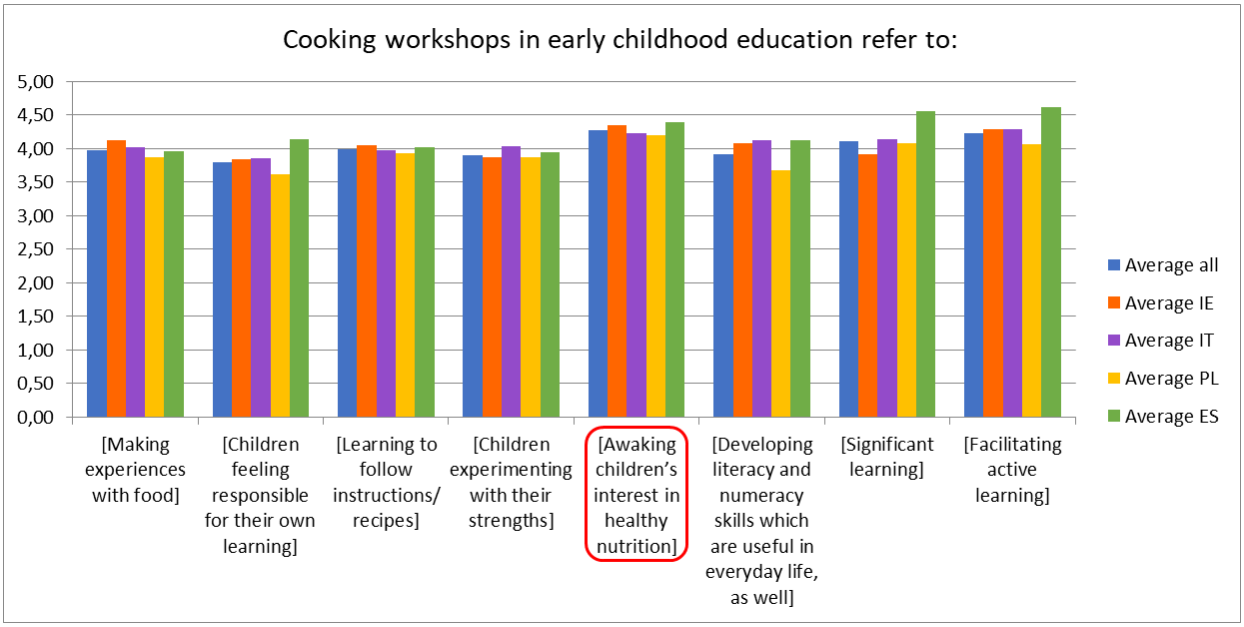
In Poland, 5.4% of the respondents made comments about this question highlighting the "importance of teacher training" and "the favourable attitude of the entire educational community (management, parents and teachers)". This last comment was also made by the only participant in Spain who decided to answer this question.

Q18. **Cooking workshops in Early Childhood Education refer to**:

For the global sample of all the countries involved, cooking workshops in Early Childhood Education, in descending order, refer to "**awaking children's interest in healthy nutrition**" (4.27%), facilitating active learning (4.24), significant learning (4.12), learning to follow instructions/ recipes (3.99), making experiences with food (3.98), developing literacy and numeracy skills which are useful in everyday life (3.92), children experimenting with their strengths (3.91) and in the last position, children feeling responsible for their own learning (3.79).

In the analysis per country, in Ireland (4.27) and Poland (2.21) the most valued item is also "awakening children's interest in healthy nutrition" and in Italy (4.29) and Spain (4.62) the respondents consider in the first place that cooking workshops refer to "facilitating active learning.". The minimum value is the same in Ireland (3.84), Italy (3.86) and Poland (3.62) and it coincides with the global minimum value. In Spain, this minimum value is for "children experimenting with their strengths" (Fig.11).

Figure 11. Results of the answers to the question: cooking workshops in Early Childhood Education refer to…



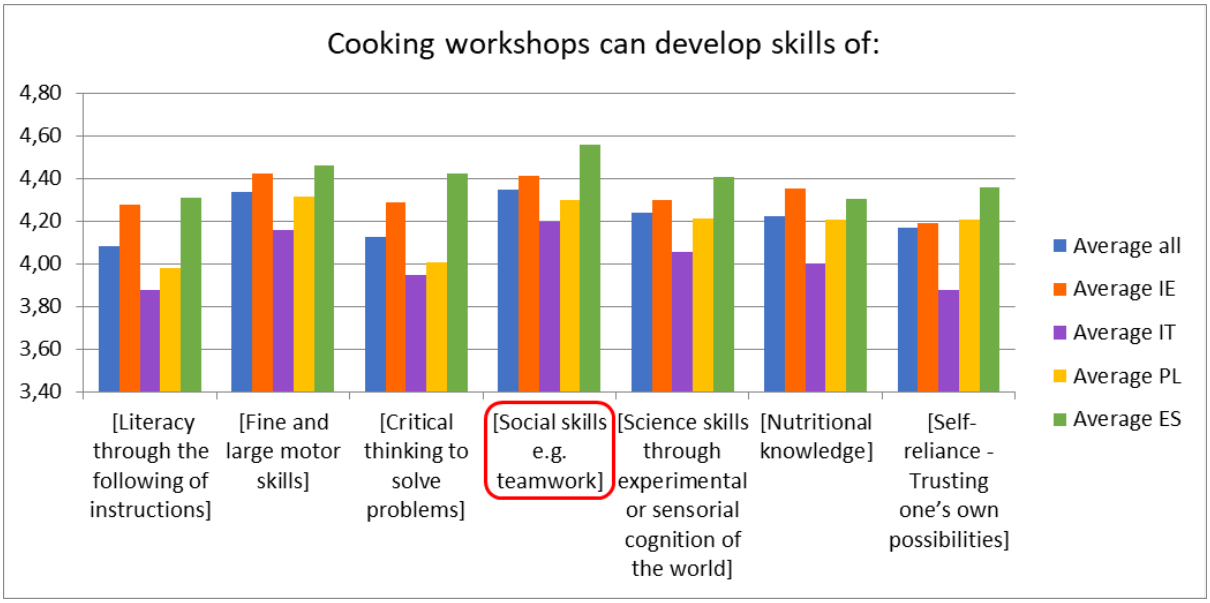
Q19. **Cooking workshops can develop skills of:**

The highest average in the global analysis is for "**social skills** such as" (4.35) followed by fine and large motor skills (4.34), science skills through experimental or sensorial cognition of the world (4.24), nutritional knowledge (4.23), self-reliance-trusting one's own possibilities (4.17), critical thinking to solve problems (4.13) and finally, literacy through following of instructions (4.09). The differences between the items are not very large.

The highest's average in Italy (4.20) and Spain (4.56) is also social skills such as teamwork while in Ireland (4.42) and Poland (4.32) it is fine and large motor skills.

The least valued skills are: self-reliance in Ireland (4.19) and Italy (3.88), literacy through the following of instructions also in Italy (3.88) and Poland (3.98) and nutritional knowledge in Spain (4.30) (Fig.12).

Figure 12. Results of the answers to the question: cooking workshops can help develop skills of…



Q20. Open answer to complete Q19 (optional)

Do you have any other comment about skills that can be developed through cooking workshops?

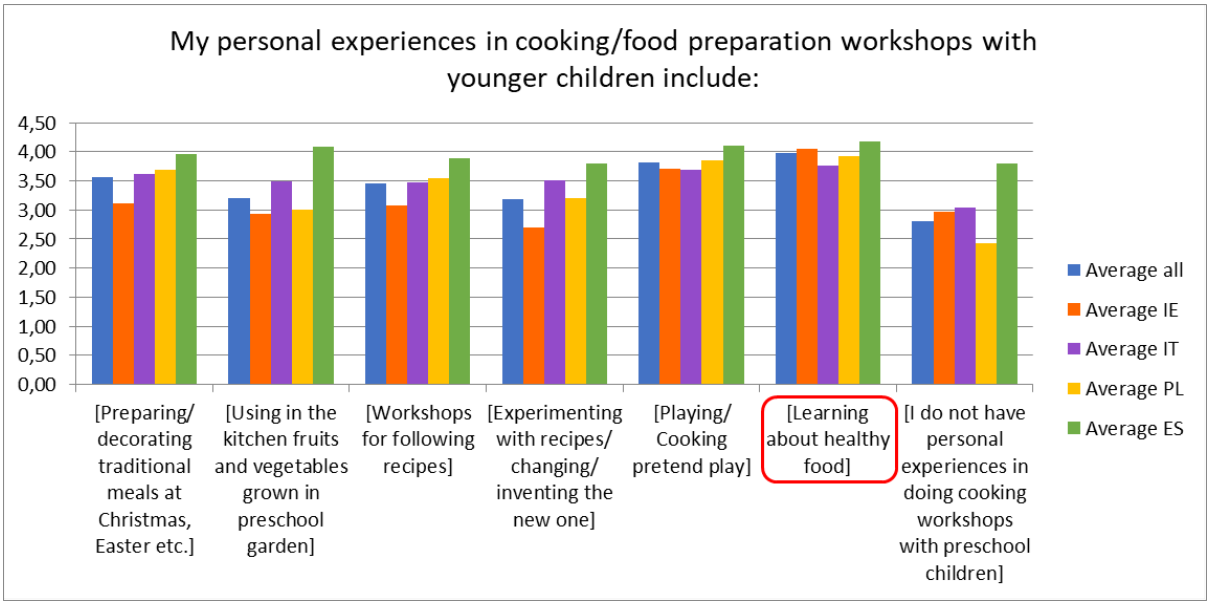
6% of the respondents from all the participating countries add comments about skills that can be developed through cooking workshop apart from those selected in the previous question. In Ireland, they consider "numeracy skills, listening skills and concentration and creative skills" can also be developed. In Italy, teachers add "intuitive thinking, autonomy and prediction.". In Poland, teachers consider that it is possible develop "motivation to investigating the world, passion for cooking, the ability to plan and organize and the sense of taste". In Spain, teachers add the "development of the characteristic abilities of scientific thought."

Q21. **My personal experience in cooking/food preparation workshops with younger children includes**:

Referring to the personal experience in cooking/ food preparation workshops with younger children, the average of the teachers (Fig. 13), from all four countries is, from major to minor importance: "**learning about healthy food**" (3.97), playing/cooking pretend play (3.81), preparing and decorating traditional meals (3.56), workshops for following recipes (3.45), using in the kitchen fruits and vegetables grown in the preschool garden in the kitchen (3.21), experimenting with recipes/ changing them/ inventing the new ones (3.19) and 2.80% answer they do not have any personal experiences in doing cooking workshops with preschool children. As seen in Figure 13, the maximum value is the same in all countries and the lowest is: do not have experience in doing cooking workshops with preschool children in Italy

(3.04), Poland (2.42) and Spain (3.79). In Ireland, the minimum value is for using in the kitchen fruits and vegetables grown in the preschool garden (2.93).

Figure 13: Results of the answers to the question: my personal experiences in cooking/food preparation workshops with younger children include…



Q22. Open answer to complete Q21 (optional)

Do you have any other comment about your personal experiences in cooking/food preparation workshops with younger children?

6% of the global sample of teachers adds comments about their personal experiences in cooking/food preparation workshops with younger children. In Ireland, teachers say that their "experience or abilities are very limited", they manifest "not having resources for cooking with children" and one of them "has used cooking workshops in Primary School.". In Italy, some teachers have considerable experience and mention a particular case in a school and others say they lack personal experience. In Poland, some teachers add comments such as "I often link food topics with tasting sessions" "preparing meals and recipes" and "food preservation and preparing breakfast once a week". In Spain, some teachers mention their lack of experience and consider the workshops interesting because "they are truly motivational to encourage active participation in children's involvement in their own learning".

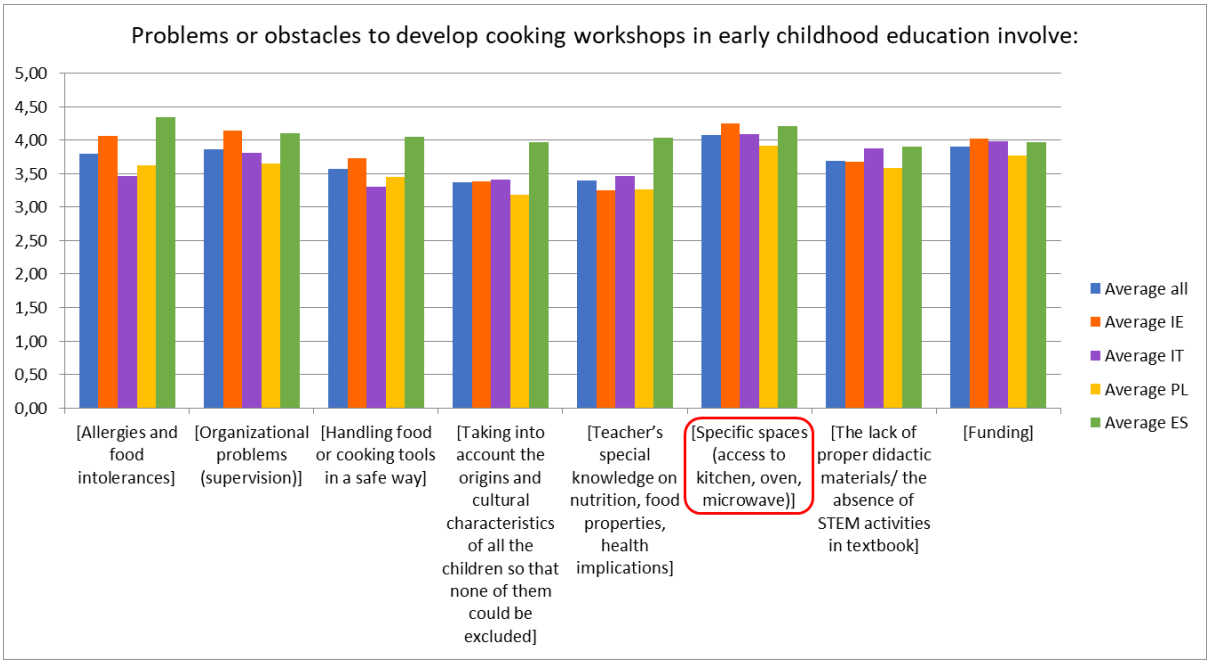
Q23. **Problems or obstacles to develop cooking workshops in Early Childhood Education involve**:

Globally, the main problems or obstacles to developing cooking workshops in Early Childhood Education that all the **participants considered were, in descending order:** "specific spaces - access to kitchen, oven, microwave…" (4,07%), "funding" (3,90%), organizational problems-supervision" (3,86%), "allergies

and food intolerances" (3,80%), "the lack of proper didactic materials-the absences of STEM activities in textbooks" (3,70%), "handling food or cooking tools in a safety way" (3,58%), "teacher's special knowledge on nutrition, food properties, health implications" (3,39%) and "taking into account the origins and cultural characteristics of all the children so that none of them could be excluded" (3,37%).

Figure 14 shows the maximum average in Ireland (4.24), Italy (4.09) and Poland (3.92) is the same. In Spain, the maximum rating is for allergies and food intolerances (4.34). The minimum average in the analysis per country is: taking into account the origins and cultural characteristics of all the children (Ireland 3.39 and Poland 3.18); handling food or cooking tools in a safety way (Italy 3.30) and the lack of proper didactic materials/the absence of STEM activities in the textbooks (Spain 3.91).

Figure 14. Results of the answers to the question: problems or obstacles to develop cooking workshops in early childhood education involve…

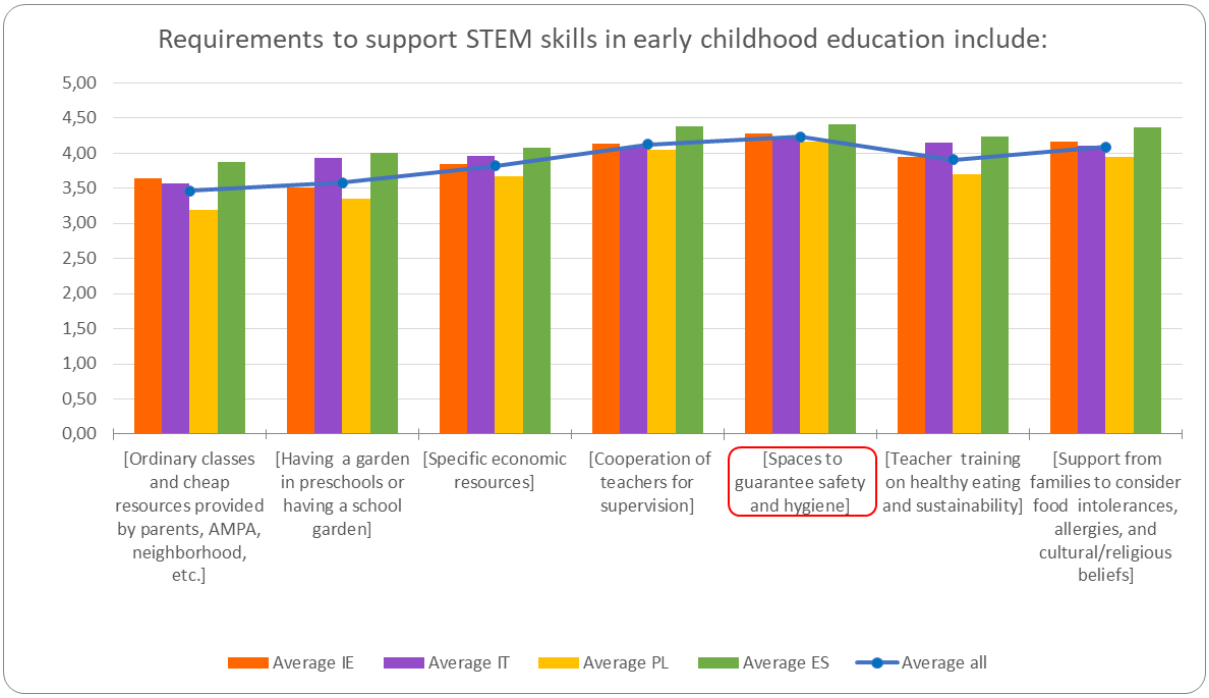


Q24. **Requirements to support STEM skills in Early Childhood Education include**:

The main requirement to support STEM skills in Early Childhood Education that teachers in all four countries consider is the need of "**spaces to guarantee safety and hygiene**" (4.23). This maximum value is the same in all the participating countries: Ireland (4.28), Italy (4.21), Poland (4.16) and Spain (4.41).

As shown in Figure 15, the least valued requirement in the four countries is "ordinary classes and cheap resources provided by parents…" (3.46). It is the answer of 3.57% of the teachers in Italy, 3.19% of the teachers in Poland and 3.87% in the case of Spain. In Ireland, the least valued requirement is having a garden in preschools or having a school garden (3.51).

Figure 15. Results of the answers to the question: requirements to support STEM skills in Early Childhood Education include…



4. Conclusions

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Highly differentiated character of research group makes the process of drawing conclusions from the project's survey quite difficult, however the comparative analyses reveals both, some important similarities and cultural differences between teachers' knowledge and opinions about STEM education in different countries:

1. Teachers' opinions and knowledge about STEM education were highly differentiated depending not only on the country, but also - or even first of all - on their own professional experience in working with children. The perception of aims and possibilities of organizing STEM education in preschool becomes more sensitive and flexible along with personal, practical experience. All the respondents consider STEM education as possible and valuable part of preschool program.
2. **The importance of the *KLb4Kids* project has been confirmed by the fact that over 1/3 of respondents was not familiar with the term "STEM education", therefore has not been trained in implementing the idea in their teaching practice.** At the same time it is worth noticing that the term is not equally popularized in different countries across Europe (with over 93% of Irish respondents comparing to only 50% of Italian, 67% of Spanish and 62% of Polish teachers declaring the knowledge of it). At least 2 factors can be responsible for such differentiation:
    - Considering the fact that STEM education has originally American roots, the common language (English) might have been very helpful in spreading the idea in countries like Ireland (Irish teachers have easier access to professional literature, examples of good practices, digital materials available on internet etc.);
    - Another factor of high importance is educational policy of a country - although the term itself is not present in any core curricula in countries participating in the survey, some programs might be more closely connected with inquiry-based learning and problem solving, therefore having more indirect interconnections with skills embedded in STEM education. The research proves that there is an urgent need to make the policy makers aware of the importance of STEM skills in our modern world. Disseminating the idea on this level should be seen as an important aim of our project.
3. **On overall level the teacher's knowledge of STEM education seems to have rather intuitive character, sometimes even based on internally inconsistent assumptions. It may be described as a "knowledge in the course of constructing/ knowledge in development", not fully grounded in scientific ideas, and therefore difficult to be consciously justified or explained**, e.g.:
    - The essence of STEM education on preschool level (Q4) is perceived in categories of play or learning through direct, sensorial experiencing of natural environment (hands-on learning) rather than in terms of precise, scientific, logical thinking which might be nurtured by this playful activity. Scientific thinking is not perceived by the respondents as a unique value of STEM education.
    - Teachers explain the value of preschool STEM workshops from the perspective of child's active engagement. Exploring, inquiring, experiencing the world - are the keywords to

describe teachers' understanding. In Q6, when explaining the value of STEM, all the respondent chose the answer - STEM education allows "**Asking questions and searching for answers by doing experiments**". If we analyse each country separately, in Spain this indicator reaches the greatest difference with respect to the rest of the indicators (with "awakening positive emotions and motivation to learn science" on the second place), while, in the other countries it is followed very closely by or at the same level as, "Encouraging children to learn by playing" (Italy) and "Having practical experience (Ireland and Poland)

- The above conclusion has been confirmed in Q7 where respondents noticed the importance of such skills as discovering and thinking creatively, planning and conducting observations/ experiments. But, at the same time such research-based activities seemed to be defined mainly as a source of free, creative, joyful play rather than in terms of precise, logical thinking, drawing evidence-based conclusions or critical evaluation of facts/data. On one hand such perspective might by justified by the fact that learning through playing is a natural instinct of young children. On the other hand however, relatively low position in teachers' choices was obtained by cognitive autonomy/ self-regulated learning as if these two areas of development were not strictly connected (with research-based activities being the road to cognitive autonomy). This observation confirms that the important aim of *KLab4Kids* project should be underlining the importance of STEM education in the process of building the self-efficacy feelings in children, offering them the possibilities to achieve an independence of thinking, the ability to plan, observe and evaluate their own learning. Self-regulation in this area is perceived by many researchers as a key competence in a modern world.
- The same contradiction can be found in teachers' perception of emotional aims of STEM education (Q9) - the importance of children internal motivation and engagement were strongly underlined along with self-reliance defined as an ability to trust one's own

potential (capabilities) as a learner. Again, the missing factor in teachers' answers was self-regulation understood as an ability to monitor and deal with own emotions (particularly difficult, unpleasant emotions which might be evoked by the learning process in a preschool classroom). It seems like for many respondents the terms "self-regulated learning/self-regulation" are probably too theoretical, maybe even unclear or unfamiliar. There is a need to ground teachers' everyday experiences in theoretical reflection to make their knowledge more internally consistent, susceptible to critical reflection, evaluation, and possible to be verbalized when shared with others. A learning community (planned as a part of *KLab4Kids* project) might create the opportunity for such epistemological reflection - becoming aware of one's own knowledge, its' strengths and gaps/uncertainties.

- The strongest point of respondents' opinions about STEM education aims at the preschool level (very well rooted in psychological knowledge) is the social area of development - here the teamwork skills were perceived as the most important area of learning, along with interpersonal communication and the ability to take initiative, which is fully compatible with research results presented in literature. The opinions of teachers from all the countries were strikingly similar in that area.

4. **Strong international similarities were discovered in the area of teachers' experiences and training** - the respondents have a clear feeling their prior and current training in STEM education on preschool level was not satisfactory for many reasons: either was not practical enough, or not concentrated on young children's possibilities. The integrated approach unique for STEM education was neither carefully explained, nor practiced. Also, the respondents prior experiences with conducting STEM workshops are rather poor - typically these include activities like: (1) biological observations/experiments, (2) mathematical games and plays, and (3) field trips. Not surprisingly, the lacking element are the interdisciplinary projects, integrating 2 or

more different areas of STEM education. The teachers who participated in our research are fully aware of that gap, no matter what country they come from.

5. **Another similarity in respondents opinions on international level is the perception of barriers/challenges in organizing STEM workshops in a preschool environment** (Q14) - all the respondents stressed similar obstacles: (1) lack of funds, (2) lack of proper equipment to run the experiments and (3) lack of proper spaces to organize scientific workshops. That means that teachers participating in the survey do not perceive preschool kitchen as a sort of scientific laboratory, already equipped in tools, appliances and ingredients which might be used for learning. That is the great chance for our project - to show the possibilities of using kitchen equipment for STEM education, making it less expensive and therefore available even for preschools working in difficult, socio-economically deprived environments.

Additionally:

- It is worth noticing that while being aware of many different difficulties or impediments in STEM education, the respondents do not perceive the young age of children as a problem!
- **There are also some cultural differences in teachers' perception of challenges**, e.g. several Irish teachers express the need for additional guidelines from preschool administration, or even the need for changes in core curriculum - making it more flexible to allow the innovations to be introduced by motivated teachers. Italian teachers perceive as one of the main problems, the lack of additional supervision in class allowing to manage the group. Spanish teachers mentioned the lack of motivation to engage into additional job. Polish respondents on the other hand expressed the need for additional support from other co-workers/ teachers - such support might be provided by "Learning Community", designed as an important part of *KLab4Kids* project as a forum to exchange ideas, collect and evaluate the examples of good practices and to build the participants motivation and courage to undertake the efforts in their own environments.

6. **The need for additional professional support was also surprisingly equally stressed on international level in Q16**:

- The main requirements for organizing the STEM education in preschool environment pointed by our respondents are together: teachers' motivation and their knowledge of subject areas. In other words, the teachers do not feel competent enough to explain the scientific concepts/experiments to children with the use of professional vocabulary in a comprehensible way, they feel they need additional support from more competent co-worker, they would feel much more confident in their educational efforts having a colleague working jointly or simultaneously, having the possibility to learn from someone more competent in the area. Learning community in *KLab4Kids* may fulfill this gap while having the great influence also on teachers' motivation for involving in new, innovating activities. Such open, on-line courses are designed not only to provide the reliable, easy-to-access database of learning resources, but also to create the opportunity to learn from others in a safe home environment.
- Other needs were highly differentiated on intercultural level - the same factor perceived as an important obstacle in one country was not equally important in other culture e.g. Polish teachers underlined the need for closer cooperation between teachers working in the same preschool while in Ireland, where such cooperation is a natural part of working culture, this factor was not important.

Teachers' perception of cooking/ kitchen in STEM education on preschool level

Teachers' opinions about the possibilities of using kitchen/cooking as a source or inspiration for STEM education constituted an interesting part of the survey, revealing some schemas/ stereotypes in teachers' thinking. Majority of respondents perceive cooking in a very traditional way - mainly as a road to build children's knowledge about healthy food or proper eating habits. At the same time they do not consider cooking as a scientific procedure or the process of thinking, solving problems and explaining scientific concepts underlying this process. Therefore, there is a need of broadening teachers' perception in that area, to go beyond the "healthy eating habits" zone, making their thinking more flexible and sensitive to STEM values hidden in kitchen/cooking.

Interestingly enough, the respondents while considering the obstacles in using kitchen as a scientific laboratory, underlined strongly the problems of a technical nature rather than methodological, e.g.

- Majority of respondents have a problem with access to kitchen area or other spaces which would guarantee safety for children, allowing creative experimenting at the same time;
- Majority of respondents complain about the lack of funds allowing to buy ingredients or equipment necessary to run experiments of a scientific nature;

- Many respondents expressed the need for additional supervision necessary to organize the STEM workshops in small groups, while assuring the safety rules in a classroom and the possibility to include children with special needs.

However, **nobody expressed the doubt whether STEM education on a preschool level is possible - all the researched teachers think that young children are capable of solving scientific problems and participating in STEM workshops. All respondents confirmed this should be seen as a valuable part of preschool education, even though it is not directly present in preschool core curricula**.

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Appendixes

Appendix 1. Focus group interview - research tool

The objectives

Preliminary recognition of teachers opinions, experiences and needs in the area of developing STEM skills in preschool children

Designing precise questions for survey which is the main diagnostic tool, planned in project application

Research questions

What students/ preschool teachers know about STEM education at the preschool level?

What language do they use to describe children's STEM activities - do they use the descriptors from core curriculum or other?

Research group

8 students of preschool education (pre-service training)

8 preschool teachers (in-service training)

1. Introduction - using 2 video clips as an inspiration/ stimulus for interview

(e.g. video of preschool children doing scientific activities in the kitchen - similar to those prepared by UIC. Please note: the intention here is not to intimidate respondents, give them the opportunity to open up without the feeling of being tested - it is easier to talk about somebody else's actions, than about one's own knowledge).

Movie proposed by AIK team https://www.youtube.com/watch?v=T-Oa-uHP_t0

Movie proposed by UIC: https://www.youtube.com/watch?v=me1DfTAqGWE&vl=es-419

2. Questions connected to the video

A. What do you think about this type of lessons/ workshops?

B. What are the aims of such a workshop?

C. What skills/ abilities are developed in children during this type of workshop?

D. What kind of personal experience do you have in doing this type of lesson with preschool children?

E. What type of challenges/ problems would a workshop like this generate?

F. What would be needed to run this type of workshop with the preschool children?

3. Introducing the definition of STEM education

The term "STEM education" refers to teaching and learning in the fields of science, technology, engineering, and mathematics in an integrated way; typically including educational activities across all grade levels, from pre-school to post- doctorate, and in both formal and informal classroom settings (Gonzalez, & Kuenzi, 2012).

Bybee (2013) clearly articulates that the overall purpose of STEM education is to further develop a STEM literate society. His definition of "STEM literacy" refers to an individual's:

Knowledge, attitudes, and skills to identify questions and problems in life situations, explain the natural and designed world, and draw evidence-based conclusions about STEM-related issues.

Understanding of the characteristic features of STEM disciplines as forms of human knowledge, inquiry and design;

Awareness of how STEM disciplines shape our material, intellectual, and cultural environments; and

Willingness to engage in STEM-related issues and with the ideas of science, technology, engineering and mathematics as a constructive, concerned, and reflective citizen." (p.101).

4. Questions inspired by STEM definition:

• Is is possible to develop scientific thinking in the preschool? How - in what way?

• What would you need to support such skills/ abilities in preschool

children?

Appendix 2. Semi-structured interviews - research tool

Research aims

Preliminary recognition of teachers opinions, experiences and needs in the area of STEM education at the preschool level designing the precise, expressed in teachers language questions for the project main survey

Needs

At the beginning of interview we provide the definition of STEM:
The term "STEM education" refers to teaching and learning in an integrated way in the fields of: science, technology, engineering, and mathematics; typically including educational activities across all grade levels, from pre-school to post- doctorate, and in both formal and informal classroom settings (Gonzalez, & Kuenzi, 2012). Bybee (2013) clearly articulates that the overall purpose of STEM education is to further develop a STEM literate society. His definition of "STEM literacy" refers to an individual's:

- *Knowledge, attitudes, and skills to identify questions and problems in life situations, explain the natural and designed world, and draw evidence-based conclusions about STEM-related issues.*
- *Understanding of the characteristic features of STEM disciplines as forms of human knowledge, inquiry and design;*
- *Awareness of how STEM disciplines shape our material, intellectual, and cultural environments; and*
- *Willingness to engage in STEM-related issues and with the ideas of science, technology, engineering and mathematics as a constructive, concerned, and reflective citizen." (p.101).*

After reading the definition, we ask the respondent:

- Do you know what STEM skills are?
- Do you think it is important to teach STEM skills in the early years? Why?
- How do preschool practitioners promote working and thinking scientifically (in general) or STEM competencies within their contexts?
- What values and skills do children develop through scientific research based on food, nutrition and/or cooking?
- What other abilities/ procedures can be promoted while teaching STEM skills to preschool children?

Good practices

- Can you report some good practices in the area of teaching/ learning STEM skill at the preschool level in your environment? Tell us.
- What is the optimal context to develop STEM skills in the preschool education?

Barriers/obstacles for teaching STEM at early years

- What are the potential challenges to the development of scientific knowledge and skills through food/cooking-based learning in the early years?
- Do you think that everybody should have a basic level of STEM skills for the daily life? Why?

Pre-service teacher training in STEM

- What have you learned during your pre-service training about teaching STEM skills to young children?
- What important was lacking in your pre-service training in that area?

Appendix 3. On-line survey - research tool

http://kitchenlab4kids.eu/?page_id=688

Website

For further and updated information about this project please see: http://kitchenlab4kids.eu/

Contacts

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K4K

K4K - Kitchen Lab 4 Kids is an Erasmus+ KA2 project (2018-2021). The project aims at proposing interdisciplinary activities in an integrated teaching context that allows pre-schoolers to develop STEM skills while practicing exciting science at the same time.

Partnership:

Ignatianum

Fondazione Politecnico di Milano

LUMSA Università

uic barcelona

DCU

Go to the website and discover the Teaching Set, with resources addressed to preschool teachers, University teachers and researchers:

kitchenlab4kids.eu

Erasmus+

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