Communities for Sciences

Towards Promoting an Inclusive Approach in Science Education

D4.3 – Final Pilot analysis report

Project Acronym	C4S
Project Name	Communities for Science – Towards Promoting an Inclusive Approach in Science Education
Grant Agreement	872104
Start date of the project	01/10/2020
End date of the project	30/11/2023
Related Work Package	WP4
WP Lead Partner	UNIMIB
Other Partner(s) involved	EhB; EUB; UManresa-FUB; Galileo; NBU; RCE Vienna; Sesto SG; UVic
Deliverable identifier	D4.3
Deliverable lead beneficiary	
Due date	M36
Date of delivery	
Author	UNIMIB & partners
Classification	PU

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 872104

REVISION HISTORY			
Revision	Date	Comments	Autohr
V0.1	16/06/2023	6th Template Draft	Luisa Zecca (UNIMIB), Petar Lefterov (UNIMIB), Valeria Cotza (UNIMIB)
V0.2	29/06/2023	Edits on 6th Template Draft	Petar Lefterov (UNIMIB), Gabriel Lemkow (FUB), Lluïsa Sort Garcia (FUB) Myriam Navarro (FUB), Sarolta Darvan (Galileo), Antoneta Mateeva (NBU), Nadja Kocheva (NBU), Sarah Scheer (IB), Kristina Orban (ULUND), Biesmans Annick (EhB)
V0.3	18/07/2023	Final Pilot analysis report Template finalization	Luisa Zecca (UNIMIB), Petar Lefterov (UNIMIB)
V0.4	01/09/2023 - 29/11/2023	Content text	Luisa Zecca (UNIMIB), Petar Lefterov (UNIMIB), Marta Granata (GiocheriaLaboratori), Myriam Navarro (FUB), Kristina Orban (ULUND)
V0.5	30/11/2023	Final Revision	Luisa Zecca (UNIMIB), Petar Lefterov (UNIMIB), Valeria Cotza (UNIMIB), Gabriel Lemkow (FUB), Lluïsa Sort Garcia (FUB)

INDEX

1. Executive Summary

The following Deliverable D4.3 corresponds to the Final Pilot Analysis Report which aims to present the findings of a multiple case study, carried out in 6 European Countries. As such this Deliverable gathers all the data from the pilots and presents results that directly and specifically address and focus upon the value-laden messages and exclusionary practices used in science towards members of different vulnerable groups, such as: members of Roma community, people with migrant background, people with a disability and women and girls' members of these communities.

At the same time, the Deliverable involves establishing a framework for a potential transferability of C4S pilots to other realities and/or countries. To do so, a common number of guidelines and settings have been designed and discussed to make this transferability feasible. Furthermore, to ensure the validity of the results analysis guidelines were shared with each partner and periodical assessment meetings were scheduled.

2. Introduction

The topic of inclusive science education has gained considerable scholarly attention in the last decades, as evidenced by Markic and Abels (2016) and Koomen et al. (2018). Hence, the necessity for inclusive practices in ordinary classrooms is widely acknowledged globally, as illustrated by case studies (Koomen, 2016; Asghar et al., 2017; Reynaga-Peña & Sandoval-Ríos, 2018). Despite this growth of relevance, the practical implementation of inclusive education poses a substantial challenge for practitioners all over the world. Furthermore, research in science education, specifically on fostering inclusivity while learning-teaching, remains noticeably lacking. Some studies suggest initiating the process with reflective practices within the classroom to identify effective strategies for all students, including those with disabilities. Noteworthy among these strategies are activities involving hands on learning, and more precisely, purpose-built robots, as demonstrated by Pennazio (2015), which support and integrate play and social interactions, benefitting all children.

In the pursuit of promoting inclusive science education, it becomes imperative to thoroughly consider the emotional aspects involved. This dimension encompasses attitudes, values, beliefs, opinions, emotions, interests, motivation, and the degree of acceptance or rejection. An exploration of this dimension holds the potential to influence students' interest in science topics. However, the heterogeneity of conditions and the complexity of different forms of learning present challenges, yielding less clear overall results. This emotional awareness consistently underscores the competencies of science teachers and the importance of collaboration within inclusive school contexts, as emphasized by Kahn, Pigman and Ottley (2017), and Tang (2021).

In response this framework, the idea of constructing a more comprehensive framework for inclusive science education gains relevance, aiming to intersect the concepts of science education with a broader inclusive pedagogical perspective, as suggested by a recent systematic review by Brauns and Abels (2020). A focused examination of inclusion in science education/STEAM reveals various perspectives on promoting science in diverse contexts. Eco-justice pedagogy in environmental sciences (Djonko-Moor et al., 2018), offers a promising avenue for inclusive science education. This approach addresses the accessibility of science for all, particularly in the context of social or cultural barriers and discrimination, providing empowering tools for children from underrepresented communities. The study by La Force et al. (2019) in 20 inclusive STEAM education high schools in the United States underscores that inclusive STEAM education can reduce existing gender and ethnicity gaps.

Further, Nasri et al. (2021) conducted a study testing the effectiveness of the Universal Design for Learning (UDL) model and Multiple Intelligence (MI) theory in STEAM programs. The results indicate that UDL-MI oriented STEAM programs significantly enhance student interest and motivation in STEAM education, recommending the adoption of the Universal Design for Learning model for creating inclusive STEAM education classes. Du Plessis (2020) contributes to the discourse by offering recommendations for educational leaders and reflections on improvement strategies in STEAM subjects.

In conclusion, in the intricate process of navigating the multifaceted landscape of inclusive science education, characterized by its diverse challenges and evolving dynamics, these studies stand as instrumental contributors, actively engaging in the formulation of strategies and insights that not only address the existing gaps but also play a significant role in shaping the trajectory towards a more inclusive, accessible, and ultimately equitable future for the realm of science learning. As part of this collective effort, the C4S project seeks to contribute to this ongoing debate by further enriching the discourse on inclusive science education.

2.1 C4S aims and research questions

The C4S project explores the relationships between Science and Society by focusing on vulnerable communities as active social agents or members of the science community, aiming to make scientists and educators from these communities more visible.

Through the creation of local hubs in the eight participant countries (Austria, Belgium, Bulgaria, Germany, Hungary, Italy, Spain, Sweden), the project aims at collaborating with formal and non-formal pedagogical institutions, involving political and cultural entities. Distribution across hubs focuses on communities in vulnerability risk situations, including immigrant communities in Manresa-Vic Hub, Vienna Hub, and Brussels Hub; persons with disabilities and/or SEN in Milano Hub; and the Roma community in Budapest Hub and Sofia Hub. The RRI approach includes a Gender intersectional perspective. The project is committed to inclusivity, detecting barriers that impede access to science education for vulnerable communities. It reflects on exclusionary practices in scientific knowledge, which may inadvertently convey discriminatory messages. Furthermore, the project aims to provide data and recommendations on creating and boosting inclusive research communities with children, detecting and overcoming inclusiveness barriers, promoting engagement of communities and social actors, addressing asymmetries in accessing science concepts, and enhancing the positive role of communities.

Both the data collection and the analysis perspective have integrated the reality of the children, the participants, the families, and the policy makers. Although science is vital for our current societies and the understanding of the phenomena that surround us is not a simple activity, but, on the contrary, coexistence is also integrated into learning, the recognition of knowledge of the populations with whom we build actions and transversality of scientific knowledge in many areas of the fields is a must. This incorporation of “previously abandoned” scientific knowledge can also be accompanied by inclusive work that may impact the entire educational community.

Thus, the pilot activities aim to gather valuable insights for the transfer of inclusive science initiatives to other EU contexts or countries. To guide this process, general research questions (GQ) and specific questions (SQ) have been formulated:

GQ1: Co-Creation and Boosting of Community Living Labs (CLL)

- SQ1.1: To what extent and in what manner do CLLs facilitate co-participation?
- SQ1.2: What are the lived experiences of participants, co-researchers, and stakeholders during CLL activities?
- SQ1.3: What types of activities, topics, initiatives, and practical strategies are implemented in the CLL?

GQ2: Development of Inclusive Science Education in CLLs

- SQ2.1: How can CLLs facilitate the development, promotion, and implementation of inclusive science education through co-creation and co-research initiatives with children and families?
- S.Q.2.2: What external or internal factors within CLL contexts facilitate or hinder inclusion in science education activities for communities in vulnerability risk conditions?

GQ3: Short-Term Impact of CLLs on Social Environment

- SQ3.1: What is the material, relational, and psycho-affective impact of inclusive science education activities on children, educators, families, and communities?
- SQ3.2: What standout factors are observed in each research context, and which aspects are common across different contexts?
- S.Q.3.3: How do participants perceive the impact of the activities undertaken?

GQ4: Potential Social Transference of Pilot Activities Results

- To what extent can the results of the pilot activities be transferred to other realities?

These structured questions will serve as a comprehensive framework, ensuring a systematic and detailed examination of the pilot activities, their impact, and the potential for broader social transference.

3. Methodology

The C4S project entails a mixed methods research approach centred on a multiple case study framework. In this approach, researchers will actively participate as observers in pilot processes, employing shared tools for data collection and triangulation. This collaborative data collection strategy facilitates comprehensive analyses of each reality, encompassing its development, outcomes, and impacts. The goal is to distil valuable recommendations and strategies for the transfer of each pilot activities to other European Union contexts and communities.

The selected case study methodology (Stake, 1994; Yin, 2014) involves comprehensive data gathering, focusing particularly on diverse perspectives, structural attributes, pedagogical methods, quality processes, and curricula associated with each context. This methodology enables to delve into the nuanced aspects of phenomena as necessitated by the qualitative method. Moreover, it facilitates not only the explication but also a profound comprehension of the observed phenomena. By juxtaposing multiple data sources, it uncovers the interpretations actors assign to their practices. Significantly, the C4S project has opted to adopt a multiple case study approach (Stake, 2006), which entails identifying recurring patterns and phenomena among a designated set of observed and analysed situations. This approach, characterized by a comparative analysis of distinct constellations of attributes, serves to enhance triangulation opportunities. By combining various information sources, it broadens the scope of comprehensive understanding and analysis.

3.1 Pilot Protocol

The C4S project is aimed at working with and for communities in vulnerability risk conditions by promoting science education to children and young people aged 0-16 years old (and to their families and surrounding communities), through formal and non-formal pedagogical institutions, involving political and cultural institutions and policymakers. The project intended to detect the barriers that prevent access to science education for people from communities at risk of vulnerability and to reflect together on the exclusionary practices in scientific knowledge.

For the research to be undertaken during 2022 at least one Community Living Lab per Hub has been chosen to obtain reliable information and data on the CLL pilot interventions about its development and implemented activities and results. The development of the pilot activities was included in Task 4.3 - Pilot activities development, implementation and data gathering, and lasted from M13 (jan-22) to M19 (jul-22). For a CLL to become a Pilot site the hosting institution had to meet some common requirements:

Table 1 - Pilot sites selection criteria

Length of commitment	From 2 up to 6 months (from January 2022)
Number of participants (children & youth 0-16)	From 6 up to 30 participants, involving at least one of the target project communities (Roma communities; People with immigrant background; People with disabilities and/or SEN).
Practitioners	Practitioners should commit to: - Full engagement in Training Programme. - Commitment in regularity of activities and assessments. - Commitment in data gathering. - Transformational interests.
Policymakers and Stakeholders	At least, one representative connected with the activities and events carried out in the CLL pilot site.

Furthermore, a road map (Figure 1) with shared achievable steps was designed to systematize the research and to guide partners in the writing of the Final Pilot analysis report.

Figure 1 - Road map to the Final Pilot analysis report

Step I - Before the Pilot (October-December 2021):

1. Select and develop the CLL sites.
2. Design the pilot interventions according to common criteria.
3. Organize a Training Programme for educators and collaborators.
4. Achieve the Ethical Committee approval.

Step II - During the Pilot (January-June 2022):

1. Start and implement the Pilot according to a common approach and set of technical research tools.
2. Plan periodical assessment meetings (follow- up of activities, practical assessment, extra-training…).
3. Gather first needed data to answer the general and specific research questions (observations during the laboratories, recording, questionnaires, diaries).

Step III - After the Pilot (July 2022-September 2023):

1. Start data analysis (July-Decembre 2022).
2. Provide periodical meetings to give feedback and updates (July-Decembre 2022).
3. REDcap creation (July-Decembre 2022).
4. Gather last data (interviews and focus groups) (Decembre-April 2023).
5. Fill in the first part of the REDcap by each HUB (Section 1 – Children and adolescents) (Decembre-April 2023).
6. Finisch the data analysis (April-September 2023).
7. Finish the REDcap report by each HUB (April-September 2023).
8. Draft the Final Pilot Research Report (April-November 2023).

3.2 Research tools

Given the complexity and richness of each reality, to manage the transferability of each case study a pilot protocol (see 3.2. Pilot Protocol) and a common set of research tool has been established.

A pre- & post- questionnaire has been drawn up; the questionnaire is made of three macro-sections *"A. In the general context/location of my Community Living Lab(s)", "B. If I think about the Science Education approach in my CLL(s), I can say that"* and "*C. If I think about the Inclusive aspects of our CLL(s), I can say that*". The questionnaire is made of 35 items and had to be hand out to the practitioners prior to the start of the pilot activities and after the end of the pilot.

By the end of April 2022 each case study had to fill in the Description of the pilot site participating at the activities. The Description of the pilot site's template is made of six items, five of which were survey questions, and one was an open-ended question.

During the data gathering period, each practitioner participating at the research had to keep a diary. The practitioner's diary had both an open section in which practitioners could write down their thoughts, opinions on the activity, ideas and observations, and a close-ended section made of twelve Likert scale items.

Finally, to better understand the possibility of transferability, a set of common observational categories has been developed. The Observational Report is a tool used by researchers, divided in children and in adults, needed to observe the scientific laboratories carried out with children. Observational Report's categories were chosen a priori, but each partner had the option of adding additional categories based on his or her own context.

3.3 Data analysis methodology

For the data analysis process two steps of thematic analysis have been implemented: a deductive thematic analysis, followed by an inductive thematic analysis.

Once the pilot phase has been concluded (see 3.3 Pilot protocol) and each partner has finished gathering the data, the data was processed through a deductive thematic analysis, meaning that the categories referred to were established a priori by the project partners. Such analysis consists of approaching the data with some preconceived patterns; those patterns are used to create codes that can summarize data. It is later the researcher who re-assembles the data, creating robust themes (Lochmiller, 2021).

After the data analysis phase, each partner was required to file its analysis report in the REDcap, which is a repository, that allows for high personalization and covers all safety standards required by the ethics committee. Storing all the analysis reports in one single repository allowed for a cross-country analysis, which brought out common patterns and themes. This cross-country analysis was carried out through a inductive thematic analysis, which differs from the deductive thematic analysis since the categories, the codes and the themes used in the analysis process aren't chosen beforehand through the use of the literature, but emerge in the reading of the process.

4. Results

Inclusion is a dynamic systemic, and relational process that actively involves different actors on multiple levels. Therefore, for this reason, inclusive education should present distinctive plans of action on a given context, as well as various actors for change (Mitchell, 2014). By adopting a systemic perspective, based on Bronfenbrenner's ecological theory (1979), the interventions implemented in the different realities have tried to take into consideration the peculiar social environments that intervene in a person's development.

In the following section, after describing the Context, the study's results are presented through the framework of Bronfenbrenner's theory. The microsystem is examined to reveal findings related to activities within the school, shedding light on the experiences of both students and practitioners. Transitioning to the mesosystem, an exploration of outcomes concerning families and their interactions within the educational context is undertaken. Subsequentially, attention is directed towards the macrosystem, where an in-depth analysis of results related to policymakers and the broader systemic impact of inclusive science education initiatives is conducted. Lastly, the potential social transference to other realities of the pilot activities is presented. This structured presentation of results facilitates a comprehensive understanding of the complexities inherent in the promotion of inclusive educational environments within the different European realities that took part in the C4S project.

4.1 Context

During the second year, each HUB had to choose at least one Pilot site, in which to conduct the research and gather the data. It's important to clarify that conducting a pilot activity/intervention extends beyond mere scientific experimentation within the confines of the HUB. It encompasses the vibrant integration of the pilot's activities into the local community, engaging children, young individuals, and families in diverse activities, experiences, and events.

Sofia HUB pilot took place at the HESED Kindergarten. The HESED Foundation has developed a specific program called 'Preschool Education and Care for 3–4-Year-Old Children' that engages with young children living in compact Roma communities who are not covered by the education system, as well as with their parents. The pilot worked with practitioners and psychologist to help Roma children develop their scientific skills.

Infant School Bambini Bicocca is one of the two pilot sites of HUB Milano, it is a private school managed by the University of Milano Bicocca. The pilot site aimed at implementing inclusive science educational laboratories for and with children 3-6 years old with disabilities or special educational needs.

Infant School Monte San Michele, the second pilot of HUB Milano, is a state infant school of the municipality of Sesto San Giovanni. Children aged 5 years old of two classrooms took part in the pilot period research participating in scientific activities regarding the realm of physics. The activities were carefully designed with the support of GiocheriaLaboratori.

The children from Dominiques school participated in a program to improve their STEAM education through the development of 3D printing laboratories. Through the laboratories, students have become familiar with new technologies and engineering basics. They have worked on a project to create technical aids for disabled children from Estel School. In doing so, they have developed mathematical competencies and learned human kinetics and anatomy. They have developed empathy and a sense of citizenship too.

The pilot RiverLAB Valldaura School was carried out in a highly complex school in the city of Manresa with kids from 3 to 6 years old. The aim was to work on inclusion through science with communities of migrant origin. The school is located near the Cardener River, taking advantage of this situation to work on science subjects in nature, visiting the river as a scientific laboratory with the class group.

Through the C4S project and the involvement of the Primary School Robert-Blum-Gasse 2, Vienna HUB inaugurated the Garden4Siences pilot. By working in the 20th district of Vienna, one of the districts with the highest proportions of people with an immigrant background and one of the lowest average incomes, the Garden4Sciences involved in the project children, aged 9-12, from a migrant background.

In 2022, Budapest HUB set up an EduLAB 0-6 community living lab in a nursery in the 8th district of Budapest. The EduLAB 0-6 community worked with and for Roma children, aged 0-3, and their families implementing together an inclusive science education approach, both inside and outside the nursery.

HUB Brussels' pilot, the Sound of Music, was carried out thanks to the student-teachers who did their final year internship during the pilot period. Working with children and families with a migrant background Brussels's pilot managed to merge inclusive science education and art together.

4.2 Inclusion in Science Education - Microsystem

Social environments are interdependent on each other, interconnected ecological levels thought of as systems embedded in each other. The following paragraphs present the results of the microsystem, which refers to the institutions and groups that have the most immediate and direct impact on the child's development; it is the layer closest to the child and contains the structures with which pupils have direct contact. In the specific case of C4S, the interconnections between peers, and peers and adults in formal and/or informal educational systems, such as preschools, kindergartens, elementary school, and educational centres, were analysed.

4.2.1 Co-creating an inclusive environment

Involving children and youth connecting with the needs and participation of surrounding communities is a challenging endeavour, which, when carried out meticulously, may lead to the co-creation of educational settings and spaces where inclusion and Inclusive Science Education can be promoted. Thus, questioning oneself how it is possible to co-create and boost inclusive educational setting, i.e. nurseries, schools, parcs, museums…, with the children's and youth leadership carries a substantial importance.

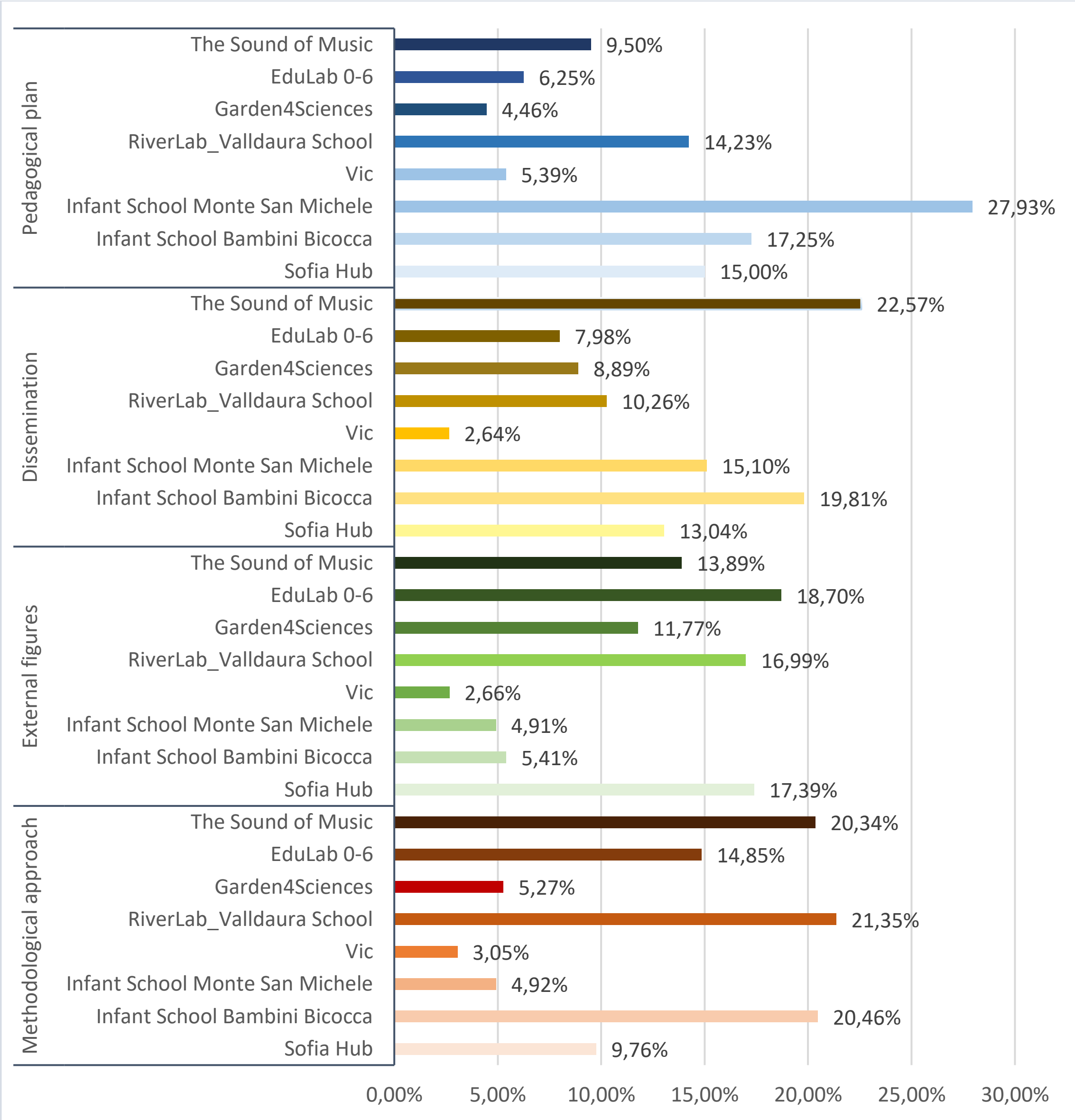
Through the analysis of the different data, it was possible to identify four macro-themes that guided the co-creation of an inclusive educational environment in the eight European pilots:

1. **(theme) Methodological approach**, with an occurrence of 55%, is the theme that received the highest frequency. This theme indicates all those strategies designed, implemented, and observed that are essential to construct and propose inclusive science activities in the various educational settings.
2. **(theme) Dissemination**, with a frequency of 27% the aforementioned theme is the second highest. It is used to indicate all those actions implemented to communicate children's and practitioners' lived experience.

3. **(theme) Pedagogical plan and structure**, at 11% the Pedagogical plan and structure theme indicates the core categories needed to be developed in the educational setting in order to nurture and maintain the inclusive environment in the communities.
4. **(theme) External figures participation** is the least frequent theme, but nevertheless with a frequency of 7% is still of significant importance, since the involvement of different participants in the activities may lead to a sustainable and inclusive educational setting.

In Chart 1 there is a visual representation of the occurrence of the 4 macro-themes by pilot site. For major explanation of the themes and the categories please see the Codebook in the Annex section.

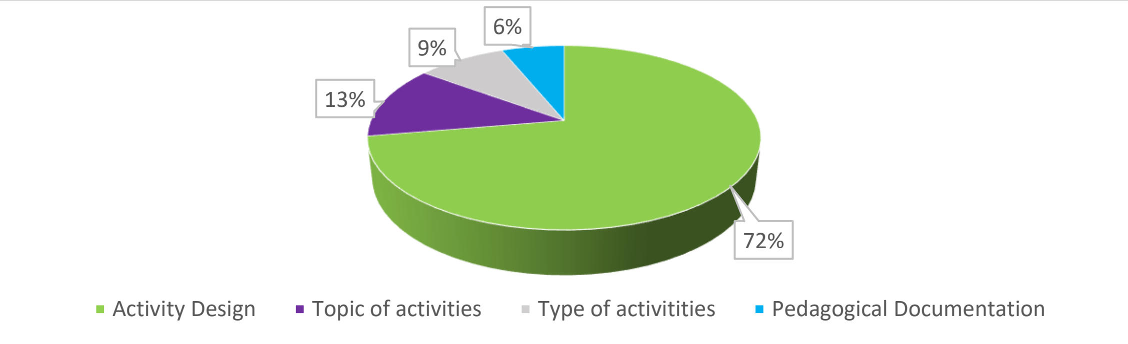
Chart 1 - Themes distribution by pilot site



4.2.1.1 Methodological approach

Building inclusive communities with and for vulnerable communities, in which science education is thought to pupil, children and youth, requires a careful design of the experiences that are offered in educational settings. In the C4S project the children and the practitioners from one nursery, five infant schools and three primary schools, each one in his/hers-own context, worked together to create inclusive communities by implementing different educational methodological approaches. Through the analysis of the data gathered by the European partners it was possible to identify some common daughter-categories of the Methodological approach theme (see Chart 2), that may suggest that those very strategies are the once that make an inclusive educational setting sustainable in the long run.

Chart 2 - Frequency of subcategories of the methodological approach shared among different pilots



It emerged that the way of designing the activity, thus the process of creating and structuring learning activities or tasks that are specifically designed to help students acquire and apply knowledge, skills, and understanding in a meaningful way, leads to the co-creation of an inclusive setting. More precisely it was observed that the input of the activity, the design of the setting, and the learning condition management affect the educational context.

Designing educational activities for children is hence a multifaceted endeavour that necessitates a variety of inputs to ensure children's success. It is crucial to consider the diverse interests of children, as activities tailored to their individual passions and curiosities can ignite a deeper engagement with the learning process. As observed by HUB Manresa-Vic in the RiverLAB Valldaura school, and by Milano HUB in Bambini Bicocca infant school and Monte San Michele infant school, practitioners followed children's interests in various occasions: In Bambini Bicocca infant school children worked on plants growth since some of them expressed the desire to observe the seeds; In RiverLAB Valldaura school build on children's curiosity and questions regarding the outside events. Simultaneously, as encountered by the children and the practitioners of Dominiques and ESTEL school in Vic, addressing the personal needs of each child is essential, as it helps create a supportive and inclusive learning environment. Indeed, the children from Dominiques schools, worked together with the children with sensorimotor diversity form Estel school to co-design 3D printed assistive devices. Moreover, recognizing and representing the unique characteristics and backgrounds of the children involved fosters a sense of belonging and diversity appreciation. Whilst working with children and youth with a migrant background it is important to represent their diversity by involving role models, and artists, like has been done in the Brussels' pilot The Sound of Music or linking the lives of the children and their families in the school curricula, like the RiverLAB Valldaura school has done by talking about the Ramadan. Lastly, tying activities to the community and surroundings of the children, for example by going to the surrounding river, going in the near park, or going to museums, (all activities done respectively by HUB Manresa-Vic, Budapest HUB and Milano HUB) can make learning more relevant and practical, connecting the educational experience to real-world contexts. Therefore, a well-rounded approach to activity design considers the rich tapestry of children's interests, needs, identities, and environments to create meaningful and effective learning experiences.

As stated before, the activity design encompasses a range of actions that go beyond the initial input. By carefully managing the setting, the materials, and the tools it is possible to adopt a methodological approach that nurtures an inclusive educational environment. Utilizing open ended materials, such as natural or recycled materials, which don't present a single mode of use, but allow for a multiple level of exploration, and setting up those materials in a way that the children are free to choose them, allows for a major involvement, a growth of curiosity, and, thus, a major learning output.

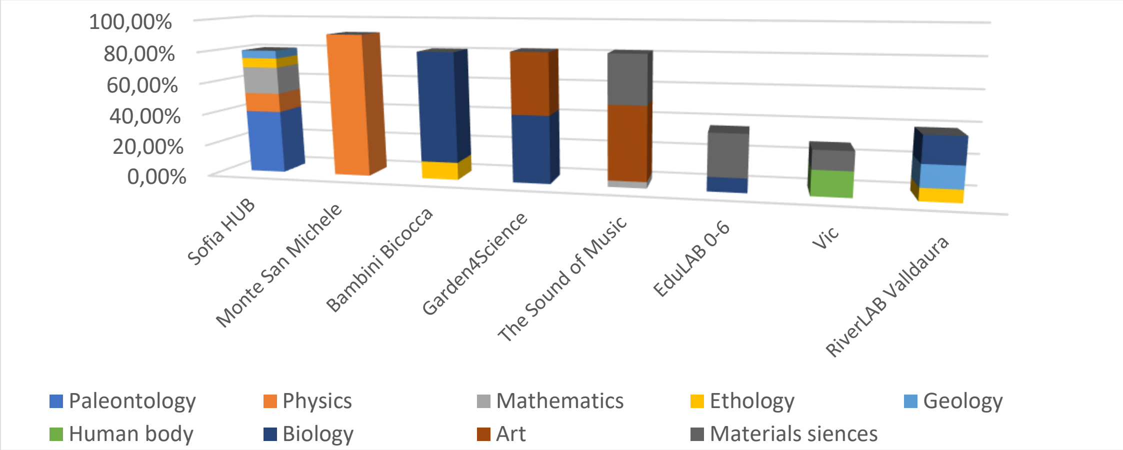
However, to cherish the learning opportunities and to benefit from the experiential learning done with the materials the teaching conditions management and selecting appropriate approaches is crucial. One of those approaches is the Laboratorial approach: As observed by Sofia HUB, practitioners may create many opportunities for children during the science learning sessions to encourage their autonomy and initiatives. However, in line with the laboratorial approach and with the experiences proposed in all the different pilots, the practitioners have to assume a scaffolding position and delve deeper into the children's and youth's assumptions by asking guiding questions and respecting individual learning style.

Other teaching approaches that have implemented by the different partners are the Artful approach and the Holistic approach. The first one, stresses the importance of the A-rt in STEAM education since it stimulates curiosity and encourages participation. Even though, artistic creation has been detected in all the pilots, the Artful approach goes beyond the simple production of drawings and collages, but it takes a centre stage. Both in The Sound of Music and Garden4Scieces art wasn't used as a mere product, but it was a conduit of knowledge; performing and graphical arts weren't collateral activities that helped children to represent what they have learned but were tools to learn. For example, during the activities within the performing arts, children were allowed to experience how a space can be divided and demarcated by interconnected ropes, and experienced how this network of ropes, together with selected music fragments, guides and inspires their motor skills.

Integrating art in science supports and intertwines with the Holistic approach carried out by Sofia and Budapest. As the concept of STEAM has become more and more apparent, it has become increasingly clear that the phenomena, fundamental connections and interconnections of science, technology, engineering, arts, and mathematics are very much present in young children's play activities and everyday life situations. The child asks questions, builds, constructs, draws, examines tools and objects of interest, tests how they work, discovers, and applies rules and algorithms, looks at picture books with adults and asks about objects and how they work, explores nature during outdoor play: bushes, flowers, ants. Meaning that science laboratories should be integrated in the daily life of children and follow the regular kindergarten curriculum.

Not only the activity design, but also the topic and the type of activities affect the success of the inclusive educational environment. In Chart 3 it is possible to see the patterns of the proportion of the provision of topic of the activities for children and youth in different countries. In this chart it is possible to notice, that whereas some pilot sites have experimented in different scientific domains, others have decided to investigate a singular peculiar subject.

Chart 3 - Patterns of the proportion of the provision of topic of the activities in the different pilots



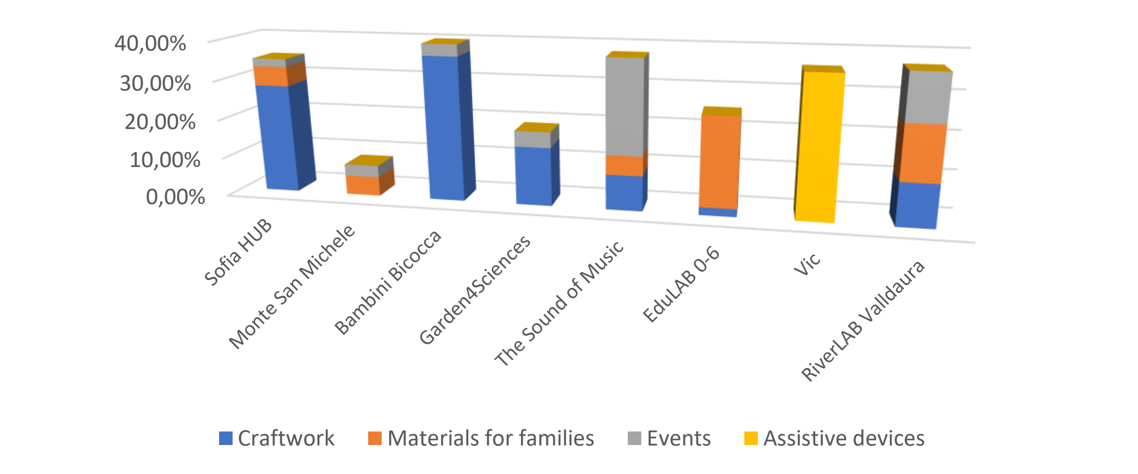
Choosing the correct topics/subjects isn't enough to develop and maintain an inclusive community, it is essential to structure the activities, by following the above-mentioned activity design strategies, and keeping in mind the type of activities that one wants to propose. The various types of activities play a crucial role in facilitating learning and skill development. These activities can be categorized into different types, each serving a unique purpose:

1. Unguided exploration activities: Encourage students to independently explore and discover knowledge. These activities involve self-directed learning, allowing students to investigate and experiment, fostering a sense of curiosity and problem-solving skills.
2. Manipulation activities: Involve hands-on, practical tasks that require students to manipulate objects or materials. Essential for developing motor skills, coordination, and understanding concepts through direct interaction with physical elements.
3. Artistic activities: Encompass creative endeavours such as drawing, painting, music, drama, and other forms of artistic expression. These activities promote self-expression, creativity, and emotional intelligence, while also enhancing fine motor skills.
4. Classification activities: By organizing information, concepts, or objects into categories or groups, these activities help students develop critical thinking and analytical skills as they learn to identify patterns, relationships, and distinctions within a given set of data.

By incorporating a variety of these activity types into the educational process, practitioners can cater to different learning styles and promote a well-rounded, holistic approach to learning and skill development.

Finally, in this carefully designed environment different types of pedagogical documentation can be made (see Chart 4). During the pilot period children involved in the research produced both tangible and un-tangible material to share with their parents, such as booklets in case of RiverLAB Valldaura and Bambini Bicocca Infant School, or performances, as it was done during the Sofia HUB pilot and The Sound of Music. With the help of the practitioners, children could also exhibit their craft, namely drawings, collages, frottages and pictures. Furthermore, as in the case of Monte San Michele infant school, it is important to notice that the final product of the activity shouldn't be the goal of the activities rather the process accompanied by an educational objective. However, products crafted by children can be used for the dissemination of the activities carried out in the learning environment allowing so for a meaningful impact that can support the inclusive environment and gives agentic power to the children (see 4.2.1.2 Dissemination).

Chart 4 - Patterns of the proportion of the provision of Pedagogical documentation created in the different pilots

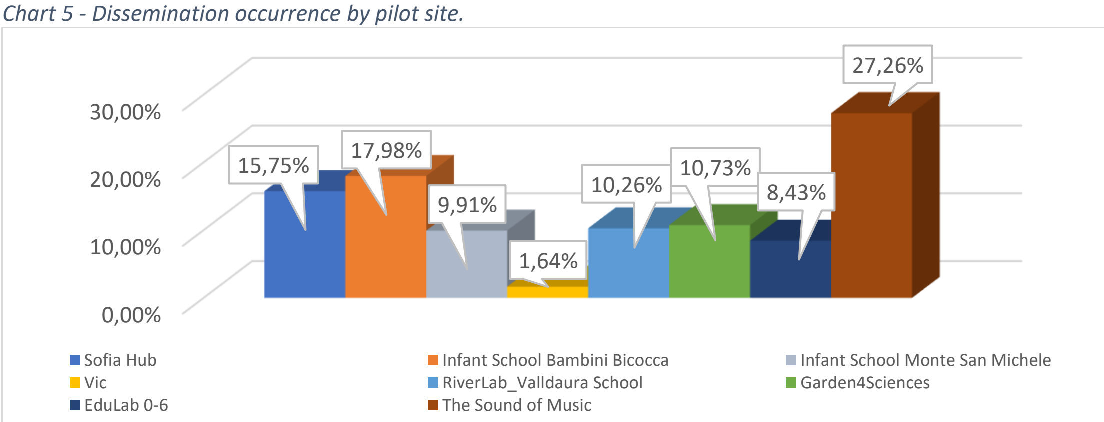


In conclusion, the methodological approach, which systematically clusters the key elements of Activity design, Topic of the activity, Type of the activity, and Pedagogical documentation, serves as a powerful foundation for fostering inclusivity within a lasting educational community. By meticulously considering each of these facets, educators can craft dynamic and engaging learning experiences that cater to a diverse range of learners, ensuring that no one is left behind.

4.2.1.2 Dissemination

As already mentioned, dissemination is pivotal for the survival and thriving of an inclusive educational setting, as it fundamentally underpins the principles of understanding, empathy, and collaboration that are the cornerstones of such an environment. Inclusive education aims to create a space where students of all abilities, backgrounds, and identities can learn and grow together. Dissemination, in various forms, facilitates this mission by enabling the sharing of experiences, knowledge, and ideas among different participants within the educational ecosystem. In Chart 5 it is possible to see the frequency of dissemination activities done in the various European pilots.

Chart 5 - Dissemination occurrence by pilot site.



During the pilot period two types of Dissemination strategies have been observed in the eight different European realities: Dissemination done by children and dissemination done by adults. Firstly, children themselves actively engage in dissemination by sharing their unique perspectives and experiences with their peers. This form of dissemination can have a profound impact on the inclusivity of the classroom. When children express their thoughts and feelings, it helps their peers understand them better, fostering empathy and reducing prejudice. In this way, young students become ambassadors for inclusion, breaking down stereotypes and promoting a sense of belonging for all (see 4.2.2 Inclusive Science Education). Pupil's dissemination can go beyond the peer-to-peer communication, as observed by Sofia HUB children disseminated knowledge outside the school's walls to their parents: children shared some of the things they learned in the science activities with their parents. For example, about extinct animals and the traces they left (they brought home the drawings of mammoths to talk about them). They showed their mothers how to put together a puzzle and how to work with some of the materials such as scales and magnifying glasses. Instead, pupils from the RiverLAB Valldaura school invited parents to go to see the river together so they could share what they have learned at school with their families.

Furthermore, Pedagogical Documentation made of children's craft can be used as a tool for children to communicate what they have learned to families and/or surrounding communities. In The Sound of Music, the children communicated their experiences and creative achievements within the STEAM framework to their families, using their performance art session as a platform to highlight the central impressions that influenced their creations and research. This dialogue was facilitated through the use of pedagogical documentation created of children's crafts.

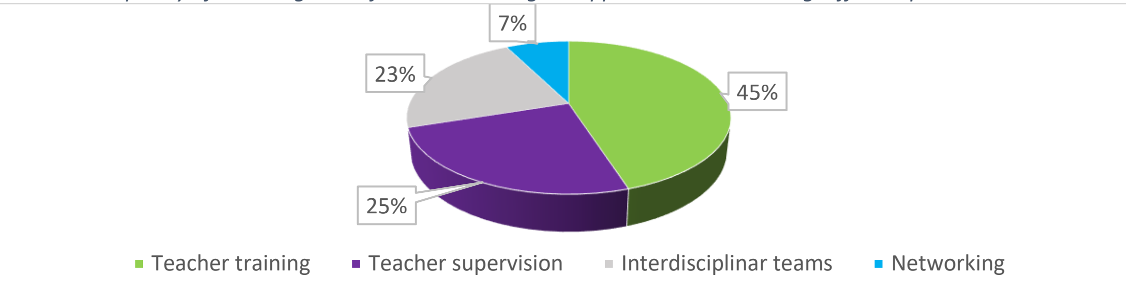
Practitioners, also play a crucial role in the dissemination process, by designing sessions, workshops, events and/or documentation to involve the surrounding community. Dissemination helps bridge the gap between the school and home, creating a more seamless and supportive educational journey for all students. Furthermore, dissemination events, such as parties, gatherings, celebrations, and exhibitions hold a key role in the co-creation of an inclusive community, since these occasions bring students, teachers, and parents, closer together. For example, Garden4Sciences, at the end of the school year, held a small exhibition followed by a tour of the property and a buffet with local products prepared together. They also developed learning products, which include interactive learning posters.

In essence, dissemination serves as a linchpin for the sustainable growth and success of an inclusive environment. By encouraging the free flow of information, experiences, and insights among children, practitioners, parents, and the wider community, it creates a supportive and empathetic ecosystem that nurtures the development and well-being of all students, regardless of their individual abilities or backgrounds. Dissemination is not just a tool for sharing information; it is a powerful force that can transform an educational setting into a vibrant, thriving, and harmonious community. To learn more about dissemination and inclusive science dissemination please see the D5.3 Style Guide on Inclusive Science Communication.

4.2.1.3 Pedagogical plan and structure

The pedagogical plan, bolstered by structures like teacher supervision, teacher training, interdisciplinary teams, and network (see Chart 6), serves as the bedrock of an inclusive educational environment. This comprehensive framework not only sets the foundation for a feasible and continuous educational context, but also ensures equitable and personalized learning experiences for all.

Chart 6 - Frequency of subcategories of the methodological approach shared among different pilots



In an increasingly diverse and multifaceted educational landscape, it is imperative that schools adopt a proactive approach to ensure every student, regardless of their unique abilities or backgrounds, receives the support and opportunities they need to succeed. Teacher supervision is a critical component of this process, as it involves regular, constructive feedback and guidance to educators. By engaging in ongoing reflection and assessment of their teaching methods, and by building a safe and open space for sharing, as it has been done by Sofia HUB, teachers can fine-tune their strategies to better cater to the varying learning styles, strengths, and challenges of their students.

Teacher supervision can be done by different figures, both external and internal to the educational context. Both in Bambini Bicocca and Monte San Michele infant school the teacher supervision has been done thanks to the involvement of the University of Milano Bicocca. Furthermore, in Monte San Michele, since it is an Infant State School of the Municipality of Sesto San Giovanni, teacher supervision is done systematically by municipal pedagogists. This supervision allows for a lasting inclusive environment.

Teacher training, another pillar of this theme, equips educators with the knowledge and tools required to address the diverse needs of their students. Inclusion is not a one-size-fits-all concept, and effective teacher training ensures that educators are well-prepared to implement a range of strategies, accommodations, and interventions that support students with differing abilities and learning profiles. It fosters a culture of continuous learning, enabling teachers to stay current with evolving pedagogical best practices and research in the field of inclusive education. Prior, during and after the pilot phase, practitioners from all the pilots took part in teacher training courses, both on the topic of inclusive education and on STEAM education, to see a comprehensive summary of the teacher training activities that took part in the 6 HUBs please read the D3.4 Final Report on HUB activities.

The formation of interdisciplinary teams within the school setting is equally instrumental in promoting inclusivity. By bringing together educators from various subject areas and disciplines, schools can leverage the collective expertise of their staff to design inclusive curricula, teaching methods, and support mechanisms. These teams facilitate the sharing of insights and strategies for accommodating students with diverse needs, encouraging a holistic approach to education that considers not only academic growth but also the social, emotional, and developmental well-being of each student. For example, The Sound of Music's STEAM approach was designed by an interdisciplinary team involving teacher, student teachers, artists, role models, art lecturer and pedagogy lecturer.

Furthermore, the concept of networking extends the reach of inclusive education beyond the school's walls. Establishing connections with external resources, organizations, and experts in the field enables schools to access valuable insights, support, and materials. These external networks can serve as a source of inspiration and innovation, and, by doing so, nurturing and maintaining in time the educational environment. For a better understanding about the importance of Network go to 4.4 Inclusion in Science Education - Macrosystem.

In conclusion, the pedagogical plan, and its associated structures, including teacher supervision, teacher training, interdisciplinary teams, and networking, combine to co-create and maintain an inclusive educational environment that not only values diversity but actively embraces it. This comprehensive approach not only fosters equity but empowers all students to reach their full potential, ensuring that every child's unique journey is supported, acknowledged, and celebrated within the educational community.

4.2.1.4 External figures participation

Achieving an inclusive educational setting hinges on the collaboration and engagement of various figures, each playing a unique and vital role:

- Artists' involvement enriches the educational experience by infusing creativity and diverse perspectives into the curriculum. In the Sound of Music creative expressions intertwined with STEAM activities to stimulate critical thinking and foster a culture of inclusivity, thanks to the involvement of an African descend artist.
- Role models, whether they are individuals with diverse backgrounds, abilities, or life experiences, serve as inspirations for students. While working with migrant communities is important to include representative figures that may inspire students, as it has been done in Brussels' The Sound of Music, or if working with Roma children, it is essential to involve Roma practitioners as Sofia's pilot has done, or other Roma role models like in EduLAB 0-6. Role models involvement shouldn't only include the physical participation of the external expert: as demonstrated by RiverLAB Valldaura, simply by acquiring new materials, created by people form the targeted community might be a successful strategy. In their case, they have bought books about Black Women in the Science, written by Zinthia Álvarez Palomino, A Spanish journalist from the Afro-descendant community.
- Psychologists' involvement, as demonstrated again by Sofia HUB, is pivotal in assessing the relational thinking and the learning outcomes of children.
- Natural scientists have been involved in Bambini Bicocca Infant school and in Garden4Sciences, sparking curiosity and wonder among students, by showcasing the real-world applications and relevance of scientific concepts. Thanks to their expertise it was possible to work on complex topics such as biodiversity, ecology, and sustainability.
- Special needs teachers bring specialized expertise to cater to the individual learning needs of students with disabilities. Their role is instrumental in ensuring that no one is left behind, and that every student can learn and thrive, and to learn to interact with their peers. In Monte San Michele and Bambini Bicocca infant schools, special needs teachers, such as communication assistants, who mediate the communication between children with hearing impairment and their peers, have been involved.
- Student teachers' involvement offers a fresh perspective and energy to the educational environment while also learning about and implementing inclusive practices. Their active participation serves as a bridge between established pedagogical practices and innovative, inclusive teaching methods. Both in The Sound of Music and in Bambini Bicocca infant school student teachers were involved in the pilot phase, not only observing the activities, but also designing and carrying out scientific laboratories tailormade for the children they're working with.
- Policy makers' involvement is essential for establishing the foundation of inclusive education. Through legislation, funding, and the creation of inclusive policies, they

provide the necessary resources and guidelines to support teachers, students, and the community in their journey towards inclusivity (see 4.4.1 Co-creating an inclusive environment).

- Family and friends' involvement is vital for creating a strong support network that extends beyond the classroom. Family and friends' involvement can take various forms, such as, activity participation, field trip participation, parents-teachers meeting, event participation, communication, and focus groups. For a better understanding of the different levels of family and friends' involvement please jump to subsection 4.3.1 Co-creating an inclusive environment of the Mesosystem.

In sum, the involvement of these various stakeholders is not only important but necessary for the realization of an inclusive educational environment where every student, regardless of their background, abilities, or circumstances, can thrive and reach their full potential. It is through their collective efforts and collaboration that inclusivity becomes a reality, enriching the educational experience for all.

4.2.2 Inclusive Science Education

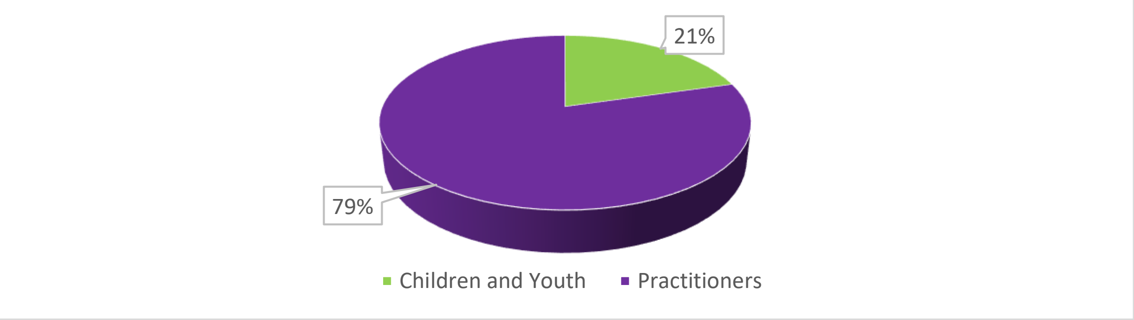
In the subsequent paragraph, the barriers to inclusion in science education observed during the pilot programs will be examined, alongside an exploration of strategies implemented to surmount these obstacles. Equitable access to quality science education is of paramount importance in the current landscape, necessitating the identification and mitigation of impediments that may hinder the full participation of diverse learners. This discussion is designed to illuminate the challenges encountered and the promising solutions that have been enacted to promote inclusivity within the science education domain on a microsystem level.

4.2.2.1 Hindering Inclusion

Inclusion in science education can be hindered by several factors that create barriers for students of diverse backgrounds and abilities. These obstacles often impede the goal of providing equitable access to quality scientific learning experiences. Some key factors in the science education include lack of representation, language and communication barriers, limitation of the tools and materials, obstruction by practitioners. The study seeks to understand how internal and external factors within the educational contexts can either enhance or impede inclusion in science education activities for vulnerable communities.

However, in the C4S project, due to the thoughtful and attentive co-creation and co-design of the educational environment not all of the abovementioned have been observed. More precisely practices that may hinder the inclusion in the science education path have been detected in the children and in the practitioners (see Chart 7). In the following subparagraphs the different exclusionary practices will be presented.

Chart 7 - Frequency of practices that hinder inclusion during the Pilot activities



4.2.2.1.1 Children and Youth

Language proficiency is fundamental in understanding and engaging with scientific concepts. When students struggle with the language of instruction, it can impede their comprehension of scientific content and their ability to express their thoughts effectively. As observed in Brussels, *"not all children have the necessary skills to do this: among other things; speaking skills are lacking, language skills are missing, some children need more time to share their knowledge."* This barrier is particularly challenging for non-native speakers and may lead to feelings of exclusion in the classroom. Non-native speakers are not exclusively children with migrant background: in Sofia, young children from the Roma community, born in Bulgaria, struggle with language comprehension and exposition, since were raised in their family idiolect.

Thus, special consideration should be given to Second Language learners, as they may need additional support to bridge the language gap in science education. For example, in Bambini Bicocca Infant school, while carrying out a story telling activity, the practitioner paid attention to the foreign language speaking pupil by making sure that the child understood the content of the story; for better understanding of the strategies that may help the inclusion process, please se paragraph 4.2.2.2 Supporting Inclusion.

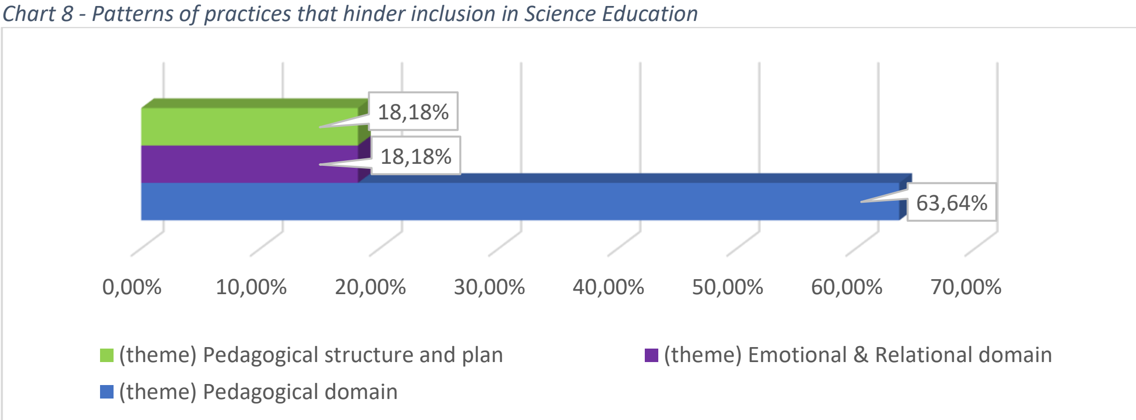
Lack of language competences due to foreign background or different language origins, isn't the only obstacle to surmount. Children with hearing disability may have difficulties to communicate with their peers. However, as noted by Monte San Michele in Italy, special needs teachers, such as communication assistants (see 4.2.1.4 External figures participation) may help to establish a better relational climate between peers.

Inclusive teaching strategies, such as using visual aids, hands-on activities, and simplified language, can help make complex scientific ideas more accessible to students with diverse language backgrounds. Moreover, fostering a classroom environment where students are encouraged to ask questions, express their ideas, and collaborate can enhance communication skills and promote a more inclusive science education experience.

4.2.2.1.2 Practitioners

Since embedded in an educational system that includes children and adults, practices of exclusion and hindering inclusion are not only limited to the inherent characteristics of learners, but also have to do with the adults who design, propose, and conduct the activities. In the C4S project three themes, that lead children and youth to a potential state of vulnerability, have emerged, namely the Pedagogical domain theme, the Emotional & Relational domain theme and the Pedagogical structure and plan theme (Chart 8).

Chart 8 - Patterns of practices that hinder inclusion in Science Education



The Pedagogical domain, with 63,64% is the most occurrent theme between the Practitioners hindering inclusion group. It indicates all those actions that have been put into practice by the adult but that may lead to a potential practice of exclusion. This theme cluster two sub-categories, the Activity Design category, which indicate the pedagogical actions undertaken prior to the start of the activity, and the Pedagogical Intervention category, which denote the interventions that take place during the activity.

In the former case, Activity Design category, 7 out of 8 pilots have acknowledged that an inattentive, not well thought, and messy management and design of the setting, the group and the materials might hinder the inclusion of some of the children. For example, both in Monte San Michele Infant school and in RiverLAB Valldaura school, high frequency of negative practices, such as disagreement, conflicts, and cry, have taken place due to a fight over a possession of a material (to see strategies to overcome these barriers go to 4.2.2.2.3 Pedagogical Intervention Domain). Furthermore, as observed by Garden4Sciences, materials can exclude participation, not only because of the limited availability of the material or the lack of a proper management of the time of use, but also due to the type and the choice of the material itself: Many learning materials are out of date in their representation of the realities of students' lives. Often, as a result, Austrian children are more visually represented and more visible in learning materials.

Limitations of the setting and the way that the classroom is designed have been observed by researchers and practitioners of The Sound of Music. During one focus group with practitioners one participant states that the space remains a limitation to pursue STEAM as optimally as possible since it limits the movement of the children. Lastly, while designing a science activity, the way the children are divided into groups might limit the inclusion of some children. For example, in Bambini Bicocca infant school, children were clustered in homogenous groups, divided by abilities and age, inhibiting the participation in mixed groups and so the peer-to-peer learning.

As for the latter category, Pedagogical Intervention, the lack of interest and passion in carrying out the activities, and the inability to respect children’s learning time are the two leading exclusionary practices. By not respecting each child's learning time, and by substituting for them, the adult limits learning opportunities and does not allow the achievement of deep and meaningful exploration.

Having a well-rounded Emotional & Relational domain is quintessential: it is important to note that sometimes teachers can be a source of exclusion. For example, to work with the group and carry out the activity the practitioner decided to leave one child, who was having trouble staying in the group. SO, a 5-year-old girl, not only couldn’t stay seated with the others, but she also kept moving around, crawling, she wanted to catch other children’s attention and play with them. The teacher tried to engage with her but SO didn’t want to, so, the practitioner decided to keep the other pupils’ attention, leaving SO aside. It is thus essential to know how to manage the groups dynamics in the classroom and to know how to relate with children. However, as stated by Garden4Sciences, practitioners feel unsure and unprepared in conducing scientific activities, feeling not at ease and not knowing how to manage both the STEAM laboratory and the emotional and relational domain of the children.

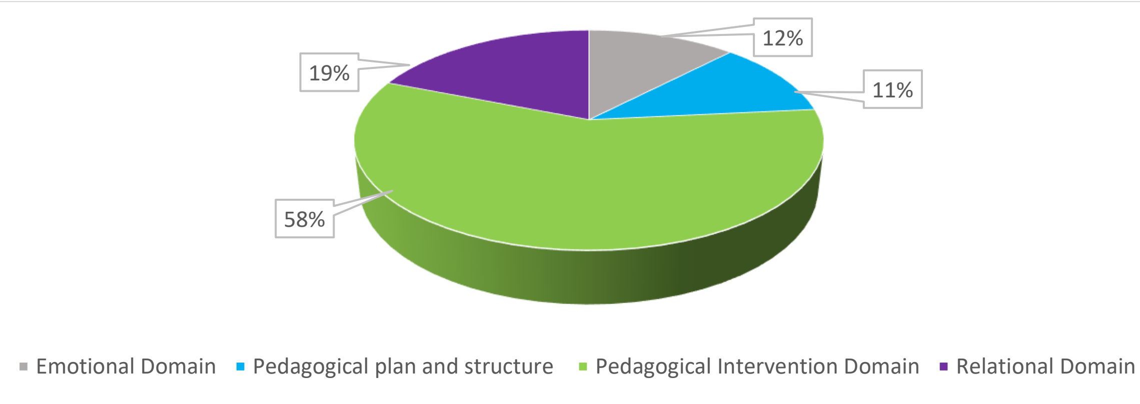
In conclusion, the Pedagogical structure and plan may restrain inclusion by not giving the right support to the practitioners to work with the children. The absence of sufficient workforce and financial resources can significantly impede the successful implementation of an inclusive science activity, limiting its reach and effectiveness in engaging a diverse and representative group of participants.

4.2.2.2 Supporting Inclusion

In this research endeavour, the primary aim is to explore the educational environment's role in promoting and implementing an inclusive science education approach through collaborative co-creation and co-research initiatives involving children and their families. Through the NVivo analysis process, it was possible to identify key themes (see Chart 9) that offer insights into addressing inclusion challenges, and inclusion supportive practices:

1. **(theme) Pedagogical Intervention Domain**, with an occurrence of 58% clusters the mental and practical management procedures that deal with the ability to manage groups and organise the conditions and facilitators for learning.
2. **(theme) Relational Domain**, at 19% is the second highest theme, it is used to denote those mental and social functions related to the disposition to act and react in a particular way to a determined social situation.
3. **(theme) Emotional Domain**, with a frequency of 12% indicates all mental functions related to the emotional and affective components and the ability to manage them.
4. **(theme) Pedagogical plan and structure**, at 11% indicates the core strategies that have been implemented in order to make the whole educational environment inclusive.

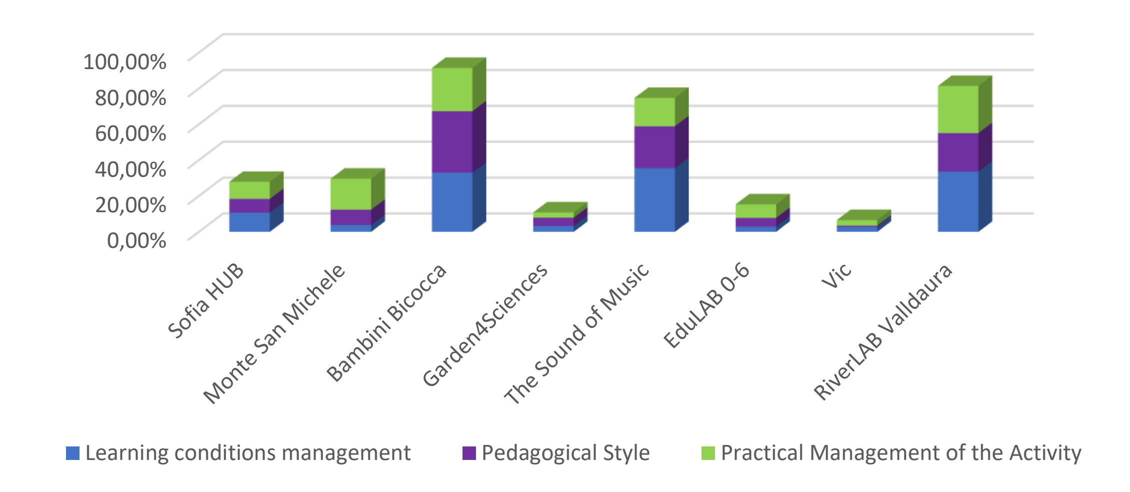
Chart 9 - Frequency of practices that support inclusion



4.2.2.2.1 Pedagogical intervention Domain

The high statistical frequency of the Pedagogical intervention domain within the context of inclusive science education may suggest that it holds a pivotal role in providing the most relevant support for fostering inclusivity and effective learning experiences. It is an adult-specific domain, whereas both the Emotional and the Relational Domains refer both to children and to adults. This domain encompasses the critical aspects of managing children and adolescents in a learning environment, emphasizing effective group management and the organization of conditions conducive to learning. The Pedagogical intervention domain can be further divided into three essential subgroups: Practical Management of Activity; Learning Conditions Management; Pedagogical Style. In Chart 10 it is possible to see the distribution of the three sub-domains in each pilot.

Chart 10 - Patterns of distribution of the sub-domains in each pilot

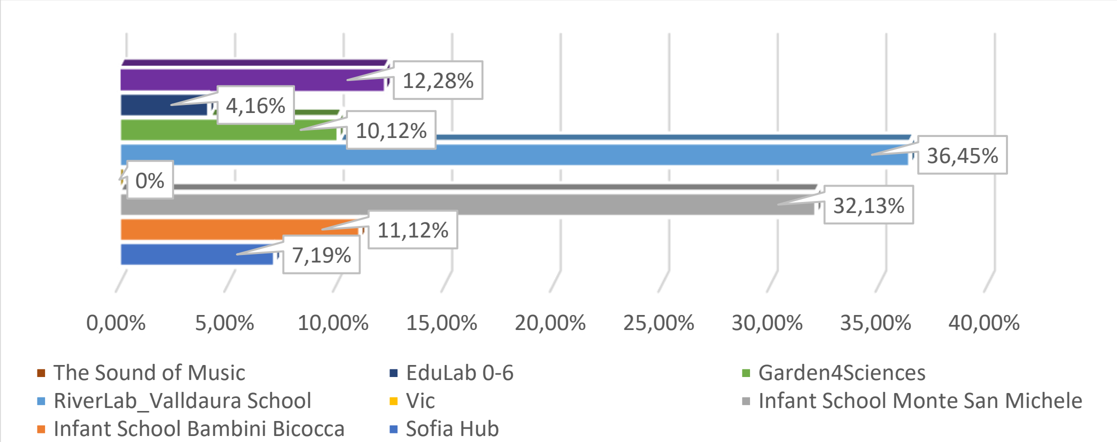


The Practical Management of Activity involves the skilful presentation of activity duration, content distribution, and the objectives to be achieved. It also involves preparing the learning environment and efficiently managing groups while maintaining authority and effectively mediating conflicts. In this category three sub-categories emerge: the input, the tool and the materials, and the management of time, space and group. As mentioned prior to this paragraph, four types of input have been observed:

1. Child's interest - In Bambini Bicocca and Monte San Michele infant school children worked on plants growth since some of them expressed the desire to observe the seeds. Activities tailored to individual passions can ignite a deeper engagement with the learning process and include all the different participants of the activities.
2. Child representation - It is important to represent diversity by involving role models, and artist, like has been done in the Brussels' pilot The Sound of Music, since it fosters a sense of belonging and allows for a more profound participation and inclusion.
3. Child's needs - As encountered by the children and the practitioners of Dominiques and ESTEL school in Vic, addressing the personal needs of each child is essential, as it helps create a supportive and inclusive learning environment.
4. Surrounding and community - Tying activities to the community and surroundings of the children, for example by going to the surrounding river, as done by the RiverLAB Valldaura school, can make learning more relevant and practical, connecting the educational experience to real-world contexts.

Working on those inputs to start a scientific laboratory might help to make the proposed activities more inclusive to all the participants that take part in them. However, working on the input isn't enough to make the management of the activity more inclusive, choosing the right tools and materials is equally as important. As done by Sofia, the learning materials should be thoroughly discussed and coordinated with the teachers in advance in order to be suitable and to fit the educational needs according to the children's age, kindergarten curriculum, learning aims, scientific activities planned, etc. During the pilot phase seven out of eight educational settings favoured the use of unstructured and open-ended materials because they were considered more inclusive (Chart 11).

Chart 11 - Patterns of use of unstructured materials by pilot



As explained by the Sound of Music, the predilection for this type of material is driven by the fact that neutral and open-ended materials allow each child to make his or her own meaning out of the material. Adding to that, RiverLAB Valldaura noted that all the science materials found in nature around the river, such as sticks, stones, flowers, leaves, insects are accessible to each child and invite for different modalities of exploration. Moreover, borrowing the words of Monte San Michele Infant school: using recycled materials, which are open ended and don't tell children how to be used, makes them suitable for everyone. During the focus group with the practitioners, one said that the open-ended recycled materials are perfect for the promotion of laboratorial activities to children because the children don't fell the stress to use the materials the way they "have to be used" but are free and explore in their own way.

Not only the materials, but also the tools used to explore and learn must be inclusive and well thought. As acknowledged by Garden4Sciences, practitioners should be aware of the fact that not all children know how to use specific tools, like microscopes, and thus, a major attention should be paid in order to create a better learning environment. Once the obstacle of becoming acquainted with the tool has been surmounted, it is possible to see how the tool can become a vehicle for inclusion: In Bambini Bicocca the use of the Digital Diorama, engaged children in the STEAM activity and helped with the creation of a group that shares the same focal point of interest. In RiverLAB Valldaura, by simply giving the remote control to a child with special educational need and disability, subverted the different roles adopted by children, integrating him in a harmonious and non-distorting way in the day-to-day life of the class.

However, as observed by most of the participants to the Pilot period, conflicts between peers may occur due to the desire to use the same tool and or not willing to share the different materials. In this case, EduLab 0-6 suggests having an abundancy of different materials so to be able to mitigate conflictual interaction over materials. On the other hand, as noted by Monte San Michele infant school, having so many materials and tools, could limit observations and experiential learning, as children move from one material to another and constantly shift their centres of interest. Hence, it is important for practitioners to know how to properly manage the group, the setting, and the time of the activity.

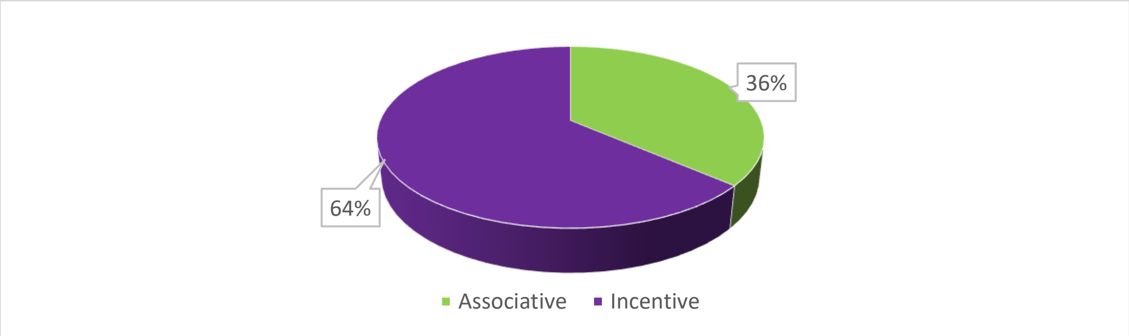
Designing the setting is crucial in achieving inclusion in science education as it ensures that all students, regardless of their backgrounds or abilities, have an equitable and accessible learning environment that fosters curiosity, engagement, and a sense of belonging. As highlighted in The Sound of Music, to stimulate children's creativity in technology education, practitioners must revamp the classroom layout and provide specialized materials: for instance, setting up workshops with measuring tools and various tube shapes. Moreover, the selection of the setting can significantly impact inclusion in science activities, the river's open space offers vital opportunities for many students to move, play, and find well-being, potentially aiding their learning. RiverLAB Valldaura's observations suggest that children may, in open, natural environments, experience a level of well-being in school that might lead to inclusion.

Through the C4S pilot research period it has been also observed that the design of groups plays a pivotal role in inclusive science education. Working in small groups not only promotes inclusion but also enhances the overall learning experience through peer-to-peer collaboration. Heterogeneous groups, by mixing students from diverse backgrounds, foster a deeper understanding of diversity and inclusion, enriching the educational experience. Conversely, homogenous groups offer ease in guiding towards specific goals, making them particularly effective for focused learning objectives.

However, to ensure an inclusive science learning managing the learning conditions, which pertains to the ability to differentiate between pedagogical and teaching-and-learning interventions, is essential. It centres on fostering inclusivity and participation, all the while respecting the diverse learning styles and individual timelines of each participant. Practitioners fostered inclusion during the science activities by using children's mother tongue, as in the case of RiverLAB Valldaura with a child from south-America, who spoke only Spanish and not Catalan, or in the Sound of Music in Brussels, where three girls who shared the same first language with the student teacher, were engaged in the activity by talking in their mother tongue, and lastly in Sofia, where Roma Assistant teachers helped the young participants of the activities to participate by mediating and translating. Practitioners tailored the activities not only by adapting their language to the group they were working with, but by also using visual support, giving enough time to explore freely the phenomenon, showing what/how to carry out a project rather than explaining verbally, and allowing children to use all senses and not only the orality and listening.

In conclusion, Pedagogical Style plays a pivotal role in tailoring the teaching approach, with a focus on learner activities and their learning processes. It can involve open-ended questioning and exploration, closed-ended questioning, or a subject-matter-oriented approach. Two types of Pedagogical styles have been detected (Chart 12), the Incentive pedagogical style and the Associative pedagogical style. In the Incentive style, teachers pose open-ended questions that encourage free exploration and creativity among students, avoiding a one-size-fits-all approach. Conversely, in the Associative style, teachers respond synchronously and coherently to children's suggestions and responses, refraining from immediate evaluation and instead asking questions to gain insights into the children's learning processes.

Chart 12 - Frequency of types of Pedagogical Styles



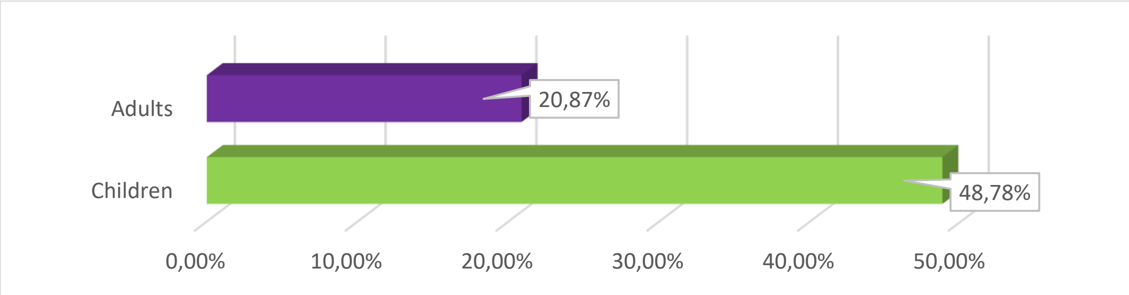
In conclusion, when these three subgroups, Pedagogical Style, Learning Conditions and Practical Management, are thoughtfully and empathetically respected, they collectively contribute to making science activities for children more inclusive, ensuring that every individual's unique needs and abilities are acknowledged and accommodated.

4.2.2.2.2 Relational Domain

The Pedagogical Intervention Domain focuses exclusively on actions and interventions initiated by adults to foster an inclusive approach to science. In contrast, the Relational Domain encompasses interactions between both teachers and children, encompassing social and mental behaviors that govern peer-to-peer and peer-to-adult relationships. Practitioners have noted the constructive impact of a positive Relational Domain, leveraging it to facilitate the inclusion of individuals who may have been overlooked. Additionally, it serves as a tool for transmitting knowledge and aiding in the comprehension of STEAM concepts.

As demonstrated in Chart 13, 48.78% of the identified categories in the children sections belong to the Relational Domain, while the 20.87% of the categories of the adult section fit in the same domain.

Chart 13 - Patterns of frequency of the Relational Domain themes in Children and in Adults



The most prevalent subset within the Children’s Relational Domain theme is the peer-to-peer category, recognized as a valuable tool for promoting inclusion in science activities. Sofia's pilot study observed instances where younger children faced challenges in completing specific activities, prompting practitioners to enlist the assistance of older peers. This collaborative approach was also evident in Brussels' The Sound of Music project, where children collaborated to explore the physics of sound and construct musical instruments, aiding each other in tool usage and material selection. Peer-to-peer teaching played a crucial role in supporting children with limited linguistic abilities or difficulty understanding concepts. At Bambini Bicocca Infant school, for instance, Italian-speaking peers endeavoured to explain the concept of pinecones to a non-Italian-speaking classmate through verbal communication and a hands-on exploration of the classroom to find pinecones. On this regard, as noted by RiverLAB Valldaura, practitioners employed occasions the strategy to ask the pupils to explain a difficult concept to their peers, who had trouble understanding, in order to ease the process and make a shift in the power positioning by giving agency to the children.

Within the Children’s Relational Domain, along with the peer-to-peer category, the Negotiation and Positive Relation categories can be found. Collaborative discussions among peers during negotiation address diverse perspectives and ensure participation. Positive relations contribute to a supportive environment, promoting teamwork and mutual understanding within the classroom. In instances of small crises, such as fear of dogs, ants, or wasp stings, the entire group unites in solidarity to support the affected pupil, actively seeking solutions and offering assistance. But even when working with toddlers, as noted by EduLab 0-6, positive relationships, such as look at and show each other the tools, or group around a toy according to their interests, can be found, if mediated by the practitioner.

Thus, it is essential for the practitioner to create a climate of positive relationships and to build positive relations with children in order to achieve an inclusive science learning environment. To build positive relations with children and youth, practitioners should encourage children's participations, motivate them and as above mentioned, mediated the relational climate in the class. As noted by Sofia *"[t]he goal was to promote science learning through participation during regular kindergarten science activities by empowering children to be active, to explore, to feel free to choose what to do and how to do it"*. Using EduLAB 0-6's word, to achieve this goal, it is essential to "*offer an experiential and problem-based learning environment that encourages children to interact directly with materials, tools and phenomena*". Children encouragement can be done by different modalities, in the case of the Sound of Music three girls who were initially timid to get started were encouraged by the practitioner "*by mirroring, but also by showing them how to get started. After this demonstration, she allowed the children to continue working independently*".

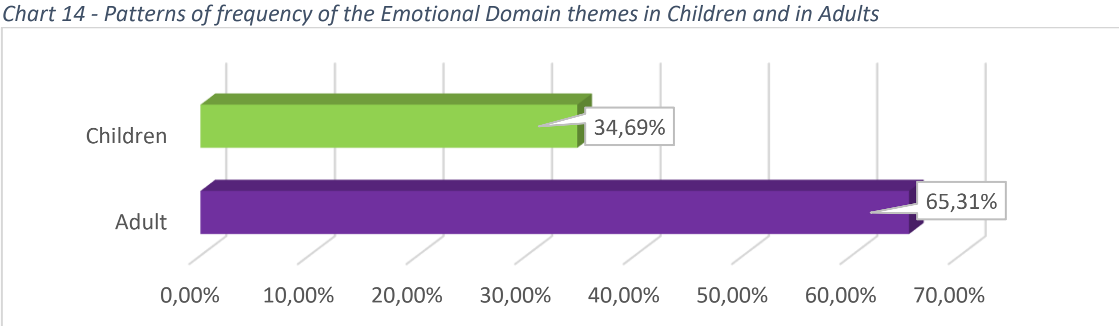
As observed by Vic, it is also important to motivate the children taking part in the activity by "*providing significant challenges that adapt to their needs*", if not the risk might be that children won't be interested in the activity or will find it to difficult and cease participation. Same risk has been observed by the Bambini Bicocca practitioner, who felt that some of the proposed activities might be too difficult of some children, so she thought to adapt each session in a way that is challenging for everyone, but at the same time not too much.

In conclusion, the integration of the Relational Domain within the pedagogical framework emerges as a pivotal factor in fostering inclusive science learning environments. The emphasis on peer-to-peer interactions, negotiation, and positive relations showcases the transformative impact of building a supportive social structure. This not only facilitates the understanding of STEAM concepts but also addresses challenges faced by individuals with varying linguistic abilities or comprehension difficulties. The practitioner's role in creating a climate of positive relationships and motivating children is paramount, as highlighted by various studies and projects. By empowering children to actively participate, explore, and make choices, educators contribute to the construction of an experiential and problem-based learning environment. Ultimately, the success of inclusive science education lies in the practitioner's ability to navigate the relational climate, offer meaningful challenges, and adapt activities to cater to the diverse needs of every learner.

4.2.2.2.3 Emotional Domain

Also, the Emotional domain refers both to practitioners and children (Chart 14).

Chart 14 - Patterns of frequency of the Emotional Domain themes in Children and in Adults



Furthermore, as the later one, this domain in education plays a pivotal role in shaping the overall learning experience. Given that emotions significantly impact cognition, memory, and motivation, influencing how students engage with academic content, practitioners must be attuned to the emotional needs of their students, offering support and creating a space where feelings are acknowledged and validated. Emotional intelligence, both on the part of teachers and students, contributes to effective communication, conflict resolution, and collaboration within the educational setting. By cultivating a positive emotional climate, educators can enhance student resilience, enthusiasm for learning, and overall academic success. Integrating the emotional domain into education not only nurtures a holistic approach to learning but also equips students with essential life skills for emotional regulation and social interaction.

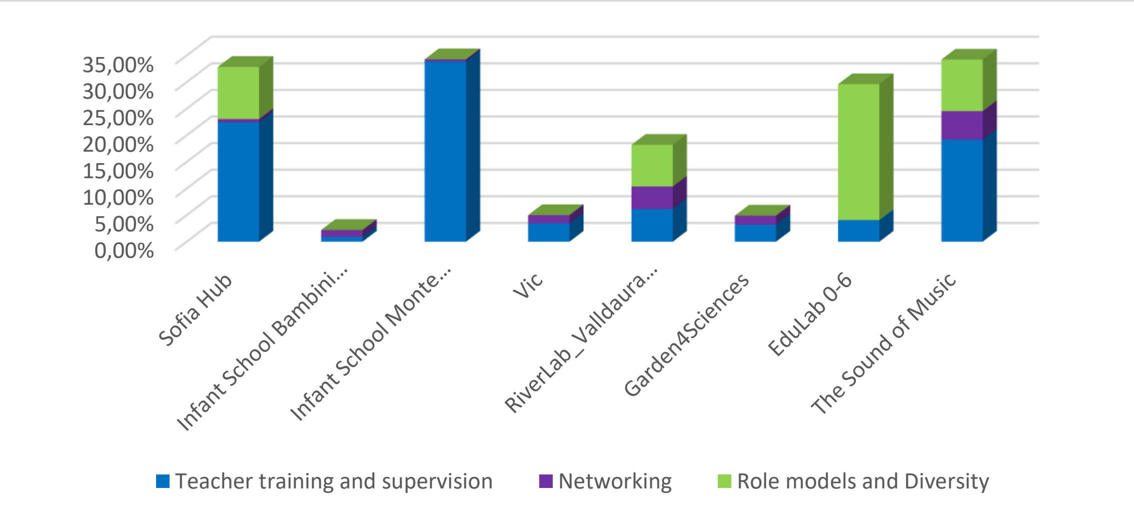
Borrowing Sofia's words "*children's inclusion in the activities comes as a result of teachers' creating an appreciative and supportive atmosphere. Teachers were open and involved children*". Observed as well by the Sound of Music, adopting strategies that deal with the management of the emotional climate, such as speaking in a pleasantly calm voice, asking open-ended questions, giving suggestions without being directive, paraphrasing children who did not come out in their words, sitting close between the children at eye level and looking at the children, help to create a more inclusive science education path. The importance of meeting at once's eyes level is stressed by Garten4Scieces: "*when you meet at eye level, don't take yourself so seriously and stay open, not only respect comes back from the children, but also openness, trust and the willingness to try new things together…".* Furthermore, they've observed that *"there should be room for mistakes, and if you teach the children that you don't know everything yourself, and that you can even learn something from them, then they will participate almost everywhere or at least try something new*". The importance of not being afraid of personal mistakes is highlighted by RIverLAB Valldaura too, since it is a tool to create an emotional environment in which the fear of speaking your opinion or being judged is smoothed. For example, when they opened a jar with water coloured fruit pigments that the children had made in Lab 0-6. That day they were supposed to observe the behaviour of matter over time, what liquid had been secreted, what liquid remained compact. When the liquid fell, the educator's white T-shirt was stained. She humbly explained the problem to the children, together they proposed solutions.

However, to achieve a positive Emotional Domain, as observed in all Pilot sites, practitioners should be positively engaged with STEAM activities. The interdisciplinary nature of STEAM encourages creativity, critical thinking, and collaboration, breaking down traditional silos in education, so practitioners can engage in different types of proposals. Through hands-on activities that integrate science with arts and technology, practitioners can captivate students' interests and make science more accessible to a broader audience. In doing so, they contribute to dismantling barriers and stereotypes that may have historically excluded certain groups from pursuing scientific fields. Ultimately, positive engagement with STEAM activities empowers students with the confidence to explore and contribute to the scientific community, fostering a more inclusive and equitable future in science education.

4.2.2.2.4 Pedagogical structure and plan

The latest identified theme centres on the Pedagogical Plan and Structure, revealing the core strategies implemented to cultivate an inclusive educational environment. This theme transcends the focus on individual children or practitioners, addressing the holistic educational setting. Three key clusters have emerged (Chart 15): Teacher Training and Supervision, fostering educators' competence in facilitating inclusivity; Networking with other professionals, emphasizing collaboration to leverage diverse expertise; and Engaging Role Models and Respecting Diversity, promoting an environment where students encounter diverse perspectives. When an educational setting aligns with these categories, it paves the way for a more inclusive science education, laying the foundation for a dynamic, collaborative, and respectful learning atmosphere.

Chart 15 - Patterns of distribution of categories in each Pilot



Cultivating an inclusive science education posture demands a comprehensive and dynamic approach. While the foundation of initial teacher training is undeniable, as it has been acknowledged by all the partners of the project, the journey toward inclusivity extends beyond these foundational skills. Ongoing professional development and robust supervision mechanisms are indispensable, providing educators with the tools to navigate the ever-evolving educational landscape and fostering a continuous commitment to inclusivity. The synergy of training and supervision ensures that educators not only acquire inclusive teaching strategies but also embody an inclusive mindset, adapting to the diverse needs of their students. Teacher supervision can and should be done by involving different figure and creating a strong network with professionals of the field. In the C4S project supervision has been done by pedagogists from the Municipalities, as in the case of Monte San Michele, or by the involvement of university experts, as in Sofia, Bambini Bicocca Infant school and RiverLAB Valldaura school.

Thus, beyond the classroom, forging connections with external realities is pivotal. Collaborative networks, both within and beyond the educational sphere, offer a rich tapestry of perspectives. These connections bring authentic, real-world applications of scientific concepts, enriching students' learning experiences. Exposure to varied viewpoints and cultural contexts cultivates a more profound understanding of science as a dynamic, globally relevant field.

However, inclusivity in science education extends beyond academic considerations. It involves dismantling barriers and providing equitable opportunities. To achieve this, it is crucial to incorporate role models from vulnerable communities into the educational narrative. The role models involvement can be done on different levels, for example in EduLAB 0-6, *"the manager and deputy manager of the Sure Start Children's House were the referrers representing the vulnerable community, both of Roma origin and BA qualifications. They are the direct contacts with vulnerable families in the district. They were the key people for us as mediators, connecting us with the vulnerable families we wanted to reach".* These role models serve as beacons of inspiration, demonstrating that science knows no boundaries and that individuals from all walks of life can contribute meaningfully to the scientific community. By integrating these diverse role models into the educational framework, we create a more representative and relatable portrayal of scientific success. Furthermore, as observed by the Sound of Music, educating practitioners to acknowledge all types of diversity can have a positive effect on inclusion in science education since practitioners "*become more attentive to the use of variations in interesting role models when handling teaching materials and impressions […] now dwells more also on interesting female figures. [Practitioners] become even more aware of the impact of visual materials on children's self-image.*"

In essence, an inclusive science education paradigm hinges on a holistic integration of teacher training, ongoing supervision, external network building, and the incorporation of diverse role models. This multifaceted approach not only equips educators with the necessary tools but also fosters a learning environment where every student, regardless of background, can thrive and find their place in the exciting world of science.

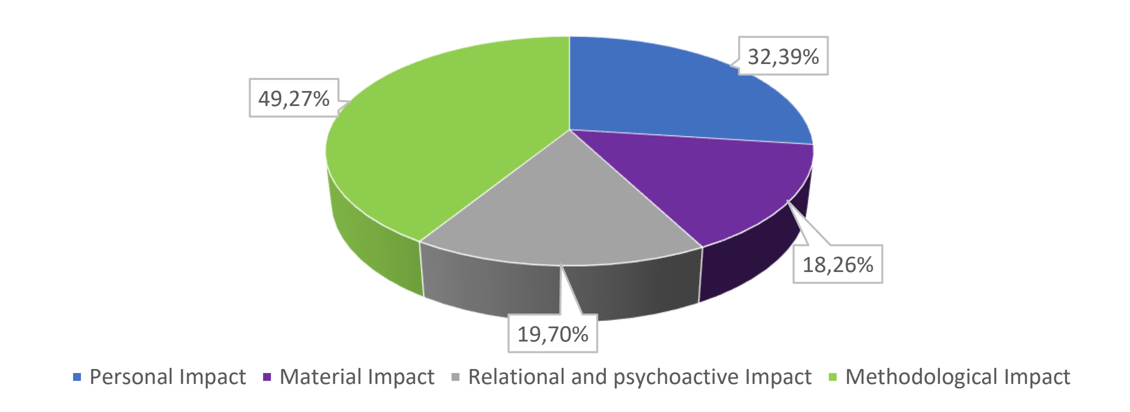
4.2.3 Short term impact

The diverse datasets underscore the significance of short-term impacts of inclusive science education on a personal, material, relational and methodological level for children and participants. The direct and immediate impact is noticeable and noteworthy, encompassing an increased awareness of changes in the relationship with learning, shifts in group coexistence and cohesion, inclusivity, and also in the connection with environments and content. While families are not directly represented, occasional and secondary mentions of their names are made. It is highlighted, in a separate section, the participants' perception of the impact on children, as well as the impact on their own educational practices. In this section, we emphasize the short-term impacts on the lives of children, participants, and the educational community connected to the environment of the Hubs.

1. **(theme) Personal Impact** is the most frequently mentioned category, comprising 32.39% of the occurrence. This underscores the significance influence of inclusive science education on the formation and development of the individual, as well as learning and education.
2. **(theme) Material impact**: The Material Impact represents 18.26% of the overall direct impact. This indicates the significance of the influence that materials have on the educational experiences and outcomes within the context being assessed. The material impact encompasses various dimensions, including attitudes towards materials, knowledge about materials and technology applications, exploration of new materials, positive opinions, sharing practices, and accessibility to materials. Understanding and evaluating these aspects contribute to comprehending the role that materials play in shaping the learning environment and its outcomes.
3. **(theme) Relational and psychoactive Impact**: The direct relational and psycho-motional impact, accounting for 19.7% of the frequency, addresses the observed effects on interactions among peers and with the adult environment. Beyond specific information entries about the actions taken, this aspect carries significant weight in the group's coexistence and the emotional well-being of the children.
4. **(theme) Methodological Impact** constitutes a significant portion, accounting for 29.56% of the overall data on direct impact at the micro level. Within this domain, the

distribution of information reveals that 50.73% pertains to Teacher Training, while the remaining 49,27% focuses on Children Learning.

Chart 16 - Frequency of distributions of themes regarding the Short-term impact



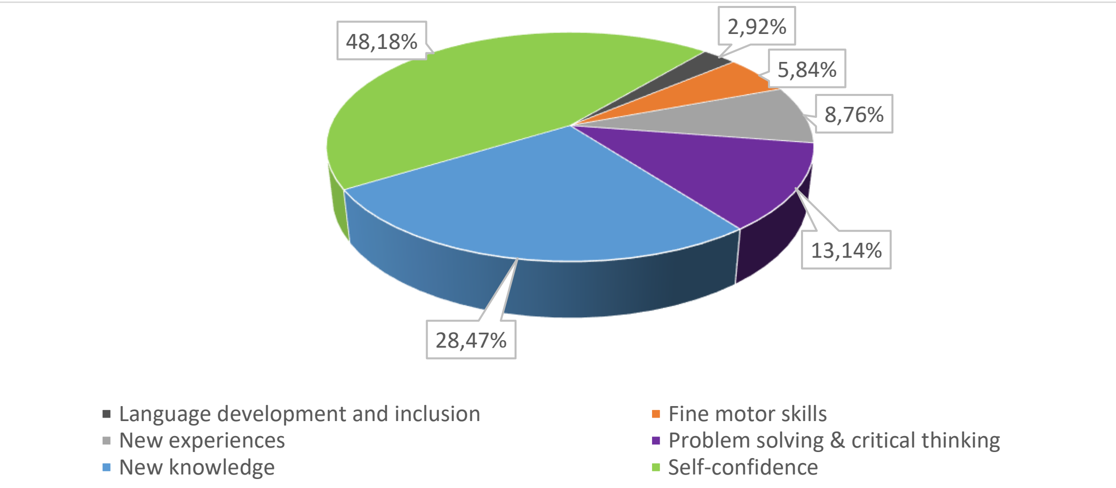
4.2.3.1 Personal Impact

Of all the annotations related to the direct personal impact, 91.95% are associated with children, while only 8.05% are mentions of the practitioners. Notably, the references to practitioners are consistently linked to facilitating children's participation in activities and providing support in acquiring new knowledge. This pattern underscores the predominant focus on the impact of inclusive science education on children, emphasizing their active engagement and knowledge acquisition, with practitioners playing a supportive role in enabling and enhancing these outcomes.

4.2.3.1.1 Children

In the educational context, the impact on children within the inclusive science program is multifaceted, as shown in the Chart 17.

Chart 17 - Frequency of categories concerning the children's personal impact



Firstly, language development and inclusion play a pivotal role. As children engage with the program, they not only learn new words but also enhance their ability to articulate thoughts, fostering effective communication. Additionally, the program contributes to the development of fine motor skills as children participate in various hands-on activities. These experiences, ranging from problem-solving to critical thinking, not only introduce them to new knowledge but also provide a platform for honing observational skills. Through categories like description, classification, and comparison, children explore scientific subjects such as life cycles, body parts, seasons, gravity, biology, and technology. Furthermore, the emphasis on documentation, including graphical material, scientific drawings, and journals, enables them to express their newfound knowledge creatively. Overall, the program introduces children to technology concepts and instils an understanding of diversity, contributing to a holistic educational experience.

Moreover, the program fosters an inclusive environment where the local language becomes a common means of communication. Through diverse experiences, children's perspectives expand, and they are encouraged to make hypotheses, a crucial aspect of scientific inquiry. The documentation process not only reinforces their understanding but also creates a tangible record of their scientific journey. With an emphasis on technology and an exploration of diverse subjects, the inclusive science program ensures that children not only gain new knowledge but also develop skills essential for their intellectual and personal growth. Through hands-on activities and creative expressions, children become active participants in their learning journey, fostering a love for science and a foundation for future exploration.

Among the mentions of personal impacts on children, it is noteworthy that 28.47% of the information is connected to the acquisition of new knowledge and specific learning related to competencies and subjects associated with STEAM. Out of the total knowledge acquisition, it is explicitly stated that 5.1% is oriented towards incorporating knowledge about cultural diversity connected with science.

The analysis of impact mentions related to children reveals significant emphasis on the development of self-confidence, constituting 48.18% of the total discussions. These aspects are categorized within the self-confidence domain, including conscious output, openness to new knowledge, creativity, and the ability to generate and communicate new knowledge. The prominence of these elements underscores the profound impact of inclusive scientific education on the emotional and psychological aspects of children. The nurturing of confidence, participative spirit, and enthusiasm is evidently a vital outcome of this educational approach, highlighting its comprehensive influence on shaping not only cognitive skills but also emotional resilience and self-assurance in young learners.

The inclusive science program significantly contributes to the development of children's self-confidence through various mechanisms. One notable aspect is the conscious output of their newfound knowledge. As children engage in the program, they not only acquire information but also develop an awareness of their own understanding, creating a positive feedback loop that boosts confidence. Additionally, the program fosters an openness to new knowledge, encouraging children to embrace learning as a continuous and exciting process. This openness lays the foundation for creativity, empowering them to generate and communicate new knowledge effectively.

Furthermore, the inclusive science activities play a crucial role in instilling confidence in children. The participative and enthusiastic nature of these activities ensures that children actively engage with the learning process. As they contribute ideas, explore scientific concepts, and express themselves creatively, they develop a sense of confidence in their abilities. This participatory approach fosters an environment where children feel secure in sharing their thoughts and taking risks, ultimately enhancing their self-confidence in both academic and social contexts.

4.2.3.1.2 Practitioners

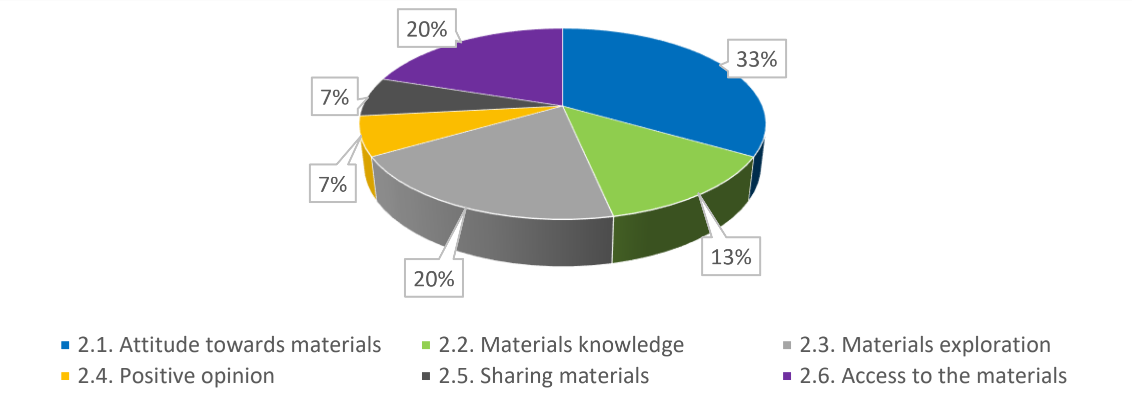
Engaging practitioners in the inclusive science program yields valuable outcomes, primarily cantered around acquiring new knowledge and promoting participation. The program equips practitioners with innovative teaching methods, scientific content, and pedagogical approaches, enhancing their knowledge base. This newfound knowledge not only enriches their professional expertise but also provides them with the tools to create inclusive and stimulating learning environments.

A key aspect of the program's impact on practitioners is the emphasis on promoting participation. Through various activities and strategies, practitioners learn how to actively involve children in the learning process. This goes beyond traditional teaching methods, encouraging practitioners to create dynamic and interactive science education settings. By fostering participation, practitioners become facilitators of inclusive learning experiences, ensuring that children actively contribute to and benefit from the science education program. This dual focus on knowledge enhancement and participation promotion empowers practitioners to play a pivotal role in delivering effective and inclusive science education.

4.2.3.2 Material Impact

The theme of material impact encompasses various dimensions related to the utilization and interaction with educational materials, such as Attitude towards materials, which clusters sub categories like happiness to use the proposed material, high level of engagement, take care of or handle carefully, wonder and felt like getting started with the materials, and preferences towards certain materials, then there's the category Materials knowledge, Materials exploration, Positive opinion, Sharing materials, and finally Dissemination (Chart 18).

Chart 18 - Distribution of categories concerning the material impact



One key aspect is the attitude towards materials, which is characterized by indicators such as enthusiasm, engagement, careful handling, and the expressed desire to initiate activities with materials. Additionally, preferences for specific materials contribute to understanding individual inclinations and interests. Another facet involves materials knowledge, including proficiency in technology applications and the ability to undertake new constructions. Exploring novel materials is a notable dimension, highlighting a curiosity-driven approach. Positive opinions, sharing practices, and accessibility to materials, whether at home, commercially, or through recycling, further contribute to the material impact theme. Dissemination activities also play a role in extending the influence of materials within the learning context.

The 39.28% of the collected data is associated with the attitude towards materials and the emotions and motivation they evoke in children. This encompasses the children's happiness and engagement in using the provided materials. The responses reveal a positive and persistent interest, high levels of engagement, identification of similarities and differences, sensorial exploration, enthusiasm, facing challenges, a sense of pride, and a connection of identity with the scientific space and activities. The emotional spectrum includes excitement, happiness, and a willingness to handle materials carefully, all contributing to a sense of wonder and eagerness to get started with the materials.

Children express a positive disposition towards using materials, reflecting a persistent interest and high engagement levels. They demonstrate an ability to identify similarities and differences, engage in sensorial exploration, approach tasks with enthusiasm, embrace challenges, take pride in their work, and establish a connection between their identity and the scientific space and activities (e.g., "*My tree, my river...*"). Furthermore, Kids exhibit excitement and happiness, along with a willingness to handle materials carefully. This emotional response is marked by a sense of wonder, amazement, and eagerness to initiate activities with the provided materials.

The acquisition of new materials in the participating schools varied across locations and contexts. In Sofia and Bambini Bicocca, there were no new materials acquired during the reported period. In Monte San Michele, reclaimed materials were provided by Giocheria Laboratori, and teachers created additional materials using reclaimed and recycled items, aligning with the themes of lights, forces, and balances. Vic reported the acquisition of two new 3D printers, enhancing their technological resources. RiverLAB Valldaura school saw a significant addition to its library with new books focusing on Black women in science by Zinthia Álvarez Palomino, a Spanish journalist from the Afro-descendant community. Books about science, authored by Shedad Kaid Salad Ferrón, were also included in the school library, contributing to diverse perspectives in scientific contexts. Additionally, students and teachers generated materials related to science and biology, enriching the school's library. Vienna did not make new learning material purchases, intending to acquire tools for the garden, which faced obstacles due to unforeseen circumstances. However, the development of interactive learning posters was initiated and made available online for broader accessibility. Budapest invested in new equipment and toys, highlighting a significant initiative of opening a door in the laboratory to the courtyard, facilitating family involvement in the care of the vegetable garden on Saturdays. In Brussels, the noteworthy aspect was the expanded use of recovered materials, emphasizing sustainable practices in the educational environment.

4.2.3.3 Relational and psychoactive impact

The relational impact of the educational interventions is multifaceted, encompassing various aspects of interaction and engagement. Networking between associations is facilitated, fostering positive interactions marked by enthusiasm, creativity, joy, and a happy attitude. The contact with referents from vulnerable communities presents both positive interactions and instances with no contact. Families are implicated in these interactions, highlighting the collaborative and community-oriented nature of the educational efforts.

Children's behaviour undergoes positive transformations, manifesting improvements in social and emotional skills. They develop a scientific approach in their interactions with peers and adults, leading to increased confidence. Diversity in attendance is observed, and there is a persistent interest in science activities. Children feel proud of their work, showcasing a sense of accomplishment. Moreover, the relational impact extends to listening to relatives, involving them in the shared effort of research.

It is noteworthy that 57.14% of the mentions regarding relational impact are associated with children's behaviour during science-related activities and learning, both inside and outside the classroom. This underscores the significant influence of these educational initiatives in the context of science, demonstrating a substantial impact on their engagement and conduct during scientific learning experiences. The impact on children's behaviour resulting from the educational interventions is noteworthy, encompassing various positive outcomes:

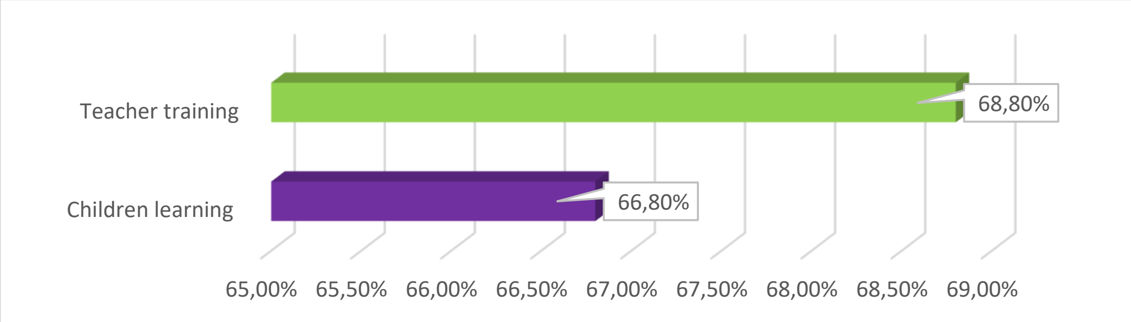
- Improving Social and Emotional Skills: The interventions contribute to the enhancement of social and emotional skills among the children, fostering better interpersonal relationships and emotional well-being.
- Scientific Approach to Peers and Adults: Children develop a scientific approach in their interactions with both peers and adults, showcasing an increased understanding and engagement with scientific concepts.
- Increasing Confidence: A notable outcome is the increased confidence observed in the children, indicating a positive impact on their self-esteem and belief in their abilities.
- Diversity in Attendance: The interventions promote inclusivity, leading to a diverse participation of children from various backgrounds, enriching the overall learning experience.
- Interest Persistent in Science activities: The sustained interest in science activities highlights the effectiveness of the interventions in maintaining the children's enthusiasm and curiosity over time.
- They Feel Proud of Their Work: The children express a sense of pride in their achievements and contributions, indicating a positive impact on their self-perception and motivation.
- Listening to Relatives and sharing Effort in Their Research: There is a collaborative aspect wherein children actively engage with their relatives, sharing the efforts invested in research activities. This emphasizes a community-oriented approach to learning.

In summary, the observed behavioural changes underscore the holistic impact of the educational interventions, encompassing social, emotional, and cognitive dimensions in the participating children. The concept of identity in connection with the scientific space and science activities is emphasized, highlighting the personalized and meaningful associations formed during the educational interventions. Overall, the relational impact plays a crucial role in shaping a positive and supportive learning environment, contributing to the holistic development of the participants. Within the theme of contact with vulnerable communities' referents, it is noteworthy that the majority of instances fall under the category of No Contact. This suggests that, in many cases, there is a lack of direct engagement or interaction with the families or communities in vulnerable contexts. This observation underscores the need for increased efforts to establish connections and collaborations with these communities, recognizing the importance of involving them in educational initiatives for a more comprehensive and inclusive impact.

4.2.3.4 Methodological impact

The Methodological Impact, which clusters different categories (Chart 19), is pivotal for enhancing the quality of science education.

Graph 19 - Patterns of distribution of the Methodological impact categories



Within this domain, the focus on Teacher Training is pronounced, encompassing various aspects aimed at equipping educators with the skills and confidence needed for effective science education. Teacher training delves into developmental pedagogical aspects, ensuring educators have a profound understanding of child development to tailor teaching strategies effectively. A crucial dimension involves planning activities with a dedicated focus on science, aligning curricular goals with engaging and informative scientific content. Material support is emphasized, enabling educators to optimally leverage resources. Teacher training initiatives go beyond traditional approaches, incorporating expert guidance and ongoing support for continuous professional development. The goal is to enhance teachers' competence and confidence, fostering empowerment and a positive group dynamic within the learning environment. Appreciating the learning process becomes integral to the training, instilling a mindset of continuous improvement.

4.2.3.4.1 Teacher training

Acknowledging time constraints for gaining experience, teacher training programs aim to set realistic expectations while optimizing available time. The STEAM-focused approach is central, aligning with contemporary educational priorities. Additionally, teachers engage in focused material-technical research, exploring innovative resources and methodologies to enhance the effectiveness of science education. Encouraging spontaneity in designing and elaborating science-related activities is a key aspect, promoting creativity and adaptability in instructional approaches.

Practitioners engaged in the Inclusive Science Education initiative demonstrated diverse skill acquisition. Sofia exemplified proficiency in engaging children through a child participation approach. Bambini Bicocca exhibited heightened awareness of exclusive practices, specifically in fostering a welcoming environment, utilizing varied communication strategies, and employing inclusive teaching materials. Monte San Michele developed precise skills tailored for teaching physics in infant schools. Budapest exemplified continuous learning, actively supervising meetings and facilitating the learning process. Vienna, while not acquiring specific new skills, demonstrated increased patience and flexibility. Dominiques Vic reported no specific skill acquisition. The RiverLAB Valdaura school Manresa showcased the acquisition of knowledge pertaining to river trees, biodiversity, and scientific concepts, coupled with the development of skills in formulating scientific inquiries and engaging in observational and experimental practices. Brussels demonstrated proficiency in working with phenomena, incorporating Performance Arts domains, explicit research focus, employing pedagogical documentation materials, integrating mathematics into the process, understanding spatial considerations, and recognizing the significance of role models.

Several critical aspects contribute to the overall Methodological Impact, focusing on enhancing the quality of science education in teacher training:

- Developmental Pedagogical Aspects: The training encompasses developmental pedagogical aspects, ensuring educators possess a deep understanding of child development to tailor teaching strategies effectively.
- Plan the Activities with a Focus on Science: Teachers undergo training to adeptly plan activities with a specific focus on science, aligning curricular goals with engaging and informative scientific content.
- Materials Support: A crucial facet of teacher training involves providing support for effective material utilization, empowering educators to leverage resources optimally.
- Expert and Training: Support Teachers receive expert guidance and ongoing training support, fostering continuous professional development to enhance their teaching skills.
- Improving Competence: Teacher training initiatives are designed to enhance educators' competence, equipping them with the necessary skills for delivering high-quality science education.
- Improving Confidence: Confidence-building is a key focus of teacher training, ensuring educators feel empowered and self-assured in delivering science education in the classroom.
- Positive Group Relation Support: Teacher training includes strategies for cultivating positive group relations within the learning environment, promoting collaboration and a supportive atmosphere.
- Appreciate Learning Process: Practitioners are encouraged to appreciate the learning process, fostering a mindset of continuous improvement and adaptability within the teaching profession.
- Not Enough Time to Get Experience: Recognizing challenges related to time constraints for gaining experience, teacher training programs aim to set realistic expectations while optimizing the use of available time.
- A Steam-Focused Work: The training emphasizes a Science, Technology, Engineering, Arts, and Mathematics (STEAM) focused approach, aligning with contemporary educational priorities.
- Teaching Approach Research Participation: Teachers engage in research processes, exploring innovative resources, materials and methodologies to enhance the effectiveness of science education.

Overall, Teacher training encourages spontaneity in designing and elaborating science-related activities, promoting creativity and adaptability in instructional approaches.

4.2.3.4.2 Children learning

Children learning is a crucial aspect of the reported activities, since it helps:

- Identifying Similarities and Differences: Children actively engaged in identifying similarities and differences, fostering cognitive development through comparative analysis.
- Sensorial Exploring: A significant part of the learning process involved sensorial exploration, encouraging a hands-on approach to understanding scientific concepts.

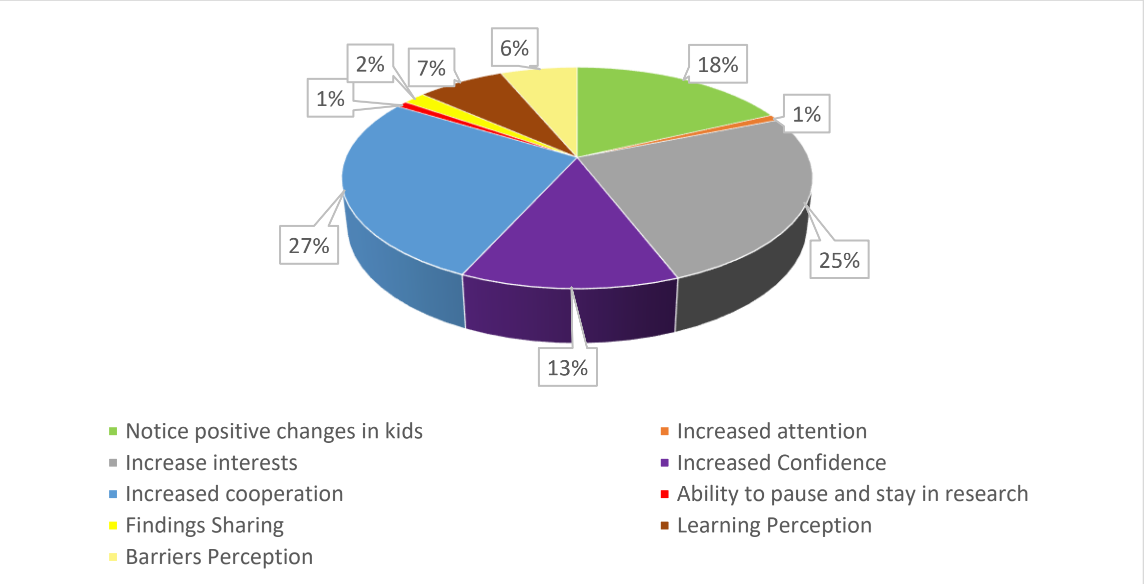
- Challenging: Children were presented with challenges, promoting problem-solving skills and critical thinking in the learning environment.
- Shared Learning Between Peers: Collaborative learning was evident among peers, emphasizing the social dimension of knowledge acquisition.
- Shared Learning with Families: Family involvement played a crucial role, with shared learning experiences contributing to a holistic educational approach.
- Role of Teacher: The teacher assumed a pivotal role in guiding and facilitating the learning process, ensuring a supportive and enriching educational environment.
- No Fear of Making Mistakes: Fostering an environment where children felt no fear in making mistakes encouraged experimentation and risk-taking in their learning journey.
- Confidence, Questioning: Children developed confidence in expressing themselves and were encouraged to ask questions, promoting an active and inquisitive mindset.
- Learning Based on Multiple Senses: The learning approach incorporated multiple senses, recognizing the importance of a multisensory experience in knowledge acquisition.
- Connection Inside and Outside School with Science Activities: Children's learning experiences extended beyond the classroom, establishing connections between in-school and out-of-school science activities.

This comprehensive approach to children's learning underscores the multifaceted nature of the educational impact, encompassing cognitive, sensory, social, and familial dimensions.

4.2.3.5 Participants' perception of the impact

The feedback from various project participants highlights noticeable changes and positive impacts on children following the inclusive science activities, as shown in Chart 20.

Graph 20 - Frequency of categories regarding the Participants' perception



In Sofia, children displayed an increased interest in the world around them, with heightened awareness of plants, bugs, and a desire for exploration. They engaged enthusiastically with scientific materials, demonstrating improved attention to object relationships and functions.

Similar positive transformations were observed in other locations. In Bambini Bicocca, practitioners reported heightened interest in the proposed topics, evident in children's independent drawings of roots and their eagerness to explore scientific materials. Monte San Michele noted expansions in children's interests, improved cooperation, changes in play patterns, and a shift in teachers' practices toward fostering an attitude of inquiry and discovery.

Furthermore, Vic highlighted the significant impact of children utilizing their new knowledge and competences to help others. In RiverLAB Valldaura school, an evolution in children's confidence and discovery approaches was observed, with a notable shift from seeking approval from teachers to sharing findings with researchers. This change positively affected group cohesion, emphasizing the role of inclusive scientific education in facilitating stronger connections among students.

Vienna reported children's enthusiasm and the development of new interests, particularly after a nutrition workshop. Children showcased a keen interest in taking self-sown plants home, ventured into cooking, and demonstrated increased confidence in handling knives. In Budapest, children's interest and motivation rose with age, and the teacher played a facilitating role in parent-child interactions during Saturday sessions. Brussels emphasized children's enthusiasm, curiosity, and confidence, even among those initially less motivated.

In summary, the diverse impacts observed across locations underscore the effectiveness of inclusive science activities in fostering positive changes in children's behaviour, knowledge acquisition, and social dynamics. In analysing the participants' perceptions of the impact of the activities, several key themes emerge:

- Participants consistently observed positive changes in children following science activities. These changes encompass various aspects, including increased interests, enhanced curiosity, and a more confident approach to discoveries.
- The attention to objects' functions stood out as a noticeable outcome, indicating a deeper engagement with the scientific materials and a growing understanding of the practical aspects of the objects involved.
- There was a collective recognition of the noticeable increase in children's interest in the world around them. The activities sparked curiosity, encouraging children to explore and engage with their surroundings more actively.
- The changes observed in children after participating in science activities were a recurrent theme. This suggests that the impact was not only immediate but also had a lasting effect on the participants.
- A significant outcome was the expansion of children's interests and curiosity. The activities succeeded in broadening the scope of what captured the children's attention, fostering a more inquisitive mindset.
- The reported increased ability to cooperate is indicative of the social benefits derived from the inclusive science activities. Children exhibited a greater willingness to collaborate, contributing to a positive group dynamic.
- Participants noted that children became more confident in their discoveries. This shift in confidence was particularly highlighted in how children presented their findings, moving from seeking approval from teachers to sharing them with researchers and peers.
- The theme of greater group cohesion emerged across multiple locations. Inclusive scientific education was seen as a catalyst for strengthening the bonds among students, fostering a sense of togetherness.

– The ability of children to pause and stay engaged in research reflects a positive impact on their focus and interest retention during scientific activities.
– The shift from showing findings primarily to teachers to including researchers in this process indicates a change in the perceived authority figures and a recognition of the value placed on the scientific aspects of their discoveries.

In summary, the participants consistently observed a range of positive changes in children, both immediate and enduring, across various dimensions, emphasizing the overall success and effectiveness of the inclusive science activities.

4.3 Inclusion in Science Education - Mesosystem

Social environments exhibit interdependence, forming an intricate network of interconnected ecological levels, often conceptualized as systems nested within each other. The following paragraphs shed light on the outcomes observed within the mesosystem, which pertains to the families of the children. the mesosystem represents the second layer of the ecological model, following the microsystem. It focuses on the interactions and interconnections between various components of a child's microsystem. These interactions occur within the mesosystem and can significantly influence a child's development. For example, the relationships between a child's family and their school or between their family and the community are essential aspects of the mesosystem. In the context of C4S, our analysis delves into the interrelationships within this mesosystem, examining the dynamics among family members and how they interact with formal and informal educational systems.

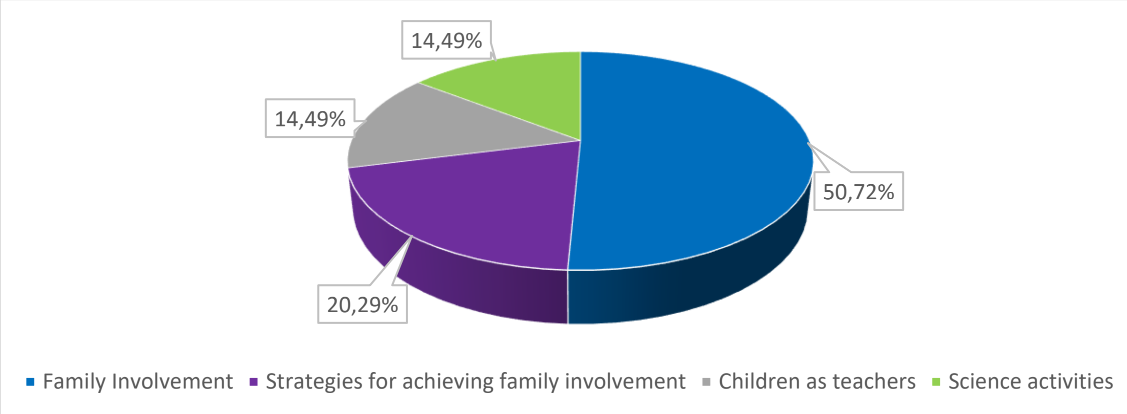
4.3.1 Co-creating an inclusive environment

In the endeavour to co-create an enriching and sustainable educational environment, with the help of children and youth, the active involvement of families and parents becomes paramount. Creating a holistic learning atmosphere necessitates forging strong partnerships between educational institutions, such as schools, nurseries, daycares, and informal educational settings, and the families of students. By establishing open lines of communication and encouraging parental engagement, not only it is strengthened the support system for children's learning, but it is also cultivated a sense of shared responsibility for their educational journey.

By examining diverse datasets, it became feasible to pinpoint 4 overarching themes (Chart 21) that steered the co-creation of an inclusive educational environment across the eight pilots:

1. **(theme) Family involvement**, at 50.72% the aforementioned theme is the most recurrent one and it clusters all the categories that indicate the participation of family members.
2. **(theme) Strategies for achieving family involvement**, with a frequency of 20.29% it is used to indicate all those activities implemented in order to overcome the barriers of family involvement and achieve participation.
3. **(theme) Children as teachers**, with 14.49% this theme indicates all those practices, in which children take a central stage, subverting the conventional idea of young learning from the elderly, and see children and youth as leaders of knowledge dissemination.
4. **(theme) Science activities**, lastly at 14.49% the Science activity theme clusters parents' and families' opinion on science education.

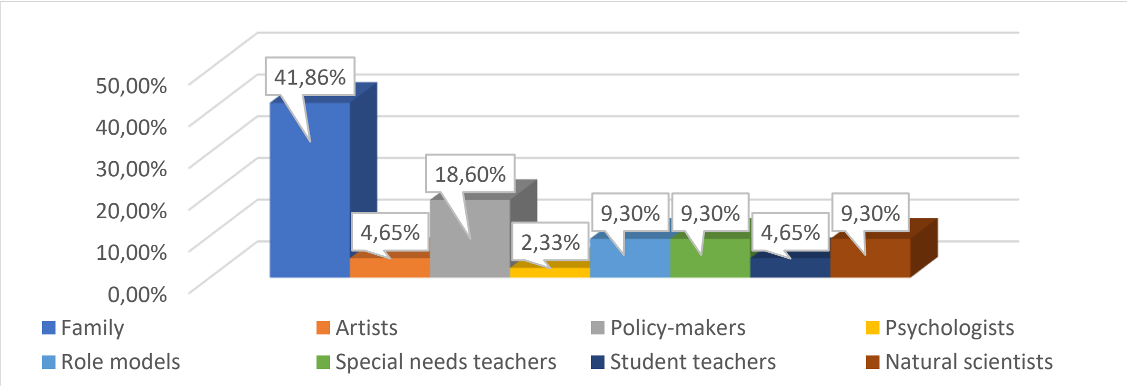
Chart 21 - Frequency of themes related to the Co-creation of an inclusive educational environments



4.3.1.1 Family Involvement

As mentioned in 4.2.1.4 External figures participation, to achieve a sustainable and engaging educational environment it is essential to involve different external figures, and among those figures, families' involvement reveals to be the most recurrent (see Chart 22).

Graph 22 - Patters of distribution of activities involving external figures.



Analysing the distribution of occurrence percentages among various external figures reveals that engaging families and parents has proven to be an effective strategy in establishing a conducive educational environment. Additionally, as highlighted earlier, the crucial role of family involvement is indispensable in fostering a robust support network that transcends the boundaries of the classroom. However, family participation can be manifested in diverse forms, and, in the C4S project, involvement has been observed in the following ways:

- Parent-teacher meetings were a common avenue for family involvement in the Pilots, with scheduled sessions serving as platforms for engagement. The nature and focus of these meetings varied across instances; for example, at Bambini Bicocca Infant school, Monte San Michele Infant school, and The Sound of Music, these gatherings allowed teachers to showcase the diverse activities undertaken during the Pilot.
- Active participation in activities was another dimension of family involvement. In Sofia's Pilot, EduLab 0-6, The Sound of Music, and Garden4Sciences, parents not only attended but actively engaged in activities, playing alongside their children. Garden4Sciences involved parents in projects carried out by pilot teachers, requiring children to continue working at home and extend the project beyond the classroom.

- Communication played a role in involving parents indirectly in pilots such is the case of Vic's pilot and Bambini Bicocca Infant school, where parents were engaged through the process of sharing information.
- Focus groups were organized to gather family perceptions regarding pilot activities and the broader topic of inclusive science education.
- Various school events, including structure openings (as seen in EduLab 0-6), exhibitions (Monte San Michele, The Sound of Music, and Garden4Sciences), actively invited and engaged families.
- Field trips and visits were additional avenues for family engagement. For example, in Sofia, parents participated in visits to the Agricultural Museum, where children had an opportunity to explore the exhibitions without a time limit. Budapest's EduLab 0-6 involved parents in a visit to the ELTE Fűvészkert. In Valldaura's RiverLAB, families were indirectly engaged in field trips since pupils, having been to the river with the school, started bringing their parents after school.

All these different activities served various purposes. For instance, in Edulab 0-6, the initiatives primarily aimed to enhance parental competence, providing parents with an opportunity to engage in relaxed, uninterrupted playtime with their children. This setting allowed for a free environment, unburdened by household chores or other tasks. Conversely, at Monte San Michele and Bambini Bicocca infant school, the focus was on regular informational meetings. The Sound of Music project, on the other hand, aspired to foster a closer connection between teachers and families through these meetings.

Despite these intentions, in agreement with Manresa's RiverLAB Valldaura school's observations and the thematic analysis, data reveal that achieving family participation remains challenging. Not all C4S project partners have established robust relationships with families or attained complete engagement. Moreover, the engagement achieved by most partners tends to be limited to indirect involvement in school activities. *"The impact is also one-sided because all the effects, whether direct or indirect, appear to emanate from the school to the community, with minimal incorporation of family knowledge and suggestions. This suggests that the potential for community impact and direct collaboration has not been fully realized"*. Although schools interact with families and aim for inclusion, the relationships often lack true partnership.

In summary, while major family involvement may be lacking, there is indirect participation observed, facilitated by children who serve as mediators of engagement. They create connections between schools and families by sharing knowledge, as discussed in section 4.3.1.3 on Children as teachers. This marks an initial step toward achieving an inclusive and sustainable educational environment with the help of families and parents.

4.3.1.2 Strategies for achieving family involvement

Achieving family involvement poses challenges marked by various obstacles; in the pilot period, partners encountered distinct hurdles, including the impact of Covid-19, as reported in Vienna's pilot. The school principal emphasized the consequences of COVID measures, where parental access to the school was restricted, creating a distance between families and teachers. Similarly, Manresa's pilot highlighted the disruptive effect of the pandemic on established family involvement, with health protocols causing a shift in dynamics, and even upon reinstating access, families expressed concerns about infection risks. It has also been observed that diversity among families could play a significant role in hindering involvement. Varied backgrounds, educational levels, socioeconomic statuses, and perceptions of STEAM education contribute to differing expectations and views on the role of teachers. Thus, inclusive scientific education often correlates with income and educational backgrounds within families.

To foster family involvement, and to overcome the above-mentioned barriers to family participation, different strategies have been observed. Brussels suggested that using pedagogical documentation, such as printing photos of STEAM activities and using them as conversation starters, may lead to a positive family engagement. This approach was also employed by Bambini Bicocca Infant School and Monte San Michele Infant School in Italy: practitioners shared photos of the weekly activities with the families, presented children's craftwork as wall-documentation in the schools, and prepared power-point presentations for the families.

Additionally, the pilots in Budapest and Brussels, which experienced significant family engagement, emphasized the importance of considering the setting. Brussels highlighted the significance of space layout during meetings to facilitate easier communication among families, creating a less scholastic environment: "*For the meetings, we also thought about the layout of the space. It is not obvious to rearrange a classroom with tables and chairs. From the first meeting, we had learnt to rearrange the classroom even more so that contacts between the families could be easier during the talks. This gave the space a less scholastic character. The teacher and steam lecture then thought how to arrange the classroom and so that there would be a sense of belonging and the parents could interact with each other*". Budapest found outdoor activities to be more effective in reaching and engaging families, fostering communication and interaction among parents: "*For them and many other families, outdoor activities were the best solution. There, families, both familiar and unfamiliar, were free to be together, with many opportunities, more than in the indoor lab. One of the main findings of the pilot is that the outdoor activities are much more effective, we were able to reach many more families. In the outdoor programmes, there were also families coming together (e.g., for a joint playground activity), in which case there was regular communication between parents. Families came separately to the indoor programmes and there was no communication, only contact when necessary.*".

In conclusion, these observations underscore the importance of employing strategies that involve parents in co-creating an educational environment. This collaborative approach is crucial for building a sustainable and enduring educational environment with the active contribution of families and communities.

4.3.1.3 Children as teachers

Establishing inclusive communities with and for vulnerable populations, where science education is tailored to pupils, children, and youth, requires a transformative shift. This paradigm change involves empowering children and young people to become active agents in knowledge production, while encouraging parents to adopt an open stance of willingness to learn from their children. The analysis of data collected by European partners has unveiled common subthemes within the "Children as teachers" category across various pilots. These findings suggest that the strategies employed in these programs contribute to the sustainability of an inclusive educational setting over the long term.

For this paradigm shift to occur, it is crucial that parents demonstrate a genuine willingness to learn from their children. This willingness is often manifested through the curiosity of parents, as evidenced by feedback received both by teachers and during the focus groups with the families. Families reported that children shared their experiences at home through stories or play, sparking parental curiosity, as noted by Monte San Michele Infant school, this opening gave parents the opportunity to ask the teachers for clarification and to learn more clearly about what was being proposed. In focus group discussions, families highlighted their children's contagious enthusiasm for topics like the river, in the case of RiverLAB Valldaura school, with children eagerly sharing newfound knowledge and even insisting on weekend visits to showcase what they had learned.

Furthermore, in the case of Garden4Sciences parents engaged in informal activities at home, driven by their children's desire to share information and experiment with concepts introduced in kindergarten. On this topic, it was shared by some family members of Monte San Michele, that they were impressed by the depth of learning in kindergarten, reached out to inquire further about their children's education. In embracing their children's inquisitive nature, parents willingly admitted when they didn't know the answers to their children's challenging questions. This openness fostered a collaborative atmosphere, with children and parents embarking on explorations together, such as tackling questions about the weight of coffee beans versus water in a glass.

As acknowledged by the Sound of Music, this shift of paradigm led to the extension of the curiosity of parents beyond basic interest in their children's well-being at school; they wanted to delve into the specifics of what their children were learning. During family meetings, it became apparent that some parents were surprised by the playful nature of the encounters, expecting a more formal setting.

This reciprocal exchange of curiosity and learning not only strengthens family bonds but also contributes to the creation of a sustainable and inclusive educational environment. As observed by Sofia, while working with the Roma community "*parents started learning new things from their children. This is important because parents can see how valuable things children learn and how interesting is that for them. This motivates parents to take their children to kindergarten regularly*". In RiverLAB Valldaura school, children "*shared fascinating facts such as the existence of honey-making ants in Africa, details about trees, observations about ducks, or the reasons behind the river's occasional brown water, which they explained as being due to mud, not a cause for concern*". Instead in the Sound of Brussels "c*hildren showed how they made connections in the classroom and how those connections created a certain experiential experience in the classroom and arrangement of space."*.

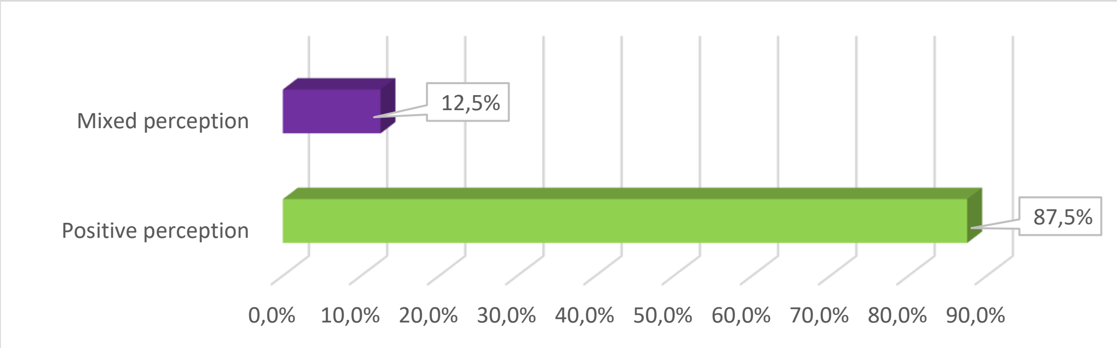
In conclusion, fostering inclusive communities for vulnerable populations through tailored science education requires a fundamental shift: empowering children as active contributors to knowledge production and encouraging parents to learn from their children are key elements.

4.3.1.4 Science activities

To establish a sustainable and enduring educational environment for and with vulnerable communities, characterized by a thriving STEAM education, it is imperative to actively investigate and understand families' opinions about STEAM education. Through the comprehensive analysis of the gathered data, it became evident that fostering a positive perception of science education within families is crucial. The opinions and perspectives held by families play a pivotal role in shaping the educational experiences of children and youth. By actively seeking and considering family opinions, educators and policymakers can better tailor STEAM education initiatives to align with the values, expectations, and aspirations of the communities they serve. This collaborative approach ensures a more inclusive and sustainable educational environment that not only meets the needs of vulnerable communities but also actively involves them in the co-creation of a meaningful and impactful educational journey.

As observed in Chart 23, most of the families that have been involved in the different pilots of C4S project had positive perception about science education. Only in one pilot it has been observed a mixed perception about the proposed science activities since it has been noted that few participants weren't really keen on the science projects.

Chart 23 - Patterns of parent's perception about steam activity among pilots



However, although a positive perception of the proposed science activities was found, each family's perception is culturally and socially connoted, as suggested by RiverLAB Valldaura "*the families' perception of STEAM is very diverse, because their backgrounds, training and relationship with science are diverse. All of them have the representation of science that connects to the stereotypes of science*". These differences in representation, nonetheless, do not block the recognition of the importance of science education from an early age. "*All families state that science is very important for the development and growth of their sons and daughters. It is perceived as a path that connects with the scientific careers of their sons and daughters*".

The recognition of the significance of inclusive science education underscores the need for enhanced science learning environments. In Milano, parents express their desire to witness GiocheriaLaboratori, an educational canter catering to children aged 0 to 12, operating daily as a museum to facilitate more frequent visits. In Budapest, families propose joint activities and excursions, such as trips to ELTE Fűvészkert, the Zoo, or strolls on Margaret Island, as positive initiatives. Parents view outdoor activities as effective means to foster community cohesion; however, affordability, including transportation, is crucial for many families. In Bambini Bicocca, families emphasize the necessity for more inclusive science activities for their children.

In summary, to establish a sustainable educational environment prioritizing science education for vulnerable communities, it is imperative to cultivate trust and positive awareness among families. To achieve this positive awareness, it is crucial to support the paradigm shift and let children be the teachers and adults the students. As per family perspectives, expanding the availability of science activities for children is deemed essential, with an emphasis on making these activities free of charge, including transportation.

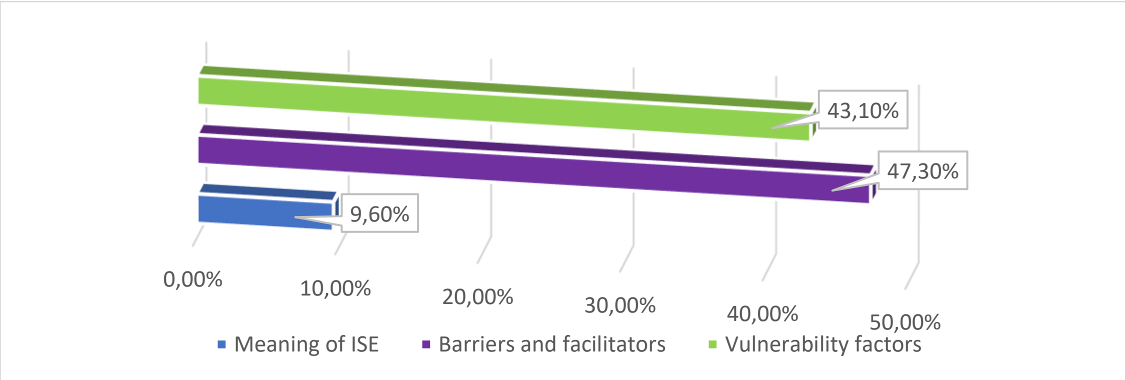
4.3.2 Inclusive Science Education

To make the educational environment and science education inclusive, it is also important to gather families' opinions about the barriers to children's participation in science education activities. In addition, it is essential to identify aspects that facilitate children's participation in such activities from the perspective of adults. Therefore, it is important to consider the perspective of adults and their views on how to make science education inclusive.

From the data analysis, three main themes have emerged (Chart 24):

1. **(theme) Barriers and facilitators to participation**, at 47.30%, is the most recuring theme. It is used to identify the variables that hinder or facilitate inclusion in science education according to families and parents.
2. **(theme) Vulnerability factors**, with frequency of 43,10%, the theme indicates the awareness of families about possible vulnerability factors that may affect the surrounding community and children. It differs from the previous theme since it clusters all the variables that put the near community in conditions of vulnerability.
3. **(theme) Meaning of ISE**, at 9,60%, the theme clusters the families' and parents' opinions on the meaning of Inclusive Science Education.

Chart 24 - Frequency of themes among the different pilots



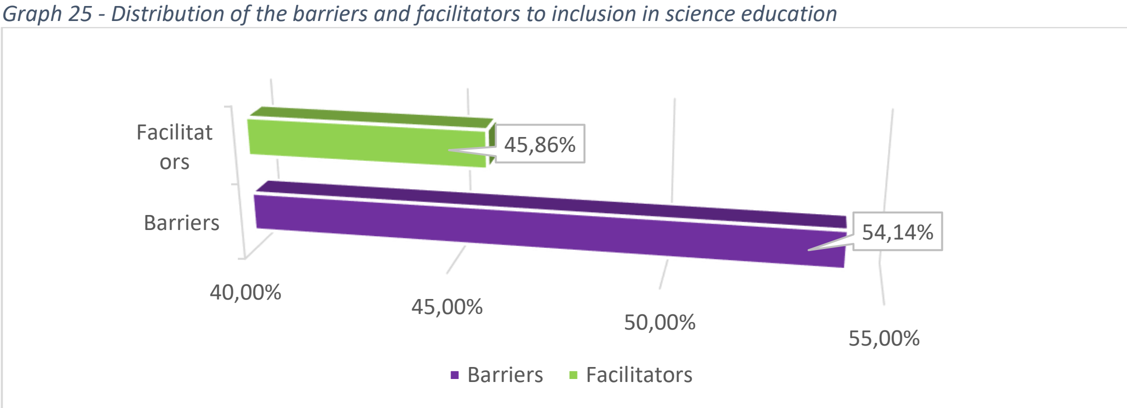
Answering these questions is critical to fully understanding adults' views about making science education inclusive for children.

4.3.2.1 Barriers and facilitators

An important part of the analysis concerns factors that in everyday life may result as barriers to children's participation in science education activities or, conversely, supports and facilitators that encourage children's participation in these types of activities.

As can be seen in the chart shown here (Chart 25), what emerges from the research is that, overall, the barriers encountered by families are greater than the facilitators that support participation in science education activities. In this case, barriers turn out to be 54.1 percent of the factors, while facilitators 45.9 percent.

Graph 25 - Distribution of the barriers and facilitators to inclusion in science education



4.3.2.1.1 Barriers to inclusion

Thematic analysis of the responses from the families of the eight pilots participating in the research have brought out seven different barriers to science education. According to families those barriers may hinder both children's and families' participation in the scientific educational environment.

Socio-economic barriers (34.9%): the prevalent and most encountered barrier is the socioeconomic one, highlighted by the pilots in Brussels, Manresa, and Vienna. In fact, families report problems such as for example, price of admission to the proposed museum or activity being too high, or the fact that it seems that activity popups are made only for a middle to high target audience, and, finally, the fact that families from vulnerable communities have to devote themselves to meetings with different social welfare agencies, thus taking away time to devote to other types of activities.

Barriers related to language and communication (19.8%): Language and communication barriers can impede meaningful participation in science education activities, limiting individuals' access to valuable learning experiences and opportunities for scientific engagement. As observed by the partners parents usually lack the language abilities in order to search for scientific activities suitable for their children or have difficulties to communicate with the educational services that offer those kinds of activities.

Furthermore, some parents have stated that they have encountered limited possibility to participate as families in the activities (11.9%). As observed during the focus groups with families in Manresa, even if parents are interested in a certain topic and would like to develop their interest and their knowledge, activities are rarely designed to be carried out both by children and parents together. Limiting thus family involvement in the process of Inclusive Science Education. Moreover, parents state that the planning of the school curriculum (9.9%) has limited theirs and their children participation in the activity, leading to believe that there should me a more careful design of the extracurricular activities.

The lack of proposals related to science education and inclusive science education (9.2%) has also been observed as a frequent barrier to inclusion in STEAM education. In Bambini Bicocca families state that they're having trouble to find suitable activities for their children, declaring that there's a limited offer and that most of the activities are targeted for older children and not for the 0-6 group. In this regard, a mom from the Bambini Bicocca pilot says, for example, that in order to counteract the problems of communicating science education proposals, her solution was to sign up for numerous online forums in which it is possible to find interesting proposals for her child to participate in.

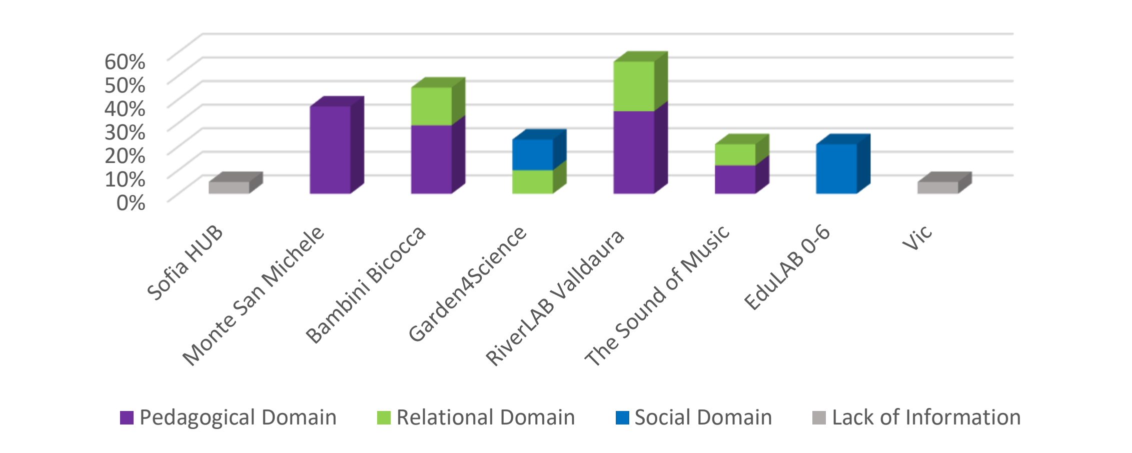
Continuing with the analysis, at 8.5% Families' opposition to their children's participation in activities has been noted as a barrier. For Instance, in the Sofia pilot there is an absence of science education offerings, with particular reference to the Faculteta neighbourhood and also shows a reluctant attitude on the part of families toward community cultural venues and a lack of trust in the staff of the preschool to which they belong.

Lastly, the closing barrier to participation in inclusive science education according to families are anti-Covid measures (5.8%). As acknowledged both by Budapest and Manresa anti-Covid measures have limited parents' involvement in school activities, but also the possibility of designing and implementing inclusive science education programs since there were more urgent issues to be tackled.

4.3.2.1.2 Facilitators to inclusion

As mentioned above, the families involved in the various pilots identified several factors that could positively influence children's participation in science education activities. Those strategies have been divided into three macro groups: Pedagogical Domain; Relational Domain and Social Domain. Since not all parents participating in the project have identified any facilitators to inclusion, there has been created a section about the Lack of information. In Chart 26 it is possible to see the patterns of distribution of the aforementioned categories.

Graph 26 – Patterns of frequency among pilot sites of the facilitators that lead to inclusion according to families



Regarding the Pedagogical Domain, which clusters topics such as learning-and-teaching approach, design of setting and materials, families of three out of the eight pilots, have affirmed that the laboratorial approach, implemented in the educational realities where their children go, may have a positive effect on inclusion. According to the Sound of Music, Bambini Bicocca and Monte San Michele infant schools, in the view of the families, a laboratorial approach, in which children can freely explore, manipulate objects, and ask questions, is significantly more effective in promoting participation than activities characterized by a more frontal, transmissive teaching approach. Furthermore, according to parents, adequate, safe, and stimulating space is essential to create an environment conducive to scientific learning. A child-friendly environment, free of hazards and rich in stimuli, encourages exploration and learning in a safe and rewarding way. Parents have also expressed the importance of a child-centred approach, acknowledging the importance of the Child-interest input while designing a specific activity: Activities set up considering the interests and peculiarities of each child promote personalized and inclusive learning. Recognizing and valuing individual differences contributes to an educational environment that respects and supports diversity.

The second most frequent category is the Emotional domain, which indicates all mental functions related to the emotional, affective, and relational components and the ability to manage them while carrying out a specific activity. Parents from Garden4Sciences, Bambini Bicocca infant school, RiverLAB Valldaura and the Sound of Music, observe that a positive school-family relationship is quintessential since it creates a collaborative environment that fosters parents' active participation in their children's science education. Thus, establishing mutual trust contributed to more effective support and open communication, key elements for positive involvement. Moreover, as observed both in Bambini Bicocca infant school and the Sound of Music, a favourable parental attitude toward science subjects could positively influence children's interest and motivation. Parents who are enthusiastic about science can convey a positive approach toward scientific learning, encouraging their children to explore such subjects with curiosity and interest.

However, as observed in Vienna's pilot, Garden4Sciences, and in Budapest's one, EduLAB 0-6, barriers to inclusion in science education for children go beyond the involvement of families in the educational environment, the personal cultural background of families or the pedagogical design of the school. It should be acknowledged that families may encounter barriers in participating in science activities due to economic issues: free science activities or financial support to families to manage related expenses can remove economic barriers, ensuring that participation is not limited by families' financial situation.

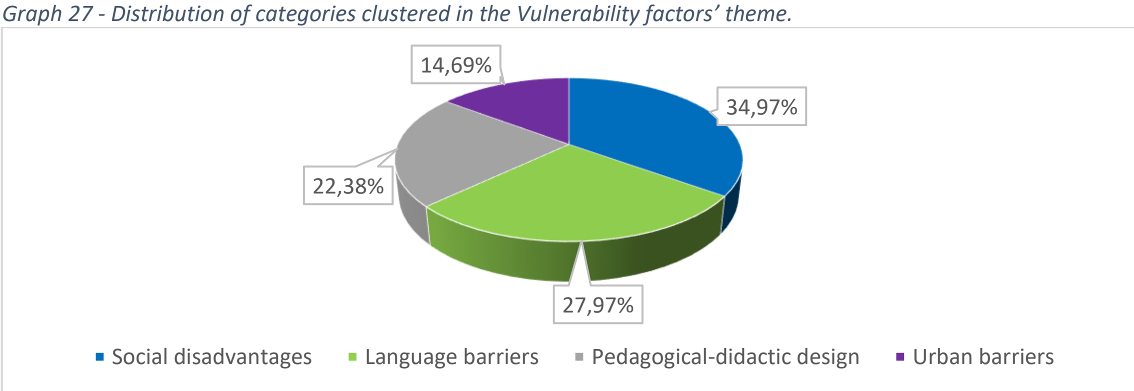
In conclusion, while examining the distribution of factors considered as barriers or facilitators in participation in the different pilots, it is observed that Manresa's RiverLAB Valldaura school emerges as the pilot with the highest number of barriers found. However, it is interesting to note that it is also simultaneously the pilot in which the most facilitating elements were identified. From these data, it can be deduced that in the context of the Manresa pilot, there was a significant response to overcome barriers to children's participation in science education activities. Another relevant observation comes from the Children Bicocca and Monte San Michele pilots: although they provided little information about the barriers they encountered, they identified several facilitating factors. This could be a sign of possible overcoming difficulties in participating in science education activities in these settings.

4.3.2.2 Vulnerability factors

In the course of cross-country thematic analysis, a salient theme that emerged is that of Vulnerability Factors. This thematic category delves into the nuanced understanding of the conditions that render communities susceptible to challenges. Unlike the Barriers and Facilitators theme, which focuses on factors affecting inclusion in a broader sense, the Vulnerability Factors theme specifically identifies variables that place communities at risk. This theme centres on recognizing the various elements that contribute to the vulnerability of both the surrounding community and its children. The analysis underscores the importance of discerning these factors, emphasizing that families, overall, demonstrate an awareness of the potential vulnerabilities that may impact the targeted community and its children.

The Vulnerability factors' theme clusters four main categories, namely Social disadvantages, Language barriers, Pedagogical-didactic design and Urban barriers (Chart 27).

Graph 27 - Distribution of categories clustered in the Vulnerability factors' theme.



Examining the vulnerability factors identified by the pilots, one prominent variable that places vulnerable communities at risk is social inequality, as reported by RiverLAB Valldaura. Specifically, social inequality emerges as a significant risk, attributed to the lack of respect for rights. This is underscored by challenges such as difficulties in obtaining necessary documents, limited access to public housing, securing dignified employment, and obstacles in accessing local resources. Moreover, as supported both by Garden4Sciences and RiverLAB Valldaura, a notable and frequent factor contributing to the vulnerability of children is a disadvantaged family situation, wherein some children grapple with issues stemming from insufficient food and housing, compounded by the irregular circumstances of their parents.

Social disadvantages aren't the only variables that may put the surrounding community in a possible situation of vulnerability, as shown in the chart, Language barriers are as relevant as the Social barriers. Both Sofia, the Sound of Music and Monte San Michele Infant school are aware of the importance that communication holds in the inclusion process. In Sofia's pilot families express their awareness that children need to be proficient in the Bulgarian language to commence their schooling, leading to a reluctance among many to enrol their children in preschool. In Italy, Monte San Michele highlights the challenges families face in communicating with their children, stating that the difficulties to communicate between parent's who are first generation migrant and their children, born and raised in Italy, may hurdle participation and hence inclusion. Notably, the Sound of Music underscores how the lack of language skills among families from migrant communities is the predominant factor hindering their inclusion in science education, positioning them in a vulnerable situation.

Furthermore, in the evaluation of factors influencing inclusion, families express concerns that the pedagogical didactic design proposed by schools may hinder the inclusion of children, particularly those facing difficulties. Families believe that the school's approach and the design of activities could potentially lead to the exclusion of children who encounter challenges. In Monte San Michele, there is a prevailing sentiment among families that a shift towards a more laboratorial approach in education could contribute significantly to fostering inclusion. They argue that a hands-on, experiential learning model may be more effective in accommodating diverse learning needs and ensuring that no child is inadvertently excluded from the educational process.

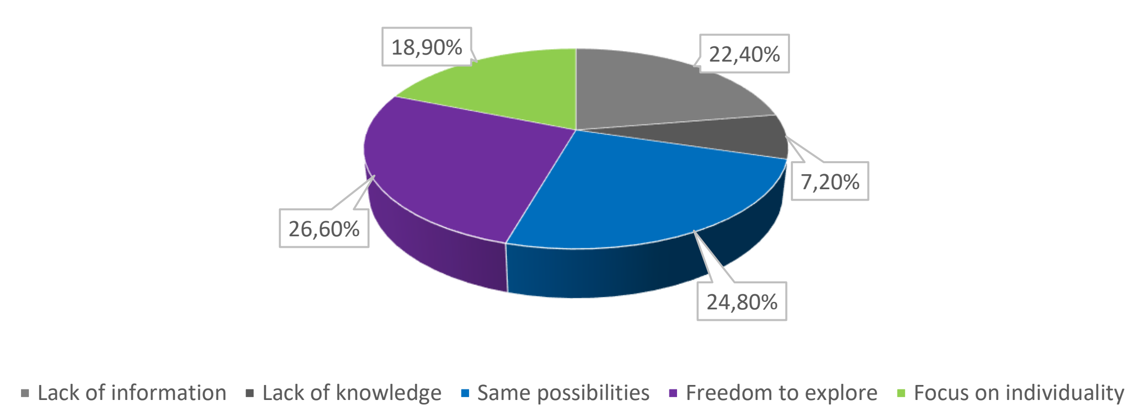
Lastly, as noted by parents from the Bambini Bicocca infant school, vulnerable communities may face urban barriers that result in exclusion. These challenges include the struggle to find suitable places for recreational activities with their children. One father emphasized the difficulty of feeling confident in allowing his child to explore in the park, highlighting that while science encourages exploration, the safety of parks is a concern.

4.3.2.3 Meaning of ISE

In the pursuit of creating truly inclusive science educational environments, it is paramount to delve into the perspectives of families and parents regarding their understanding of inclusivity. Unveiling the nuanced meanings and expectations that parents associate with inclusive education becomes a crucial cornerstone for educational institutions aspiring to embody these ideals. By comprehensively grasping what inclusion signifies to parents, educational environments can tailor their approaches to align with the aspirations and preferences of families. To this end, the following exploration delves into the insights offered by families involved in the various pilot programs, shedding light on their perceptions of inclusive science education and its pivotal role in fostering a more inclusive STEAM education landscape.

Considering the notion of inclusive science education, families were queried about their familiarity with its meaning and, if so, how they construed it (Chart 28).

Graph 28 - Distribution of categories clustered in the Meaning of ISE theme



As shown in the chart, the responses exhibited a range: some placed emphasis on the scientific dimension, contending that inclusive science education seeks to instil in children an open, curious, and reflective approach to the world. Parents state that it is important to give the freedom to explore the scientific phenomenon, so that children could learn at their own pace. Conversely, others concentrated solely on the inclusive facet, characterizing inclusive science education as an educational journey that recognizes and values the distinctive traits of each child, thereby underlining its accessibility for all. It is thus important to focus on individuality and create tailormade activities for everyone. Furthermore, some parents state that it is important to give each child the same possibilities.

However, an examination of the responses highlights that, for some parents, participating in the different focus groups with families or during casual talks with practitioners and researchers, the concept's meaning remains somewhat unclear, expressing that this marks their initial encounter with it. Moreover, not all pilots have managed to gather the viewpoint of families and parents on the topic of inclusive science education, highlighting the difficulty to involve those important figures in the educational process of the youth and the pupil.

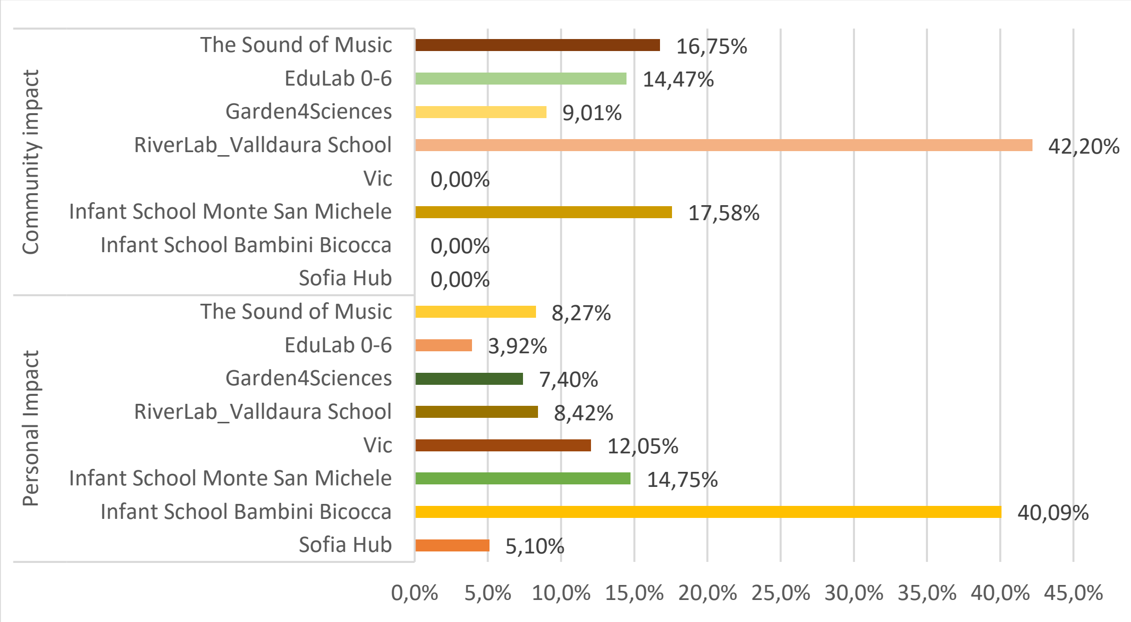
This diversity of viewpoints underscores the significance of thoroughly exploring and comprehending families' perspectives on the concept of inclusive science education, underlining the necessity for a clear and comprehensive understanding on this subject in order to achieve an environment, which isn't only inclusive for children during the STEAM activities, but it is also for parents and families who are indirectly entangled in this environment.

4.3.3 Short term impact

Investigating the impact that the pilot activities had on the extended community, i.e., the families and next of kin, and understanding the families' own perceptions of the impact is one of the goals that the C4S Project has set for itself. Through the analysis of the focus groups with the parents and families, and from the informal moments of discussion with them, it was possible to identify two themes that manage to summarize and represent the perceptions of the participants (Chart 29):

1. **(theme) Personal impact**, this theme reflects the substantial personal impact observed by 75.00% of families on their children and their knowledge. It encompasses perceptions of both individual and collective change.
2. **(theme) Community impact**, at 25.00%, which is identified by 25.00% of participants, consolidates the social utility of the project's outcomes from their perspective. It delves into the broader community impact as perceived by the families involved.

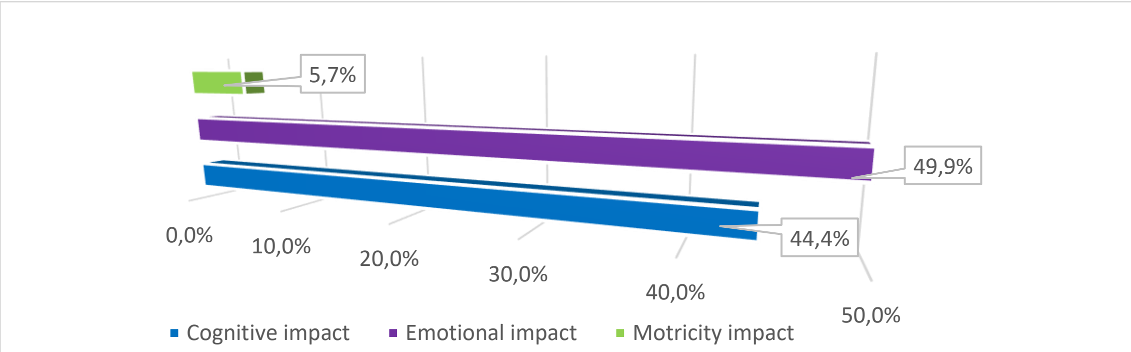
Chart 29 - Patterns of distribution of the themes among pilots



4.3.3.1 Personal impact

Through the analysis of focus groups with Parents, and informal discussion moments, held during the organization of events, participation in activities or a simple exchange at the school exit, it was possible to understand the opinion of parents and families regarding the extent of the Project's impact. The analysis revealed that Parents saw a greater impact on a personal level, both their own and their children's, in fact the theme Personal Impact has a 75% recurrence. This theme encompasses three categories: Cognitive impact, Motricity impact, Emotional impact (Chart 30).

Chart 30 - Patterns of distribution of Personal impact's categories



Parents and families have stated that they have observed the major personal impact in their children's realm. This is a trend that has been observed in all the eight pilot sites. In Bambini Bicocca infant school parents have seen an interesting change in their children's positioning towards science and the increase of self-efficiency and interest, even outside of school: "*G. is also very interested in insects at home, he talks about them often, and when he sees one, he observes it for a long time.*". According to parents, children have become better at staying in observation and relation with the surroundings and with themselves. Furthermore, on the topic of emotions, Families and parents from RiverLAB Valldaura, shared that *their children are very happy with what they do at the river with the school*. The joy and enthusiasm of what it has been done in school is also report by Garden4Sciences and Vic's pilot. In Vienna's Garden4Sciences "*parents reported that the children were very enthusiastic about producing their own seedlings and taking care of their bottle gardens*". In Vic "*children were really proud of the assistive devices produced. This was evident o the last classes and when designs converted into devices; and even more when they presented them to the Estel children.*" Furthermore, Vic observed that in some cases, children who had difficulties in the class, showed above-average abilities in the 3D printing design, boosting the self-esteem of these participants. Enthusiasm shared also by the parents of Brussel's the Sound of Music: "*They did talk about the children's enthusiasm about the activities and how they told at home about what they had done and discovered.".*

Parents and families have also observed a boost in their children's cognitive abilities, seeing an increase of knowledge, a swift change of seeing the world and a development of the language abilities. In Sofia's pilot *teachers and teacher assistants shared that parent recognized developments in children's language skills - they started using new words, and they feel more confident in their communication with others*. A trend observed also in Bambini Bicocca infant school, with the child whose mother tongue was different from Italian. Parents also stated that their children have acquired new knowledge about STEAM subjects that are useful in daily life, such as how to recycle, how to cock, or how to take care of different plants and grow their own crops. Also, only in the case of Monte San Michele infant school, some parents have observed a development in the fine-motricity skills of their children.

In conclusion, it is important to note that the above-mentioned personal impact is the reflection and restitution of the parents' and families' opinion. Children's personal abilities haven't been assessed quantitatively neither prior to the pilot period nor post.

4.3.3.2 Community impact

In five out of eight pilots, families and parents have reported a positive impact not only in the children but also on them and on the extended community. This positive Community impact can be seen both in the revaluation of previously abandoned spots of the city, in the acquisition of a new self-awareness and in the establishment of a stronger relationship between home and school.

In Manresa, RiverLAB Valldaura school, thought their passion, enthusiasm, and ability to convey to parents their knowledge and their *passion for the trees and the natural environment along the river. Some families who did not previously visit the river have now embraced this part of the city as a place for leisure and family relaxation during weekends*. Thus, transforming a previously less explored part of the city in a new centre of interest and relief: *Low-income families who cannot afford vacations have embraced the river as a space to connect with nature, find relief from the summer heat, and organize picnics and gatherings with family and friends*.

Budapest's EduLAB 0-6, has observed a major involvement of parents in their children's play and also a better understanding of the importance of a continuity between home and school play: *What children played with in the lab, they were happy to continue at home when they had the chance. In several cases, parents have taken photos of the toys so that they can implement these opportunities for their child at home*. Furthermore, this home-school activity endeavour was also observed by Garden4Sciences, where parents reported *that the children were very enthusiastic about producing their own seedlings and taking care of their bottle gardens at home*. Lastly in Monte San Michele, parents have seen an impact on their daily life, since after the activities children became more careful in the recycling "*Mommy don't throw that, we can* *use it to make this… mommy, be careful we can use that as a toy"* making parents more responsible in recycling.

4.4 Inclusion in Science Education - Macrosystem

Social environments are intricately interlinked, forming a complex web of relationships and influences. These interconnections span various ecological levels, with each level operating as a system nested within the others. The forthcoming paragraphs shed light on the outcomes within the macrosystem, which encompasses policymakers and the broader community. This layer plays a crucial role in shaping the broader context in which children grow and develop. In the context of C4S, as mentioned above, we delve into the interactions and relationships among peers, as well as between peers and adults, within both formal and informal educational settings like preschools, kindergartens, elementary schools, and educational centres, but we have also involved families, policymakers and stakeholders, in order to give a broader spectrum of the impact of the project.

4.4.1 Co-creating an inclusive environment

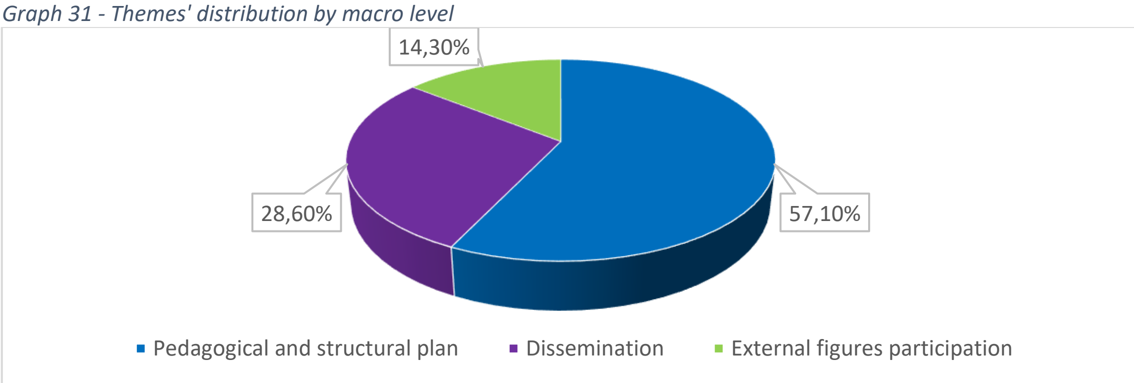
Creating an inclusive educational environment, which is sustainable and successful in time, isn't a simple task: children and practitioners, families and caregivers, but also policymakers, stakeholders and the broader community have to be involved to achieve this task.

Through the analysis of the data, three themes, that guide the co-creation of an inclusive environment with the help of policymakers and stakeholders, have been detected:

1. **(theme) Pedagogical and structural plan**, with an occurrence of 57.1% is the theme that received the highest frequency. This theme includes the material, organizational, and pedagogical dimensions of co-constructing an educational environment with the help of the surrounding community and policy makers.
2. **(theme) Dissemination**, with an occurrence of 28,6% the aforementioned theme is the second highest. It is used to indicate all those actions regarding the promotion policies in support of childhood and their communications through different channels.
3. **(theme) External figures participation** is the least frequent theme, but nevertheless with a frequency of 14,3% is still of significant importance, since the involvement of different participants in the activities may lead to a sustainable and inclusive educational setting.

In Chart 31 there is a visual representation of the occurrence of the 3 macro-themes.

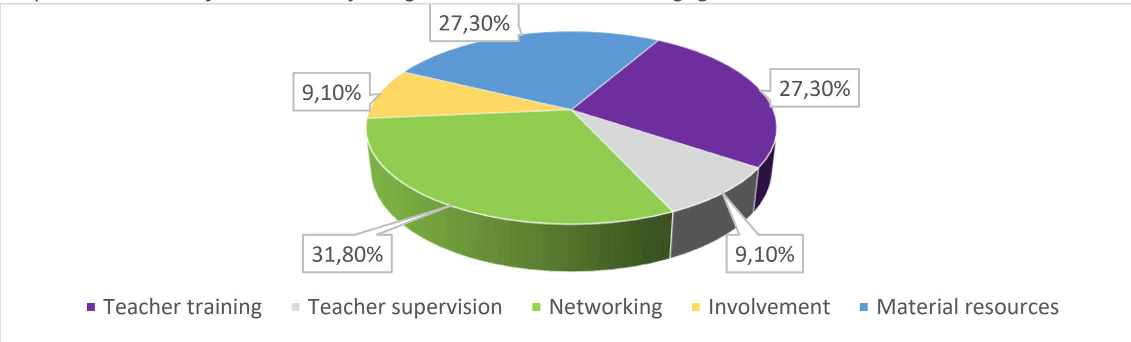
Graph 31 - Themes' distribution by macro level



4.4.1.1 Pedagogical and structural plan

The most important theme emerged by the analysis of data is the need to work on pedagogical structure and design. In particular the main focus underlined are: Networking with association, Teacher training and Teacher supervision, Material resources, and Involvement in the process. In Chart 32 there is the visual representation of the occurrence of the five categories clustered in the Pedagogical and structural plan theme.

Graph 32 - Patterns of distribution of categories clustered in the Pedagogical and structural theme



Concerning the networking between different partners, for example the participation to national and international projects such as Erasmus + project or European STEAM + project allowed the idea of setting up the EduLAB 0-6 in Budapest and reinforced the teacher's cooperation thanks to internship, visits to other services and collaboration between schools. In this frame, Gabriel Lemkow Tovias, professors at the University of Manresa, presented the Lab 0-6 and the programme to the JEB management and, the following year, prof. Lemkow held a workshop for district nursery managers and early childhood educators in Budapest at the Mini-Manó Nursery, which later was renamed in EduLAB 06. Finally, one of the nursery managers spent a month's internship in Florence and saw a similar, self-contained, one-room Discovery Lab.

Regarding the role of teachers, a deep attention was given to the dimensions of supervision and training, as shown by the chart. In HUB Milano, GiocheriaLaboratori was involved in the teacher training, the design and the supervision of the activities that were carried out in Monte San Michele school. GiocheriaLaboratori has been developing scientific laboratories for a long time, working mostly on didactics of physics. In fact, for the pilot period in Monte San Michele, Giocheria, together with the curricular teachers of the school designed laboratories on the topic of forces and balances.

The HUBs have chosen different kinds of training methodology, for example, UNIMIB, in collaboration with the Municipality of Sesto San Giovanni, has conducted a training course on inclusive education, involving 7 Comprehensive Institutes in Sesto San Giovanni. UNIMIB and GiocheriaLaboratori involved 6 state infant schools in a Professional Development Action-Research on Inclusive Science Education. UNIMIB organised a Professional Development Action-Research on Dissemination of Scientific Culture - Project “Alla scoperta degli animali robotici” (MUR 2020). GiocheriaLaboratori involved 4 State Infant School in a Teacher training on Science Education at GiocheriaLaboratori. In Brussels for the Pilot the student teacher had attended a course about STEAM and inclusion whereas in Budapest the management of the JEB organized workshops for the educators of the JEB.

Regarding the involvement in the process, it has been observed that a personal relationship can be an incentive in the activation of the policymakers in the school development. For instance, as observed by RiverLAB Valldaura school, the fact that one policymaker is also a parent of a student in the school suggests a personal connection and deeper interest in promoting a positive environment for children. This personal connection may contribute to the policymaker's dedication to addressing the specific needs and preferences of the school community. Overall, this case underscores the importance of involving various stakeholders, including children, in decision-making and adapting community initiatives to address the diverse needs of the population.

Children, girls, and educators demonstrated a high level of active and direct participation in both city council proposals and internally generated proposals. Their involvement shows a strong interest in contributing to and shaping community initiatives. Interestingly, although families' direct participation was limited, children took on the role of intermediaries. They shared the activities, discoveries, and successes resulting from their collaboration with the municipality with their families. This indirect involvement of families suggests a ripple effect, where children's enthusiasm and experiences serve as catalysts for family involvement. This dynamic shows the potential for multigenerational impact, as children's involvement not only extends the reach of community initiatives, but also fosters a sense of shared experience and participation within families. It underscores the interconnectedness of different community members and the importance of leveraging various channels to ensure broad and meaningful community involvement.

In conclusion, a final issue that emerged concerns the material resources that foster the creation of an educational environment with the help of the policy makers. In the analysis data emerge a focus on the economic resources and the physical environment. Financial support has permitted, in Budapest, the modernisation and complete furnishing of the rooms of EduLAB 0-6 in Budapest. Furthermore, the Mayor wants to support the purchase of science lab equipment in all the district's nurseries.

In Manresa the financial support from external institutions, such as funding for activities such as expert-led sessions on nurseries or visits to Lab 0-6, underscores the collaborative nature of community involvement. Timely funding from these institutions added not only valuable expertise and resources, but also expanded the scope of educational opportunities for participants. This collaborative model, in which the school takes the lead in organizing activities and external institutions contribute financial support and specialized knowledge, creates a symbiotic relationship. It allows for a more comprehensive and all-encompassing approach to community involvement, leveraging the strengths and resources of both educational and external entities. Overall, this collaborative effort improves the overall quality of activities, providing participants with a diverse range of experiences and insights that contribute to a comprehensive and enriching educational journey.

This personal participation in the pilot program seems to be a catalyst for change. It has motivated the Decision Maker, both personally and as a representative of the administration, to mobilize the necessary resources. This mobilization is aimed at fostering greater access to STEAM education by demonstrating a commitment to creating an environment that supports and encourages the exploration of science, technology, engineering, arts, and mathematics for all students, including those who may be traditionally overlooked or underrepresented.

4.4.1.2 Dissemination

Concerning the dissemination of the project and the activities, the different European partner underline the importance of the promotion policies in support of childhood through the participation to national and international projects, the definition of innovative models about education and the creation of new services.

All partners underline the use of different channels in order to promote the C4S project. In HUB Milano the two Policy Makers, Susanna Mantovani and Roberta Pizzochera, did promote the C4S project during interviews and online. Susanna Mantovani explained and promoted the participation to the project only in Bambini Bicocca whereas Roberta Pizzochera published an invitation letter, a call for participation, on the Official site of the Municipality of Sesto San Giovanni, inviting families of the Municipality of Sesto San Giovanni to take part in the scientific activities designed by GiocheriaLaboratori.

Sofia HUB published some news on Facebook and contacted external organizations in Bulgaria and discussed the project activities. Furthermore, some of the C4S project results have been presented to the scientific community at an international conference in Bulgaria. In Budapest the mayor and two deputy mayors of the district held an official lab opening, which was reported in the district press and on the district website. In Brussels, the teacher, together with the student teacher, made the documented experiences of the Pilot accessible to families through the school's digital communication channels. Further dissemination of the activities with the children was hindered because of privacy issues and ethical considerations. In summary, dissemination through various channels such as websites, social media, interviews, school channels, and district press enabled the sharing and promotion of project-related activities.

4.4.1.3 External figure participation

Involving outside professionals in the construction of inclusive learning environments proved to be a significant and multifaceted aspect for the pilot project participants, both organizationally and educationally. These collaborative efforts extended beyond mere institutional boundaries, fostering a diverse and enriching exchange of expertise.

In the city of Brussels, the pilot project unfolded with active participation from various stakeholders, each representing a unique facet of the educational landscape. The school principal of the pilot institution The Sound of Music played a pivotal role, contributing firsthand insights into the practicalities of implementing inclusive practices within the school's framework. Complementing this perspective were two professionals from a Brussels-based organization specializing in supporting vulnerable families: their nuanced understanding of diverse needs and challenges brought a holistic dimension to the project. Furthermore, adding to this collaborative tapestry were two policy members from the University Association Brussels, offering a broader institutional perspective. Their involvement not only helped align the project with overarching educational policies but also facilitated a seamless integration of the pilot initiative within the larger educational framework of the region. The educational approach was further enriched by a multidisciplinary group of lecturers, who played a crucial role in this endeavour. Simultaneously, an artist expert brought a creative touch, ensuring a thoughtful delineation of materials and a meticulous selection based on their properties. This dynamic collaboration exemplified how merging scientific and artistic perspectives can lead to a more comprehensive and engaging learning experience. The study program of the Bachelor of Education in Pre-Primary Education also assumed a pivotal role, functioning as both a sounding board and an experimental group. This close-knit team critically evaluated the development of the STEAM approach, providing constructive feedback and ensuring its alignment with the educational goals of pre-primary education.

Meanwhile, in Bambini Bicocca Infanti School, the commitment to fostering inclusive learning extended to the design of naturalistic laboratories. Drawing inspiration from methodologies proposed by two specialists in scientific themes from the University of Milano Bicocca, the school created an environment that not only catered to diverse learning styles but also promoted a deep and meaningful exploration of scientific concepts. In summary, the collaboration with outside professionals brought a richness and depth to the construction of inclusive learning environments. The varied perspectives, ranging from the practical insights of school administrators to the creative inputs of artists and the academic rigor of STEM experts, collectively contributed to a holistic and inclusive educational experience.

4.4.2 Inclusive Science Education

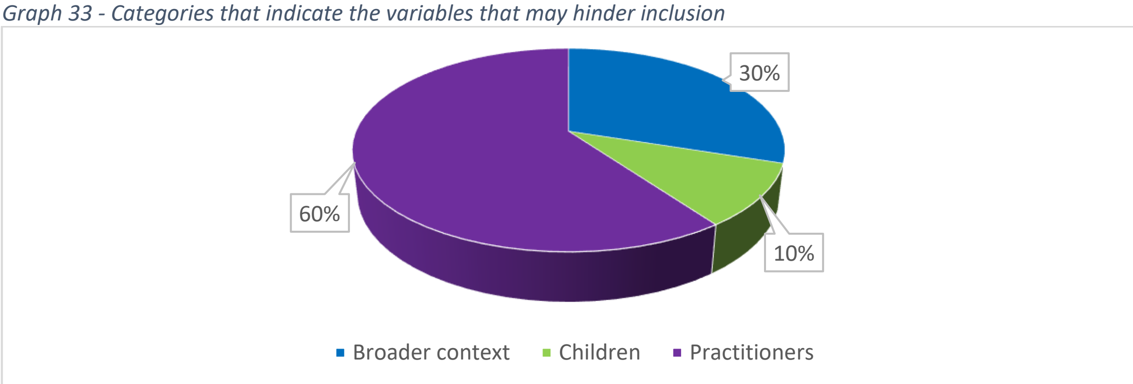
In the following section, barriers to inclusion in science education will be examined along with an exploration of strategies put in place to overcome these barriers at the macro system level. This discussion is intended to illuminate the challenges encountered and the solutions that can be put in place to promote inclusiveness in science education. There is a general awareness among policy makers and stakeholders in most cities about the factors contributing to the vulnerability of certain groups. Initiatives and projects are implemented to address these factors, ranging from inclusive practices in kindergartens to specific programs for vulnerable populations. Challenges include institutional setting barriers, resistance to certain educational approaches, and limitations on time and space for in-depth discussions. There is evidence of policies promoting inclusion, active organization, and support for inclusive initiatives across various cities. Challenges in promoting certain educational approaches, institutional setting barriers, and a need for redefining the education model are highlighted in some cases. All partners emphasized elements that hinder inclusion and others that are considered facilitating.

4.4.2.1. Hindering inclusion

In this conceptual framework, on the topic of variables that may hinder inclusion in science education according to policymakers and stakeholders, three themes have emerged:

1. **(theme) Practitioners**, at 60% this theme has the highest presence and indicates the barriers regarding the relationship with teachers.
2. **(theme) Broader context**, at 30% it indicates the variables that may hinder inclusion and that are intrinsically related to the institutional setting.
3. **(theme) Children**, lastly with an occurrence of 10%, it indicates the policy maker's opinion regarding the hardship that children encounter during their educational path.

Graph 33 - Categories that indicate the variables that may hinder inclusion



As seen by the chart, one of the most frequent barriers according to policymakers and stakeholders is the broader community context, the social environment where children, families and practitioners are situated. Important variables such as economic issues, lack of workforce, and lack of proper spaces have been observed. For instance, some partners pointed out some issues that hinder the creation of an educational environment with the help of the surrounding community and policy makers, such as the shortage of staff in schools and an educational system that is not available to face new challenges as stated various time by Vienna's Pilot Garden4Sciences. Furthermore, one of the school principals taking part in the project, when asked if the school can support community participation in Science Education, she makes it clear that the school does not have the "resources" to build such participation. Moreover, she thinks the current education system is not ready for this. She refers to initiatives she has seen abroad: working with bridge figures, underprivileged parents who are trained to support in the classroom, or a guidance person who works with children throughout their school career to support their social emotional development.

These structural contextual barriers can impact the practitioner's sphere: on this regard, the council's policy of Manresa states that there is a glaring lack of scientific knowledge in our society, especially among individuals, including preschool teachers, many of whom have not studied science since their secondary education. The limitations are exacerbated by the fact that some educators themselves struggle with scientific concepts, with varying degrees of interest and competence. While some educators show genuine curiosity and seek to improve their understanding, others face challenges in effectively conveying scientific knowledge.

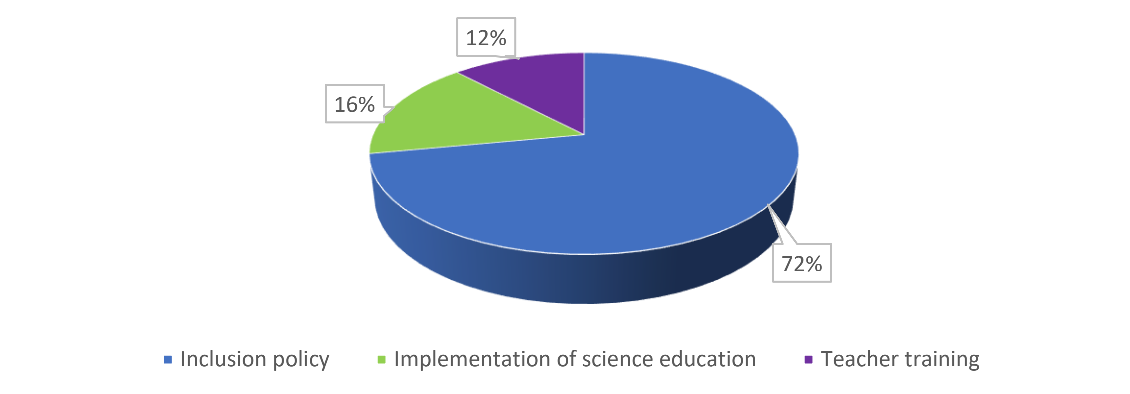
In conclusion, some variables have been observed at the personal level of the children: in Sofia Policy makers and stakeholders are aware of the barriers faced by Roma children in education, such as language and trust in teacher issues. The HESED Foundation addresses these barriers through inclusive practices in their kindergartens, including language immersion and building trust. The C4S project specifically tackles barriers related to scientific content and competence. Policy makers in Budapest are aware of the different factors that can impact vulnerable groups and so specific programs and initiatives have been set up, such as free programs for nurseries, kindergartens, and schools to address these factors. In Brussels studies, publications, and support services are in place to address vulnerability, and collaborations between education and welfare sectors are increasing.

4.4.2.2. Supporting inclusion

Regarding, the different factors that may support inclusion the following themes have been coded (Chart 34):

1. **(theme) Inclusion policy**, with a frequency of 72%, the Inclusion policy theme indicates the development of approaches, services, and resources to foster inclusive practices and environments.
2. **(theme) Implementation of science education**, at 16% this theme clusters the actions of development and promotions of science education policies.
3. **(theme) Teacher training**, lastly at 12% the teacher training theme indicates the importance of providing adequate training to staff involved in the project.

Graph 34 - Variables that support inclusion according to Policy makers and stakeholders



The support from policy makers and stakeholders is realized through the implementation of Inclusion policy, the participation to projects to foster the interaction between different fields of expertise and investing in teacher training. Initiatives in the field of Science Education and Inclusive projects are considered supporting actions. For example, in Sofia HUB, NGOs focus on inclusion, particularly for Roma children, emphasizing language and social skills whereas Bulgarian Ministry of Education runs programs for STEAM centres in mainstream schools. UVIC HUB underlines that management coordinated with municipal resources to implement projects and determine significant groups for assistance. In Budapest inclusive Kindergartens program promotes complex early childhood development and social integration and continuous professional development for teachers in various areas of inclusion. In Brussels, Primary schools, including the Pilot school, have inclusion policies and take part in initiatives like the Erasmus+ project. Flemish Parliament and Ministry of Education incentivize STEAM education for girls and the Brussels Education Centre supports Dutch-speaking education, emphasizing STEAM and Lego Education. Bambini Bicocca (HUB Milano) participates in projects promoting science education and inclusive initiatives, such as educational robotics, archaeology, and biology workshops.

It has been observed that support to inclusion can be also done through the implementation of free of charge science educational programmes. However, even if it is highly recommendable, organizing free of charge activities that can support inclusion even of families that lack the economic power to participate is a challenging endeavour since, as observed by the different pilots there is a lack of funds. Parents have expressed the desire to see GiocheriaLaboratori, a science centre for children, open on a daily basis, however, as stated by the assessor Pizzochera there's need for a better funding system.

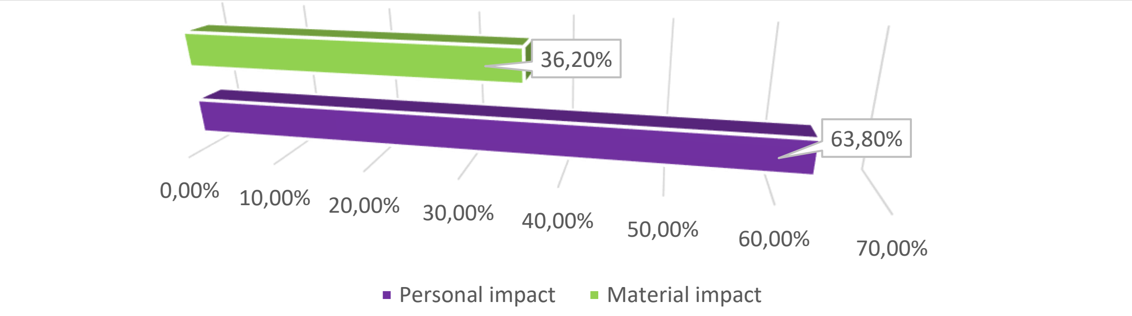
Lastly, to support inclusion, it has been observed that giving teachers the proper training on the topic of inclusive science education is a winning strategy. Providing teachers with training may lead to an increase in the understanding of diversity among children, not only diversity conceptualized as ethnic, cultural, social diversity, but as diversity in the learning teaching methods that everyone has. Allowing thus for a better adaption of the curricula to the individual needs of everyone. Leading to an ongoing professional and personal development.

4.4.3 Short term impact

In this chapter are summaries of the outcomes and satisfactions, as well as responses to the specific questions regarding the awareness and sensibility for STEAM and inclusive issues, the specific documents regarding inclusive science education, the social involvement and the training courses. Through the analysis of the different data sets shared by the partners, it was possible to identify two team regarding the short-term impact according to policymakers and stakeholders:

1. **(theme) Personal impact**, with a frequency of 63.8%, policymakers support the idea that inclusive science education may lead to an increased awareness and sensitivity to dimensions involving science and inclusion.
2. **(theme) Material impact**, at 36.2% it has been observed that the pilot realities have been equipped with new materials and there was also an increase in the drafting dissemination and promotion documents.

Graph 35 - themes of the short-term impact according to policymakers and stakeholders



Concerning the awareness and sensibility for STEAM & Inclusive Issues for example SOFIA HUB developed teachers' awareness and sensibility towards inclusive STEAM education. It noticed increased interest and curiosity about science in children. Also, in Budapest early childhood educators demonstrated a greater sensitivity to the topic, and awareness increased progressively. Growing interest not only among teachers but also children and families.

In Sesto San Giovanni (HUB Milano) limited awareness and sensibility for STEAM and inclusive issues, as indicated by the Policy Maker. Some activities like the Hydroponic greenhouse showed efforts, but overall, not much emphasis on STEAM education. UVIC affirmed a sensibility for STEAM and inclusive issues. In Vienna teacher workshops and science activities raised awareness for STEAM & Inclusive Science Education (ISE) on both cross-district and city levels. Brussels HUB emphasized awareness of inclusive issues and STEM/STEAM importance. Acknowledged the distinction between STEM and STEAM but highlighted the significance of a basic scientific attitude. The experience carried out in Manresa finally allowed not only the transmission of knowledge, but also the encouragement of even deeper connection and greater ecological awareness of the local environment. Participants are likely to develop a more ecologically informed and aware perspective through these educational experiences carried out. A greater focus on environmental education has developed, particularly regarding biodiversity, knowledge of local flora and fauna and invasive species, and finally, ecological interactions among living things.

Regarding the realization of specific documents regarding science education and inclusive education Sofia HUB generated articles describing the experience in inclusive science education, results to be included in a White Book and research report. Vienna generated comprehensive material for practitioners through the CLL, including folders and posters available to the public. In Budapest there aren't specific documents yet, but workshops for early childhood professionals have been organized, and plans to write and publish a publication are underway whereas in Brussels various texts and materials have been produced during the training program, and a STEAM curriculum refined based on Pilot insights.

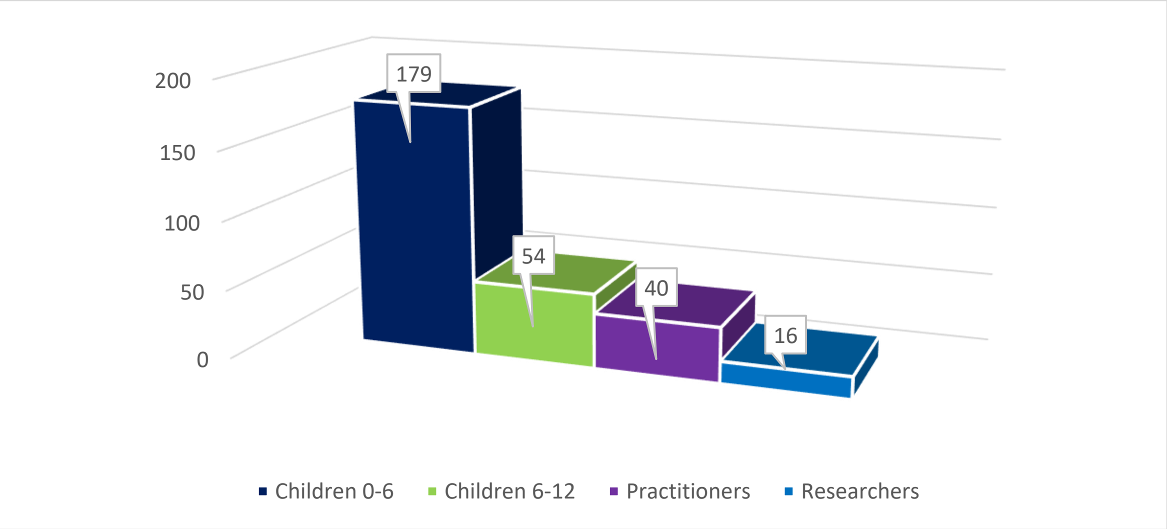
Concerning the social involvement, no significant social involvement has been mentioned by the partner, apart from the Budapest HUB which underline that the outdoor programs reached a significant number of families, particularly from the target group. In Brussels there was an engagement with migrant families in discussions on Science and Scienceful play and initiatives to open Wonder Lab to such interactions. Finally concerning the training courses different partners have underlined the important role of training in developing inclusive science education. For example, in HESED kindergartens teachers improved the design of educational activities. In HUB Milano institutions have been involved in designing science education training courses, especially with GiocheriaLaboratori's participation. In Budapest science education training have been designed for kindergarten teachers in the 8th district whereas in Brussels the study program developed a STEAM framework, which is explored and applied in various courses and projects. In summary, there seems to be varying degrees of awareness and sensibility for STEAM and inclusive issues across the mentioned organizations, with some actively contributing to the development of training materials and initiatives. Social involvement and the impact on policy or stakeholders' institutions also differ among the entities involved in the projects.

4.5 Potential Social Transferability

The last objective of the C4S project is to grasp the degree to which the results of the research project could be applicable to other contexts, situations, populations, and times. More precisely, in the present chapter it is aimed to share if, and to what extend the scientific activities carried out through the eight different Pilot periods could be adapted to other contexts.

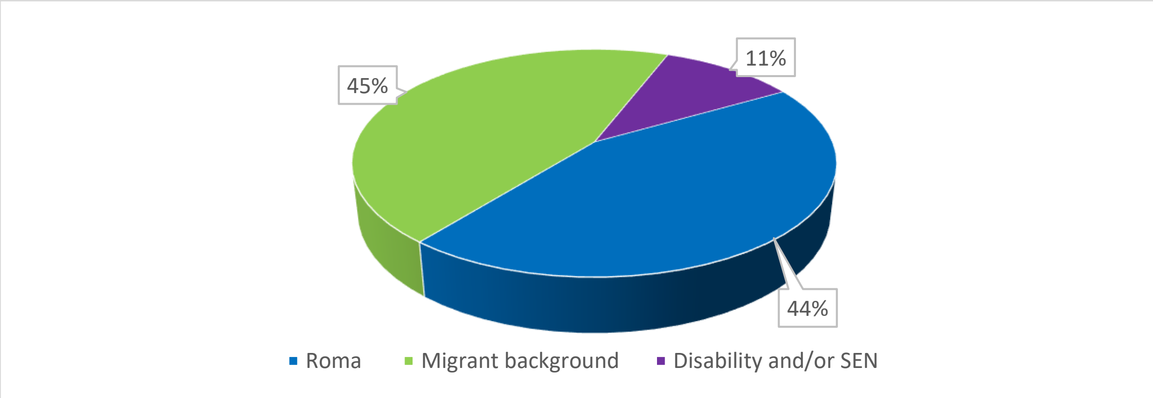
In first instance, the project engaged in a significant numerical involvement, encompassing a diverse range of participants representing various social groups and backgrounds. A total of 289 individuals were involved in the project: 233 were children, 179 of whom were aged 0-6 and 54 were aged 6-12; 40 were practitioners; 16 were researchers (see Chart 36). The inclusion of individuals from different social, legislative, and educational contexts implies a comprehensive approach that transcends traditional boundaries, suggesting that the pilot activities might be replicable in other European contexts but not exclusively in this context.

Chart 36 - Number of participants



Out of the 233 children 45% had a migrant background, 11% had disabilities or special educational need and 44% were from Roma community (see Chart 37).

Chart 37 - Vulnerable group participants in percentage



Furthermore, in the above-mentioned numbers have only been considered the participants who've been directly involved in the pilot activities; the extend of the indirectly involved figures, such as parents, siblings, cousins, friends, external experts, university professors, policy makers and stakeholders is hardly quantifiable. The high level of involvement from a variety of perspectives and roles suggests a rich ecosystem surrounding the project. This interconnected web of relationships, encompassing both direct and indirect participants, strengthens the project's potential for social transferability; the diverse range of individuals indirectly impacted by the project implies a broader resonance and applicability of its findings in different social contexts. In Table 2 it is possible to see a schematical representation of the extend of involvement of each HUB.

Table 2 - Schematic presentation of the HUBs

HUB	Pilot site	N° laboratories	N° Children	Age Children	N° practitioners	N° Researchers
HUB Sofia	HESED Kindergarten	32	71	3-5	10	3
Milano HUB	Infant school Bambini Bicocca	32	19	3-6	2	3
	Infant school Monte San Michele	43	26	4-6	4	
HUB Manresa-Vic	RiverLAB Valldaura School	12	17	3-6	2	3
	Dominiques school	10	28	10-11	6	2
	ESTEL	2	8	10-11	2	
HUB Vienna	Garden4Sciences	6	18	9-12	2	1
Budapest HUB	EduLAB 0-6	4	27	0-3	10	2
HUB Brussels	The Sound of Music	9	19	5-6	2	2

In second instance, it is important to acknowledge the fact that each reality of the C4S project is unique and diverse: countries have different political, cultural, and educational systems. This uniqueness though serves as a strength because it allowed for better understanding of the potential social transference. Thanks to the cross-country thematic analysis it was possible to identify some common results between the different pilot realities and some patterns that may suggest this potential data transferability. As seen in the previous chapters despite the inherent differences among the research has unearthed surprising similarities, such as the importance of the type of materials in inclusive science education, the involvement of different social actors in the activities or the style of management of the activities carried out by the practitioners.

In conclusion, the sheer diversity in the contexts, spatial realities, and social landscapes in which the C4S project was conducted, along with the engagement with various target groups, has yielded a comprehensive dataset inclusive of numerous facets. These aspects contribute to the project's potential for social transferability, opening avenues for the application of its insights in various social, cultural, and educational settings.

Conclusions

In conclusion, the C4S project reflects a collective commitment to advancing inclusive science education on a global scale, building a robust dialogue between the domains of inclusive pedagogy, which by definition excludes no one from education (Stinken-Rösner et al., 2020) and science education. Given that the necessity for inclusive practices in ordinary classrooms is widely acknowledged globally (Koomen, 2016; Asghar et al., 2017; Reynaga-Peña & Sandoval-Ríos, 2018), the C4S project aimed to contribute to the present issue both from a theoretical perspective, enriching the scientific debate with new results, hypotheses and publications (see Annex, publication section), and from an empirical perspective, by ensuring science education for all.

From the Sofia's HESED Kindergarten's engagement with Roma communities to the specialized inclusive science laboratories at Infant School Bambini Bicocca and Infant School Monte San Michele, each pilot site demonstrates a tailored approach to addressing unique challenges and fostering scientific skills across diverse populations. These initiatives, inspired by reflective practices within the classroom and hands-on experienced learning activities, as advocated by Pennazio (2015), involved girls and boy belonging to different *vulnerabilized* communities, such as the Roma community, in Sofia and in Budapest, the migrant community in Manresa, in Vienna and in Brussels, and the community of people with special educational needs and disability, pondering as well on the importance of intersectionality in promoting inclusive education.

The integration of 3D printing laboratories at Dominiques school and ESTEL school not only expands technological competencies but also showcases the potential for cross-disciplinary learning, fostering empathy and a sense of carrying towards the others. The Riverlab Valldaura School's focus on nature-based science in a complex setting with migrant communities highlights innovative ways in which inclusion can be achieved through hands-on, real-world experiences, resonating with the eco-justice pedagogy in environmental sciences (Djonko-Moor et al., 2018). The topic of environmental sciences was reprised in Vienna HUB's Garden4Sciences pilot, while working in outdoor settings in the effort to advocate for more sustainable education, more responsible children who care for nature and grow their own crops.

Budapest's EduLAB 0-6 pilot exemplifies the importance of context-specific strategies, particularly for children from migrant and Roma backgrounds. These initiatives extend beyond traditional classroom boundaries, implementing inclusive science education both inside and outside formal educational settings: understanding the needs of parents, where they meet, how and when they gather, helps creating an inclusive environment which invites families form different communities to participate in scientific activities.

Notably, HUB Brussels' Sound of Music pilot introduces the harmonious integration of inclusive science education and the arts, suggesting that interdisciplinary approaches can further enrich the learning experience, as strongly reported by the practitioners of the pilot. Such tailored approaches acknowledge the diversity of learners and the need for nuanced pedagogical methods.

In conclusion, the C4S pilot projects, emphasizing the emotional dimension and the need for a more comprehensive inclusive science education perspective, collectively contribute valuable insights and strategies on this still to be mastered phenomenon. These initiatives address existing gaps and actively shape a more inclusive, accessible, and equitable future for science education globally, with the purpose not to create scientist from everyone, but to give everyone the needed tools to thrive in the modern society. By building on the lessons learned from these pilots, the broader field of science education can move toward a more comprehensive, responsive, and inclusive paradigm, ensuring that all learners, regardless of background or ability, can fully participate and thrive in the realm of scientific discovery.

References

Asghar A., Sladeczek I.E., Mercier J., Beaudoin, E. (2017). Learning in science, technology, engineering, and mathematics: Supporting students with learning disabilities. *Canadian Psychology/Psychologie canadienne*, 58(3), 238–249.

Brauns S., Abels S. (2020). The Framework for Inclusive Science Education. Inclusive science education, Working Paper, n. 1/2020*, Leuphana University Luneburg, Science Education, Inclusive Science Education* (ISSN 2701-3766).

Bronfenbrenner, U. (1979). *The Ecology of Human Development. Experiments by Nature and Design*. Harvard: Harvard University press.

Djonko-Moore, C. M., Leonard, J., Holifield, Q., Bailey, E. B., Almughyirah, S. M. (2018). Using Culturally Relevant Experiential Education to Enhance Urban Children's Knowledge and Engagement in Science. *Journal of Experiential Education*, 41:2, 137-153.

Du Plessis, A. E. (2020). The Lived Experience of Out-of-field STEM Teachers: a Quandary for Strategising Quality Teaching in STEM? *Research in Science Education*, 50:4, 1465-1499.

Kahn S., Pigman R., Ottley J. (2017). A Tale of Two Courses: Exploring Teacher Candidates' Translation of Scienceand Special Education Methods Instruction Into Inclusive Science Practices. *Journal of Science Education for Students with Disabilities*, 20:1, 50-68.

Koomen M. (2016). Inclusive science education: learning from Wizard. *Cultural Studies of Science Education,* 11, 293–325.

Koomen M., Kahn S., Atchison C.L., (Eds.) (2018). *Towards Inclusion of All Learners through Science Teacher Education*. Brill Academic Publishers: Leida.

La Force, M., Zuo, H., Ferris, K. & Noble, E. (2019). Revisiting Race and Gender Differences in STEM: Can Inclusive STEM High Schools Reduce Gaps? *European Journal of STEM Education*, 4(1), 08.

Lochmiller, C. R. (2021). Conducting Thematic Analysis with Qualitative Data. The Qualitative Report, 26(6), 2029-2044.

Markic S., Abels S. (Eds.) (2016). *Science Education towards Inclusion. Science Education towards Inclusion.* Nova Science Publishers: New York.

Mitchell, D. (2014). *What really works in special and inclusive education. Using evidence-based strategies.* London: Routledge.

Nasri, N., Rahimi, N.M., Talib, M.A.A. (2021). A Comparison Study between Universal Design for Learning-Multiple Intelligence (UDL-MI) Oriented STEM Program and Traditional STEM Program for Inclusive Education. *Sustainability*, 13:2, 536-554.

Pennazio V. (2015). Disabilità, gioco e robotica nella scuola dell'infanzia. *Italian Journal of Educational Technology*, 23(3), 155-163.

Reynaga-Peña C.G., Sandoval-Ríos M., Torres-Frías J., et. al., (2018). Creating a dialogic environment for transformative science teaching practices: towards an inclusive education for science. *Journal of Education for Teaching*, 44:1, 44-57.

Stake, R.E. (1994). Case studies. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 236-247), Thousand Oaks: SAGE Publications.

Stake, R.E. (2006). *Multiple Case Study Analysis*. New York: The Guilford Press.

Tang Wee T. (2021). A Survey of Science Teachers' Perception and Practices in Inclusive Science Classrooms. *Asia-Pacific Science Education*, 6:2, 388-426.

Yin, R.K. (2014). *Case study research: Design and methods*. Thousand Oaks: SAGE Publications, 5th ed.

Annex

Coding tables

Name	Description	Example
(RQ1) MICRO - CLL co-creation		
1. (theme) External figures participation	Different levels of participation of external figures	
1.1 Artists involvement	Involvement on different levels of artists	he organised an activity for our Pilot with an African descend artist.
1.2 Family & friends involvement	Involvement on different levels of families and/or friends in the pilot	The third activity was organized by one of the parents of the class.
1.3 Policy makers involvement	Involvement on different levels of policy makers or stakeholders in the pilot	promising connection is with the Chairman of the Autrian Roma community.
1.4 Psychologists involvement	Involvement on different levels of psychologist in the pilot	This extra activity was executed with the kind help of the psychologists.
1.5 Role models	Involvement on different levels of role models from different vulnerable communities	manager of the Sure Start Children's House were the referrers representing the vulnerable community, both of Roma origin.
1.6 Special needs teacher	Involvement on different levels of special needs teachers, such as communication assistants	A special need teacher was also involved.
1.7 Student teachers involvement	Involvement on different levels of student teachers	SM, student teacher, designed and proposed the activities.
1.8 Natural scientist involvement	Involvement on different levels of natural scientist, such as biologist, zoologist…	practitioners is a biologist and gardener.
2. (theme) Methodological approach		
2.1 Activities design	Practical implementation of the activity: length; what they have done;	
2.1.1 Input	From where to start to design an activity. What is the reason we	starting with the interest some children showed in plants, the children and

Name	Description	Example
	decide to do this activity	SM worked on plant growth
2.1.2 Location	Where did the activities take place	Indoor activities in the lab
2.1.3 Materials	What type of materials were used? Deconstructed materials (natural/recycled) or structured materials	the use of "recycle unusual materials"
2.1.4 Teaching condition management	Respecting individual learning styles, by using different supports, and/or respecting individual learning time	During those initial moments, the practitioner was working as a guide, stimulating children's participation by asking guided questions
2.1.5 Setting	Design of the setting, way of placement of materials	A specific place for the material was provided to which the children had free access.
2.1.6 Tools	Type of tools used to carry out the activity	magnifying glass; torches
2.2 Aim of the activities	The developmental aim of the activity	Language development
2.3 Products	Craftwork created by children, families and/or practitioners	Booklet with the trees
2.4 Topic of activities	Arts; biology; ethology; geology; human body; materials sciences; mathematics; palaeontology; physics	mathematics (e.g., weights, quantities, sizes, measurement
2.5 Type of activities	Unguided exploration; classification; test	material classification: Children were asked to group the materials
3. (theme) Dissemination	Communication of the project: being through research, family meeting or children communication	
3.1 Children dissemination	Children communicate what they have done/learned	The children were also always motivated to show their results to their parents and friends at home.
3.2 Dissemination event	Events to showcase what it has been done	performances within each group and for the parents
3.3 Documentation for families	Pedagogical documentation	Those photos and recordings were translated into presentations to share with the families
3.4 Practitioners' dissemination	Involving teaching, workshops, poster...	The educators make the proposal to exchange the discoveries with other schools in the city connected to HUB Manresa in the C4S.

Name	Description	Example
4. (theme) Pedagogical structure & plan	Structure of the educational centre, institutional project and design.	
4.1 Interdisciplinary team	Engaging with different figures	teachers, the tutors, the support educators and the psycho-pedagogist
4.2 Networking between associations	Creating relationship with different associations	cooperation between DOMINIQUES school with the ESTEL school
4.3 Teacher supervision	Supervising practitioners during the activities	A safe and open space for sharing between teachers was created.
4.4 Teacher training	Giving the proper training in the decided topic	Training Course on Inclusive Teaching at UNIMIB
(RQ2) MICRO - Inclusive science education		
HINDERING INCLUSION		
Children		
1. (theme) Language	Difficulty in expressing themselves, due to a disability or a lack of language proficiency	Not all children have the necessary skills to do this: among other things; speaking skills are lacking, language skills are missing, some children need more time to share their knowledge.
2. (theme) Motricity	Difficulty in the motor abilities	The person with disabilities had very visible movement barriers when walking, also when speaking and seeing, these barriers were mostly overcome thanks to the support of the teachers.
Practitioners		
1. (theme) Emotional and relational domain	Inability to manage emotions and relations in the group	the student teacher herself did not have insight on how to further guide the process.
2. (theme) Pedagogical domain	Not proper setting of materials, space and tools	some conflicts occurred concerning the sharing of materials
3. (theme) Pedagogical structure and plans		staff shortages during the pandemic,
SUPPORTING INCLUSION		

Name	Description	Example
Children		
1. (theme) Emotional domain	Positive emotions between peers and peers and adults	The relational climate in the 3 groups was positive, warm and welcoming. The children were active, engaged and interested in the ongoing activities. They smiled a lot, stand physically closed and respected the turn-taking.
2. (theme) Relational domain	Positive relations between peers and peers and adults	When there is a small crisis, fear of dogs, ants or a wasp sting, the entire group comes together in solidarity to support the affected person, trying to provide solutions and help.
Practitioners		
1. (theme) Emotional domain		
1.1 Positive attitudes	Showing positive emotions, such as smiling face, warm proximity	she spoke in a pleasantly calm voice, was open for the children: asked open-ended questions, gave suggestions without being directive, paraphrased children who did not come out in their words, sat close between the children at eye level and looked at the children she was talking to.
1.2 Positive engagement with STEAM	Being willing and interested in carrying out the STEAM activities	teachers show the motivation to keep using STEAM activities at they daily practice.
2. (theme) Pedagogical intervention		
2.1 Learning condition management	Ability to differentiate pedagogical and teaching-and-learning interventions, promoting inclusion and participation and respecting times and learning styles of each individual.	children were able to learn in their own term and way, notions about balances and forces
2.2 Pedagogical Style		
2.2.1 Associative - Pedagogical style	ASS, the teacher makes interventions that respond in a syntonic and coherent way to the children's proposals and answers, does not evaluate them but asks questions to understand from the	the practitioner was working as a guide, stimulating children’s participation by asking guided questions

Name	Description	Example
	children their learning process	
2.2.2 Incentive - Pedagogical style	INC, the teacher poses problems, open questions involving free exploration and creativity on the part of the children. There is no one-size-fits-all answer and the teacher's manner is not directive	she gave free space to children, specially at the beginning of the pilot, so they could explore the materials freely and become familiar with the materials and the tools.
2.3 Practical management		
2.3.1 Input	Activity designed because of Children's interest, Children needs, Surroundings, Children's representation	The classroom environment was adapted or adjusted based on the needs of the children
2.3.2 Managing time_space_group	Designing the space based on the needs/the interest of the children. Designing the space in a way that even when children are not participating in the activity they are still focusing on the topic and are still learning	working in small groups allowed the children greater participation than in the large group, as everyone could work at their own pace, compare and relate to their peers, allowing more opportunities for integration of ideas
2.3.3 Tools & Materials	How can the materials and the tools help with inclusion?	unconventional materials and artful impressions stimulated the children to creative play and investigation
3. (theme) Relational domain	The ability to manage the relationships between and with peers in order to create a more inclusive environment	There were positive interactions between children. Most of the time the early childhood educator mediated these interactions.
4. (theme) Practitioner training		
4.1 Practitioners training	Training teachers on the topic of inclusion	Teachers were trained, supervised and supported in their attempts to implement child participation during their regular science lessons.
4.2 Networking	Teachers creating network to achieve inclusion	The teacher is therefore asking to collaborate with our University College to make use of the creative spaces and materials available there and focus more on in-depth research.
4.3 Role models	Engaging with role models from the targeted community	In Sofia CLL part took children from the Roma community, assistant teachers from the Roma community and teachers of Bulgarian origin.
(RQ3) MICRO - Impact		

Name	Description	Example
1. **(theme) Personal impact**		
Children	New knowledge, new skills, new words acquired by children.	An increase in Bulgarian language abilities has been observed.
Practitioners	New knowledge, new skills, new methodologies acquired by practitioners	Practitioners have acquired new skills regarding inclusion.
2. (theme) Material impact	New school materials acquired	New materials have been acquired by the school.
3. (theme) Relational impact	Better relationship environment between peers, and teacher and peers	
3.1 Children Behaviour	Improvement in children social and emotional skills	An increase frequency of emotional and relational categories has been observed between the sessions.
4. (theme) Methodological impact	New ways of teaching-learning	Teachers were involved in training programmes organized by GiocheriaLaboratori
5. (theme) Personal Percetion Impact		
(RQ1) MESO - CLL co-creation		
1. (theme) Family involvement	Involving families to co-create sustainable educational environments	
1.1 Aim	What is the aim of the designed activity?	strengthening parental competence, to give parents the opportunity to play with their children in a relaxed, free environment, without being disturbed by other tasks (e.g. household chores).
1.2 Location	Where has been the activity carried out?	Parental involvement occurred in a private setting where they jointly cared for and watered the plants with their children, both on weekends and during holidays.
1.3 Type	What type of activity was?	Saturday afternoon and all outdoor initiatives target families.
2. (theme) Achieving family involvement		

Name	Description	Example
2.1 Obstacles	Obstacles that don't allow parent's involvement	COVID measures where parents were denied access to the school
2.2 Strategies	Strategies to overcome the obstacles of inclusion	A relationship of trust with the families is necessary to achieve valuable conversations. We used pedagogical documentation materials to get the families to talk
3. (theme) Children as teachers	Children sharing knowledge and showing what they have done and/or how have they done it	Often children were spontaneously showing their parents how to work with the materials (for ex. how to assemble a puzzle).
4. (theme) Science activities		
4.1 Families' awareness	Being aware of the different science activities proposed in your community	Families are aware of the activities offered by GiocheriaLaboratori
4.2 Families' perception	Families idea of how the scientific laboratories have been caried out	The parents found the activities very interesting for the children. They are proud of the results of their children.
(RQ2) MESO - Inclusive science education		
1. (theme) Barriers and facilitators to participation		
HINDERING INCLUSIONE		
1.1 Parent's opposition	Parents not willing to let their children participate	During the pilot some parents have showed to be un-interested
1.2 Covid-19	Covid restriction not allowing participation	Families weren't allowed to visit the school during Covid, even after, when the restrictions felled, parents were still afraid to come to school.
1.3 Language barriers	Inability to speak the language of the larger community	Families don't understand the communications of the schools since they don't speak the language.
SUPPORTING INCLUSIONE		
1.4 Setting	The importance of designing an inclusive setting	A citation from one parent "*it is essential to have a setting that invites children to participate…*"

Name	Description	Example
1.5 Parents school relationship	Nurturing parents-school relationship	the Pilot teacher hopes that these meetings will bring teachers and families closer together in the future.
1.6 Socio-economical support	Supporting families by helping out economically or organizing free services	Families should be helped because not all of them can afford sending their children to private centres
2. (Theme) Vulnerability factors		
2.1 Work and family time balance	Finding it hard to manage their child educational path due to work	Parents have stated that they're not aware of the different scientific activities proposed by the surrounding associations, due to the fact that they have to work for long hours, or far from home and have to commute
2.2 Social inequality	Starting form a position of potential vulnerability due to the lack of position in the "social class"	Additionally, family participation is contingent on various factors, including the parents' level of formal education, socioeconomic status, and the amount of available time they can dedicate.
2.3 Communication barriers	Finding it difficult to speak with their children due to language and cultural barriers	Second generation migrant children struggle to communicate with their families due to the fact that they sometimes don't speak well a common language
3. (theme) Meaning of ISE		
3.1 Same opportunities for everyone	Parents believe that to support inclusion same opportunities for everyone should be given	Not all children have similar opportunities, some families can bring their children to visit museums, but others have economical barriers
3.2 Explorative behaviour	Parents believe that to support inclusion it is important to develop an explorative behaviour in children	One parent state during the focus group that she's seen a change in the way her child observes the world, making him more interested in science
3.3 Attention to the individual	It is important to acknowledge the individuality of everyone in order to create an inclusive environment	Not one fits all activities.
(RQ3) MESO - Impact		
1. (theme) Personal impact		

Name	Description	Example
1.1 Cognitive impact	Parents have learned something new, or they've seen that their children have learned something new.	Some families have emphasized an increased search by children for answers to questions about the workings of the world and existence.
1.2 Motricity impact	Parents have observed a growth in their children's motricity abilities	Yes they have, they've seen improvement in the motricity
1.3 Emotional impact	Parents have observed a change, or have experienced a change in their or their children's emotional abilities	One mother stated that her child is now better at following the house rules
2. (theme) Community impact	The impact of the scientific activities on the larger community	we have received information indicating a significant shift in the children's relationship with the river and its surroundings.
(RQ1) MACRO - CLL co-creation		
1. (theme) External figures participation	The involvement of external figures into the project	
1.1 Multidisciplinary groups	Participation of groups composed of people with different skills	The study programme is developing and implementing a STEAM approach with the help of a multidisciplinary group
1.2 STEAM experts	Participation of experts in STEAM education	The STEAM expert helped us with STEAM concepts and possible phenomena
1.3 Artists involvement	Involvement of artist into the project	The artist expert helped us with a more thoughtful delineation of materials
2. (theme) Dissemination	Communication of the project: being through research, policies in support of childhood and dissemination of informations	
2.1 Channels of communication	channels used for communication	The two policy makers involved did promote the C4S project during interviews and online
2.2 Policies in support of childhood	Actions in support of education about childhood	She has dedicated her life to promoting culture, services and policies in support of childhood
2.3 Obstacles	Considerations and issues that have proven to be an obstacle to dissemination	Further dissemination of the activities with the children was hindered because of privacy issues and ethical considerations

Name	Description	Example
3. (theme) Pedagogical and structural plan	Structure of relationships between stakeholders, institutional project, and activated resources	
3.1 Networking between associations	Development of knowledge relationships and involvement in the project of different partners	The idea of setting up the lab was born in the management of JEB in the context of an Erasmus project
3.2 Teacher supervision	Supervise operators during activities	GiocheriaLaboratori was engaged in the supervision of the activities proposed during the Pilot
3.3 Teacher Training	Provide adequate training to staff involved in the project	The teacher had attended a course about STEAM and inclusion
3.4 Material resources	Economic and material resources	The modernisation and complete furnishing of the room started with the financial support of the Municipality
3.5 Involvement in the process	Involvement in planning and organizing activities	The Hesed Foundation was very actively involved in the entire process
RQ2) MACRO - Inclusive science education		
HINDERING INCLUSION		
1. (theme) Broader context	Institutional barriers	There are institutional setting barriers
2. (theme) Children	Children difficulties	Two of the main barriers to the education of Roma children in Bulgari are language and trust in teachers
3. (theme) Practitioners	Barriers regarding the relationship with practitioners	The methodological basket includes training imed at strengthening and developing areas of inclusion
SUPPORTING INCLUSION		
1. (theme) Teacher training	Provide adequate training to staff involved in the project	The school is actively engaged in the creation of scientific laboratories that are inclusive for all the children of the school
2. (theme) Inclusion policy	Development of approaches, services, and resources to foster inclusive practices and environments	The centre promotes STEM education
3. (theme) Implementation of science	Development and promotions of science education	

Name	Description	Example
education		
(RQ3) MACRO – Impact		We developed teachers'awareness and sensibility towards inclusive STEAM education
1. (theme) Personal impact	Increased awareness and sensitivity to dimensions involving science and inclusion	Based on our work we have generated articles, describing our experience in inclusive science education.
2. (theme) Material impact	Equipping new materials and drafting dissemination and promotion documents	

Publications

Type of activity	Partner	Title	Date	Place
Participation to a conference	EhB	2nd International Conference of the Journal "Scuola Democratica" - 'How to Steamify a Student; Brussels Style!'	jun-21	online
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2021). "Amistat (i Esfera pública) en temps digitals" (article d'opinió). *Social.cat*.	mag-21	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. (Coord) (2022). Journal Monograph "Educació Científica Inclusiva". *Guix d'infantil*. n. 114	mag-22	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. (Coord) (2022). Journal Monograph "Educació Científica Inclusiva". *Aula de infantil*. n. 114	mag-22	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Oliveros Masakoy, C. & Lemkow-Tovias, G. (2022). "Educació científica inclusiva des de la primera infància". Monogràfic de Guix d'Infantil "Educació CIentífica Inclusiva". *Guix d'infantil,* num 114	mag-22	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Navarro, M & Rachdi Errachdi, M. "Amb les famílies: L´experiència científica a les motxilles de les famílies immigrants" Monogràfic de Guix d'Infantil "Educació CIentífica Inclusiva". *Guix d'infantil*. num. 114	mag-22	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Egea Atienza, P. Oliveros Masakoy, C. & Lemkow-Tovias, G. (2022). "Per arrodonir". Monogràfic de Guix d'Infantil "Educació Científica Inclusiva". *Guix d'infantil*. num. 114	mag-22	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2022). "Tempus Fugit" (article d'opinió). *Social.cat.*	mag-22	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2023). "Paisatges i més paisatges" (article d'opinió). *Social.cat.*	mag-23	Spain

Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2021). " Estiu de descoberta i creació: camins on es retroben art i ciència " *Social.cat*.	aug-21	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2022). "Temps de vacances, temps sense deures?" (article d'opinió). *Social.cat.*	aug-22	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2023). "Exigències pròpies" (article d'opinió). *Social.cat.*	aug-23	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2023). "Aprendre al llarg de la vida" (article d'opinió)	nov-23	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2022). "D'efemèrides i recordatoris". (article d'opinió). *Social.cat*.	feb-22	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2023). "Cultura i accessibilitat" (article d'opinió). *Social.cat.*	feb-23	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2021). "Criatures de la tecnologia: el dilema de Mary Shelley " (article d'opinió). *Social.cat.*	nov-21	Spain
Non-scientific and non-peer reviewed publications (popularised publications)	FUB	Lemkow-Tovias, G. & Egea, P. (2022). "El valor de la cultura en la infància" (article d'opinió). *Social.cat.*	nov-22	Spain
Participation to a conference	GiocheriaSesto	Presentation of C4S- Horizon2020- first year. Milan team, Communities for Sciences. In the contest of: "Per un approccio inclusivo all'educazione scientifica", Festival GenerAzioni 2021	09.10.2021	University of MIlano-Bicocca
Participation to a conference	ULUND,IB	Poster presentation: Psychosocial support for refugees: a sustainable interdisciplinary community-based approach	10-12.11.2022	Berlin Germany
Participation to a conference	ULUND,IB	Occupational Science Conference	24-26.08.2023	Odense Denmark
Participation to a conference	ULUND	Opportunities and Challenges in Community-based Inclusive Science Education	9.11.2022	Berlin, Germeny

Participation to a conference	ULUND	Inclusive science education among communities in condition of vulnerability in Europe	25.10.2023	Odense, Denmark
Participation to a conference	NBU	Participation with two posters and distribution of project flyers to all the participants of "Man - the measure of all things?" The challenges of the post-industrial information society", 17-18 October, 2023, Technical University-Sofia	17-18.10.2023	Sofia, Bulgaria
Participation to a conference	NBU	Koltcheva, N., Inclusive education through science. Project Community for Sciences (C4S). Poster, National Scientific Conference On Children's Neurology, Psychiatry and Developmental Psychology with International Participation, 2-3 September, 2021, Sofia, Bulgaria	2-3.09.2021	Sofia, Bulgaria
Participation to a conference	NBU	Koltcheva, N., Presentation of C4S Project, Annual Conference and Winter School in Cognitive Science and Psychology, 25-28 February 2021, DCSP, NBU, Sofia, Bulgaria, online	25-28.02.2021	On-line
Participation to a conference	NBU	Participation with two posters and distribution of project flyers to all the participants of X JUBILEE INTERNATIONAL CONGRESS OF PSYCHOLOGY 2023 „THE CHALLENGES FACING MODERN PSYCHOLOGY„	3-5. 2023	Sofia, Bulgaria
Participation to a conference	NBU	Hristova, P., Kolcheva, N., Mateeva, A. (in press). Child participation in science learning helps 3–4-year-olds to encode relations between everyday entities, Proceedings of Science Since Birth 2023 (abstract)	5-7.07.2023	Manresa, Spain
Non-scientific and non-peer reviewed publications (popularised publications)	NBU	Publication of a short information about C4S project at the Technical University-Sofia Newsletter	oct-23	Sofia, Bulgaria
Participation to a conference	NBU	Antoaneta Mateeva, Penka Hristova, Nadia Koltcheva, Bojan Vasilev, Tsvetina Ivanova-Schindarska, Emilia Mikova, Educational Approach for Active Participation of 3-4 Years Old Children from Roma Community in Sofia in The Process	24-25.10.2022	Sofia, Bulgaria

		of Science Learning in The Kindergarten, Interdisciplinary Scientific Hybrid Conference Migration, Cultural Diversity and Life Prospects Under Conditions of Global Crisis, November 24-25, 2022		
Publication	NBU	Mateeva, A., Hristova, P., Koltcheva, N., Vasilev, B., Ivanova-Shindarska, T., Mikova, E., & Savova, S. (2023). AN EDUCATIONAL APPROACH FOR PROMOTING ACTIVE PARTICIPATION OF 3-4-YEAR-OLD CHILDREN FROM THE ROMA COMMUNITY IN SOFIA IN THE PROCESS OF LEARNING SCIENCE IN KINDERGARTEN. *Psychological Research (in the Balkans)*, *26*(2). https://doi.org/10.7546/PsyRB.2023.26.02.02	Published 06/28/2023	Psychological Research (in the Balkans): https://journalofpsychology.org/index.php/1/article/view/127
Publication	NBU	Hristova, Kolcheva, Mateeva (under review). Promoting Relational Thinking in Preschoolers (Ages 3-5) through Participatory Science Learning: Insights from RMTS with Roma Children, Frontiers in Education,ISSN (online): 2504-284X		Frontiers in Education:https://www.frontiersin.org/journals/education
Participation to a conference	NBU	Penka Hristova, Child participation in science as an accelerator for relational choice, Annual Conference and Winter School in Cognitive Science and Psychology.	18.02.2023	On-line
Participation to a conference	UNIMIB	Cotza, V., Communities for Sciences. Verso la promozione di un approccio inclusivo nell'Educazione Scientifica, Summer School SIREM "Metodologia della ricerca. Traiettorie e strumenti per i giovani ricercatori"	09.07.2021	On-line
Participation to a conference	UNIMIB	Zecca L. & Lefterov P., Nature and robotics: A comparative overview of play in kindergarten, EECERA	23-26.08.2022	Glasgow

Participation to a conference	UNIMIB	Cotza, V., Porcheddu, A., Vimercati, S., Zecca, L. (2023). Professional development research in childhood for the inclusiveness of school contexts. *International conference in Early Childhood Education in Science. Science Since Birth.*	05.07.2023	UManresa
Participation to a conference	UNIMIB	Lefterov, P. V., Cotza, V., Pezzotti, A., Granata, M. (2023). Inclusive science education in infant school: obstacles and barriers to overcome. *International conference in Early Childhood Education in Science. Science Since Birth.*	05.07.2023	UManresa
Participation to a conference	UNIMIB	Pezzotti, A., Acquaviva, D., Lefterov, P.V. (2023). I"Leafs-eating" silkworms: an experience in ECEC. *International conference in Early Childhood Education in Science. Science Since Birth.*	05.07.2023	UManresa
Participation to a conference	UNIMIB	Pezzotti, A., Acquaviva, D., Lefterov, P.V. (2023). I"Leafs-eating" silkworms: an experience in ECEC. *International conference in Early Childhood Education in Science. Science Since Birth.*	07.07.2023	UManresa
Non-scientific and non-peer reviewed publications (popularised publications)	EUB/RCE	Release Workshop Posters HUB, availabe for download on EUB website	dec-22	Austria
Non-scientific and non-peer reviewed publications (popularised publications)	EUB/RCE	Release Workshop Materials, availabe for download on EUB website	dec-22	Austria
Non-scientific and non-peer reviewed publications (popularised publications)	RCE	White Book on Inclusive Science Education	nov-23	Austria