Communities for Sciences

Towards Promoting an Inclusive Approach in Science Education

D4.1 – Report on literature review

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	30/09/2023
Related Work Package	WP4 - Research Management & Pilots
WP Lead Partner	UNIMIB
Other Partner(s) involved	All
Deliverable identifier	D4.1
Deliverable lead beneficiary	All
Due date	M6
Date of delivery	31/03/2021
Version	V11
Author	UNIMIB
Classification	Public

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	Description	Author(s)
V1	30/11/2020	First draft of the LR protocol	UNIMIB
V2	02/12/2020	First revision of the LR protocol	UNIMIB, FUB, Kristina Orban (ULUND), Sarah Scheer (IB)
V3	14/12/2020	Second draft of the LR protocol	UNIMIB
V4	18/12/2020	General revision of the LR protocol	UNIMIB, FUB, Kristina Orban (ULUND), Sarah Scheer (IB)
V5	29/12/2020	Consolidation and loading of the LR protocol for all partners	UNIMIB
V6	30/12/2020 - 08/01/2021	Partners' comments and feedback on LR protocol	All partners
V7	11/01/2021	Final formatting and publication of the LR protocol with the Excel template	UNIMIB
V8	05/03/2021	LR protocol update with the LR short report template and *fiche*	UNIMIB
V9	30/03/2021	Final draft of the LR final report	UNIMIB
		Revision of the final draft of the LR final report	UNIMIB, FUB
V10	31/03/2021	Final version of D4.1 - LR report	UNIMIB
V11	31/03/2021	Final edition	FUB

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1. Literature review protocol

The aim of the C4S literature review is to find the main results of empirical researches, practices and experiences on Inclusive Science Education / Teaching and Learning interventions, according to an intersectional and participatory approach, aimed at children and young people aged 0-16 years old from communities in vulnerable situations or in risk of vulnerable situations (focusing on immigrants, Roma communities, and persons with disabilities and/or SEN, which means with Special Educational Needs).

C4S aims to put into the foreground that these communities in vulnerability risk situations are actually positive social actors with significant strengths and capabilities, with an important role in current and past science, which still needs to be understood and deepened. As commitment for plural and inclusive societies, this project wants to analyse those elements and aspects that put these communities at risk of being stereotyped, marginalized, or invisibilised in the field of science, promoting a new paradigm which can go beyond the deficit and diagnosis-intervention model. Therefore, C4S aims to look first and foremost at the possibilities that a vulnerability risk situation opens up, beyond the concept of "limit".

1.1 General criteria

First of all, the C4S literature review meets the following general criteria:

1. conduct a research including different types of bibliographical material, in particular: academic books and papers from international and national journals, non-academic readings, didactic material, and relevant reports from projects related to C4S topics (see 1.2.3);
2. search for bibliographical results both in English and in the local language of partners, at both international and national level, so as not to lose the specifics of anybody;
3. considering the extent of scientific literature on certain main topics, limit the review to papers and texts published from 2000 onwards.

1.2 Approach to the literature review

The C4S approach to literature review, which aims also to design in more detail and in-depth the theoretical framework of the whole project, follows six consequent stages, as depicted in the table below (Tab. 1). Each stage will then be explained more thoroughly in the following paragraphs below the table.

What	How	Who
1 Design the theoretical framework (see 1.2.1)	Questions aiming to identify literature items and European regulations on inclusive science education.	FUB, UNIMIB
	Workshops to be organized (months of January-February): 1. what we mean by science from both a philosophical and a pedagogical point of view; 2. on inclusive science education; 3. on intersectionality approach.	All partners
2 Identify the local target community in vulnerability risk situations with and for whom each partner plans to work and the target age groups (see 1.2.2)	Three communities in vulnerability risk situations: 1. immigrants; 2. Roma communities; 3. persons with disabilities and/or SEN.	All partners
	Target age groups: children and young people aged 0-16 years old.	All partners
3 Follow the steps of the literature research process so that each partner can conduct the bibliographical research (see 1.2.3 and Appendix 1)	Choose the research questions best suited to your professional skills, to select the keywords most significant for the thematic areas of your interest, in relation to your specific community and target age group(s). Select the most relevant results and insert them in the Excel template, according the four identified types of bibliographical material. (see Figg. 1 and 3)	All partners
4 Remove duplicates and apply inclusion/exclusion criteria by reading titles and abstracts (see 1.2.4)	Remove duplicates and identify, using also the scale matrix of relevance (see Fig. 2), the inclusion/exclusion criteria, to select only the appropriate results.	FUB, UNIMIB
5 Write a short report on the own literature research (see 1.2.5 and Appendix 2)	Short reports by partners, to be written following a template, will be useful to extract the first relevant information and start making synthesis.	All partners
6 Final report on literature review (see 1.2.6)	Develop a summary and a critical synthesis/overview of the available evidence pertinent to the review's research questions.	UNIMIB

Tab. 1. Stages of C4S literature review.

1.2.1 Design the theoretical framework

The first goal of C4S literature review is to define and design the theoretical framework which encloses all interventions and activities that will carried out, thus informing approaches and educational practices. So, from what is stated in the project itself, this specific research aims to clarify the sense of Inclusive Science Education, using the same databases, search engines, and online libraries that will be employed for the other bibliographical researches (see 1.2.3).

In particular, the purpose is to explain the correlation between Inclusive Education/Pedagogy and Science Education/Didactics, starting from two specific research questions.

1. Are there existing literature reviews on Inclusive Science Education?
2. What are the main European regulations/recommendations on Inclusive Education and Science Education? In these documents, are there already potential intersections between these two fields and conceptualizations?

Considering the extension of studies on inclusion and science education, the first question is functional to focus the bibliographical research, starting with the existing literature reviews about the main topics of C4S project; thanks to this analysis, it will be possible to identify items and guidelines for developing new connections and paradigms. Instead, the second question aims to approach the scientific research regarding European regulations with regard to inclusion and science educational activities, especially to verify whether there is an effective correspondence between these European regulations and educational practices.

During this research process, it would be useful organise a workshop about what partners mean by “science”, from both a philosophical and a pedagogical point of view. This training workshop, open to all partners, is functional to share the first findings and results and discuss them, receiving new inputs and suggestions.

1.2.2 Identify target communities and target age groups

Before starting to search for bibliographical documents, each partner needs to know exactly which local target community in vulnerable situations or in risk of vulnerable situations it will be working with and for; furthermore, it needs to have clear which are its target age groups.
Each partner shall carry out its bibliographic research from its own local target community.
Here is a table to guide partners in their choice (Tab. 2).

Guidance questions	Possible answers
Which is the community in vulnerability risk situations you will be working with and for?	immigrant community
	Roma community
	persons with disabilities and/or SEN
Which are your target age groups?	0-6 years old
	6-12 years old
	12-16 years old
	all three above (0-16 years old)

Tab. 2. Communities in vulnerability risk situations and target age groups to be chosen.

1.2.3 Steps of the literature research process

Each partner, within its own community of reference, shall follow four interrelated steps, as depicted in the figure below (Fig. 1; see also Fig. 3). This process will lead partners to fill in an Excel template which includes all relevant information about each bibliographical result (text, paper, or document) considered as project-related.

If necessary, further selection will be carried out applying specific inclusion/exclusion criteria according to specific guidelines and also to the scale matrix of relevance (see Fig. 2). At this point, each partner will be able to extract data and information from each source and write a short report about its literature research and review following a template (see Appendix 2).

Short reports will be necessary to build the final report on C4S literature review, developing a critical synthesis/overview of all the emerging findings project-related and pertinent to the review's research questions, following specific guidelines drawn up for this purpose.

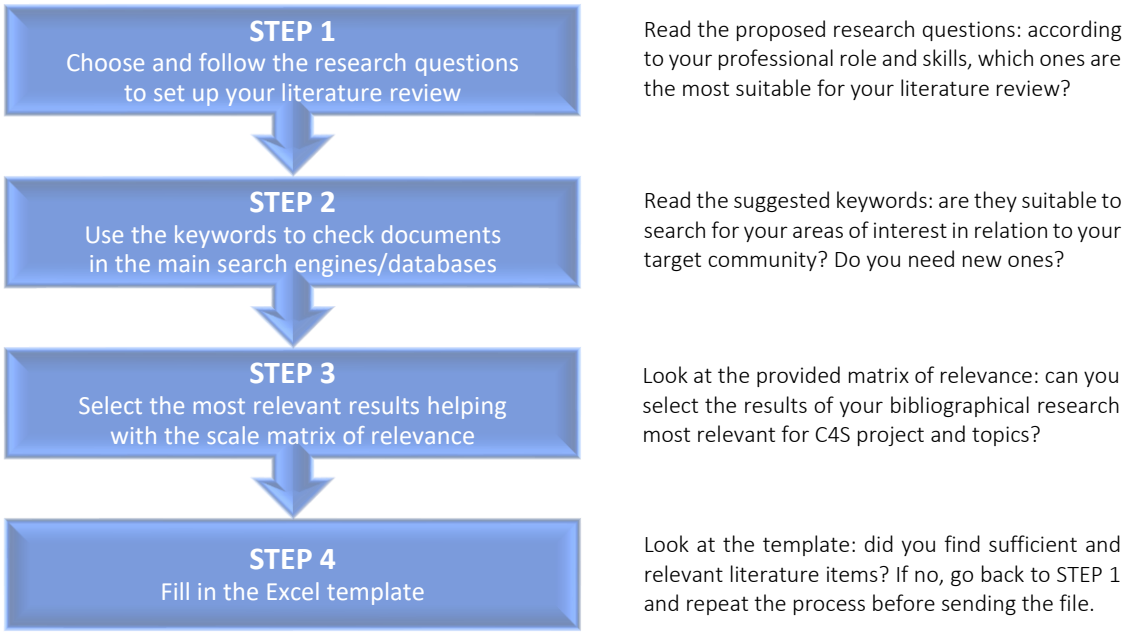


Fig. 1. Steps of C4S literature research process with guiding questions.

STEP 1. Research questions. The C4S project involves different professional skills and figures: researchers and university faculty members, project management staff, teachers, educators, pedagogists, and policy makers. So, according to its specific professional point of view and to the thematic areas of interest, each partner should choose all or only some of the following research questions, in order to focus and set up its own literature research.

1. What are the main findings on the effectiveness of inclusive interventions in relation to education and especially to science education, also looking at the involvement of families and surroundings in vulnerability risk situations?
2. What are the most effective educational and teaching and learning methods?
3. What are the most obvious outcomes of both hard and soft and life skills?

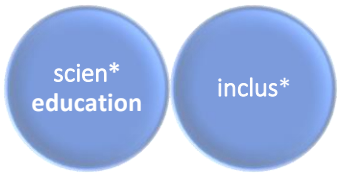
4. What are (and/or should be) the main conditions for science education to be inclusive (both accessible and participatory)?
5. What are the most effective teacher education/training models?
6. What are actually the main research gaps in inclusive science education?

STEP 2. Keywords and search engines/databases. Once the questions have been chosen, each partner should try to answer them applying in the Boolean strategy (to be applied if possible) a set of keywords, related to both local target community in vulnerability risk situations (and the related target age groups) and different core dimensions of C4S project. In this way, the bibliographical research process will consider the link between target communities, on the one hand, and literature subjects, on the other hand, concerning characteristics, activities, and impacts of inclusive science education in the field of child and youth vulnerability.

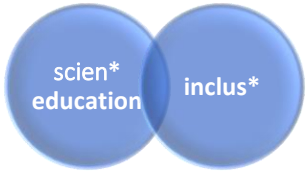
The Boolean search strategy is based on a mathematical logic that helps to expand or narrow the bibliographical search. There are three Boolean logical operators, i.e. three commands to the search engine: "AND", "OR", and "NOT", plus the possibility of using the wildcard *.

The OR command expands the search: it simply requires that one of the keywords entered is contained in the results. The AND command refines the search: it links keywords or phrases together, so that they are all included in the results. The NOT command excludes from search: it excludes from the results the keywords or phrases entered in the field following the NOT command. Furthermore, the Boolean search strategy provides for using the wildcard *, which allows to search for all keywords starting with the letters indicated before the wildcard. See the following examples with the keywords "scien* (which stands for "science", scientific" etc.) education" and "inclus*" (which stands for "inclusion", "inclusive" etc.):

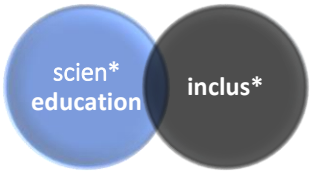
– scien* education OR inclus*:



– scien* education AND inclus*:



– scien* education NOT inclus*:



So, the wildcard * allows to search for all possible forms of a word, exploring its sematic field, without limiting the bibliographical search to a single morphological declension. In addition, the three Boolean logical operators can also be combined, as in the following example:

(scienc* education OR inclus*) AND immigrant* AND child* NOT language skill*

Therefore, as in the example above, each partner can proceed with its research **combining** the keywords regarding its **local target community** and target age groups with the following **five sets of keywords** (Tab. 3), related to the main topics and dimensions of C4S project.

Topics and dimensions (sets)	Suggested keywords
Inclusive Education	inclusive education; vulnerability/fragility; intersectionality; cultural diversity; intercultural education; pluricultural approach; human and children rights; equality/inequality; oppression; discrimination; privilege; emancipation; empowerment; gender differences; (economic/social/educational) poverties; (sensorial/learning/intellectual) disabilities; school segregation; special educational needs
Science Education / Science Teaching and Learning	science education/teaching and learning; STEM/STEAM; soft/life/language/(specific domain) skills; critical thinking; best practices; accessible learning/play materials; (playful/creative) learning environment; mediated/negotiated learning; verbal/non-verbal teacher communication (scaffolding/mentoring/tutoring); pedagogical documentation; assessment/evaluation tools; learning taxonomies; action research; participatory research; problem-based learning; IBSE (Inquiry-Based-Scientific Education); socio-constructivist pedagogy; hands-on approach; free-choice pedagogical approach
Teacher Training/Education	teacher training/education; pre-service/in-service education; laboratory; curriculum; lifelong learning; participatory action research; collaborative research; intervention-based research
Education & Public Engagement	ecological sustainability; social participation; student/citizen involvement; agency; advocacy; empowerment; community; student voice; stakeholder; policy-maker; interdisciplinarity; citizen science
Inclusive Education & COVID-19 Contexts	COVID-19/coronavirus/pandemic scenario researches/impacts; media education; virtual learning environment; digital divide/inequality

Tab. 3. Set of keywords on the main topics and dimensions of C4S project.

As stated in the table above, these keywords are only suggested: each partner can vary them, translate them in its own language or create new ones according to its research needs.

Here are some suggested search engines, databases or online libraries where to conduct the bibliographical research:

- Google Scholar: https://scholar.google.com/
- Scopus: https://www.scopus.com/home.uri
- Eric: https://eric.ed.gov/
- Web of Science: https://login.webofknowledge.com/
- PubMed: https://pubmed.ncbi.nlm.nih.gov/

STEP 3. Scale matrix of relevance. In order to select the most relevant results found through the bibliographical research, partners can use the scale matrix of relevance that follows (Fig. 2), which measures the degree of relevance of findings in relation to the whole C4S project or to its main topics. In order to bring back to mind what is relevant for the project as a whole or which are the core C4S topics, partners should reread the Proposal submitted, especially the first section on the Excellence, containing the aim of the project (in particular, § 1.1 Objectives and § 1.2 Relationship to the Work Programme).

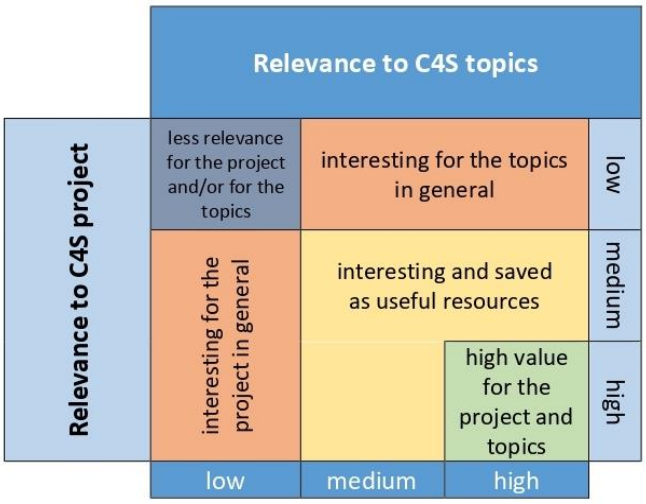


Fig. 2. Scale matrix of relevance to C4S project and core topics.

In general, the relevance to C4S project may concern:

- The relationship between an inclusive approach in science education and society, in particular communities in vulnerability risk situations who suffer from disadvantages, discrimination, or oppression and so are not often visible as active social agents;
- The creation and implementation of science inclusive activities for and with children and young people from these communities (between 0 and 16 years old), especially to increase their awareness of exclusionary practices in science;

- The promotion of an anticipatory policy-making and a positive social change fostering co-working and co-design actions with science experts and stakeholders, through an RRI (Responsible Research and Innovation) approach.

Then, the relevance to C4S topics may concern:

- The creation of science laboratories/activities in formal and non-formal institutions, to promote social participation, inclusive practices, and awareness among children and young people in vulnerable conditions, engaging them in active and attractive educational processes;
- The impacts of these science activities upon the territories where children and youths live, first of all involving their families and parents;
- Strategies, methods, activities, plans, and best practices of multilevel working teams and meetings with institutional representatives, stakeholders, and policy-makers, to foster inclusive science education, including scientists or science-related members of communities in vulnerable situations;
- Effective inclusive interventions, experiences and best practices in science education, in both formal and non-formal contexts, especially according to an intersectional and participatory approach;
- Inclusive teaching methods and teacher training models in the field of sciences;
- Research gaps, barriers, and discrimination/exclusionary practices (also in the digital world) in science education.

STEP 4. Excel template. Once the most relevant results have been selected, each partner has to fill in the provided Excel template (see a preview in Appendix 1), which is structured in four sheets, one for each type of bibliographical material to be searched for, so: 1. academic books and papers; 2. non-academic readings; 3. didactic material; 4. relevant reports from projects related to C4S. Each partner is asked to fill in all or only some of the sheets with its literature items reviewed, following an alphabetical order and paying attention to the maximum number of references which can be inserted in each sheet, depending on the bibliographical material. So, bear in mind that for:

1. Academic books and papers: min. 2, max. 15/20 items;
2. Non-academic readings: min. 2, max. 5 items;
3. Didactic material: min. 2, max. 5 items;
4. Relevant reports from projects related to C4S: min. 2, max. 5 items.

As mentioned in § 1.1 General criteria, items can be both in English and in the local language of partners, from 2000 onwards. For each item, partners have to specify, in this order:

1. Codex for each specific bibliographical item (see below);
2. Author(s): each partner is invited to search also for documents co-authored or fully authored by members themselves of communities in vulnerability risk situations, so as to give special emphasis to experts and scientists from these communities; indeed, the template requires to specify if authors belong to a specific target community and, if the answer is yes, which one;

3. Year of publication;
4. Full title of the document;
5. Place of publication: name of the journal (specifying if it is open access), monograph, book, conference proceedings etc., specifying, where necessary (such as in the case of books and proceedings), publisher and city;
6. Link to download or read the document, if any;
7. Abstract (or Summary, e.g. in the case of non-academic readings, or Explanation, e.g. in the case of didactic material) necessarily in English; if the original abstract is not in English, translate it before filling in the template; if the document does not have an abstract (or a summary or an explanation), write one in English to be able to complete the template;
8. Focus or Keywords which are relevant for the item;
9. (only for academic items and optional) Type of research, if qualitative or quantitative, if detectable;
10. (only for academic items and optional) Type of approach (the choice is between: intersectionality / community-based / participatory / other), if detectable.

When inserting items in the template, partners have to give a codex to each bibliographical reference, that has to be composed of: **acronym of the partner + abbreviation for each of the four types of bibliographical material (Ac / Non-Ac / Did / Proj) + sequential number**, as in the following example:

Acronym of the partner	Abbreviation of the 4 types of bibliographical material	Sequential number
FUB	Ac	01
Codex: FUBAc01		

Regarding the non-academic readings, this type of bibliographical material can include:

- Popular periodicals, magazines and newspapers written for a very general audience;
- Popular media sources and news outlets;
- Professional/Specialized sources of dissemination nature.

Regarding to relevant reports from projects related to C4S objectives and topics, partners are invited to pay particular attention to two specific typologies of European projects:

1. Erasmus+ Projects (VALOR-Dissemination Platform): https://ec.europa.eu/programmes/erasmus-plus/projects
2. Horizon 2020 Projects (CORDIS Platform): https://cordis.europa.eu/

For an overview of the literature research process, see the figure below (Fig. 3).

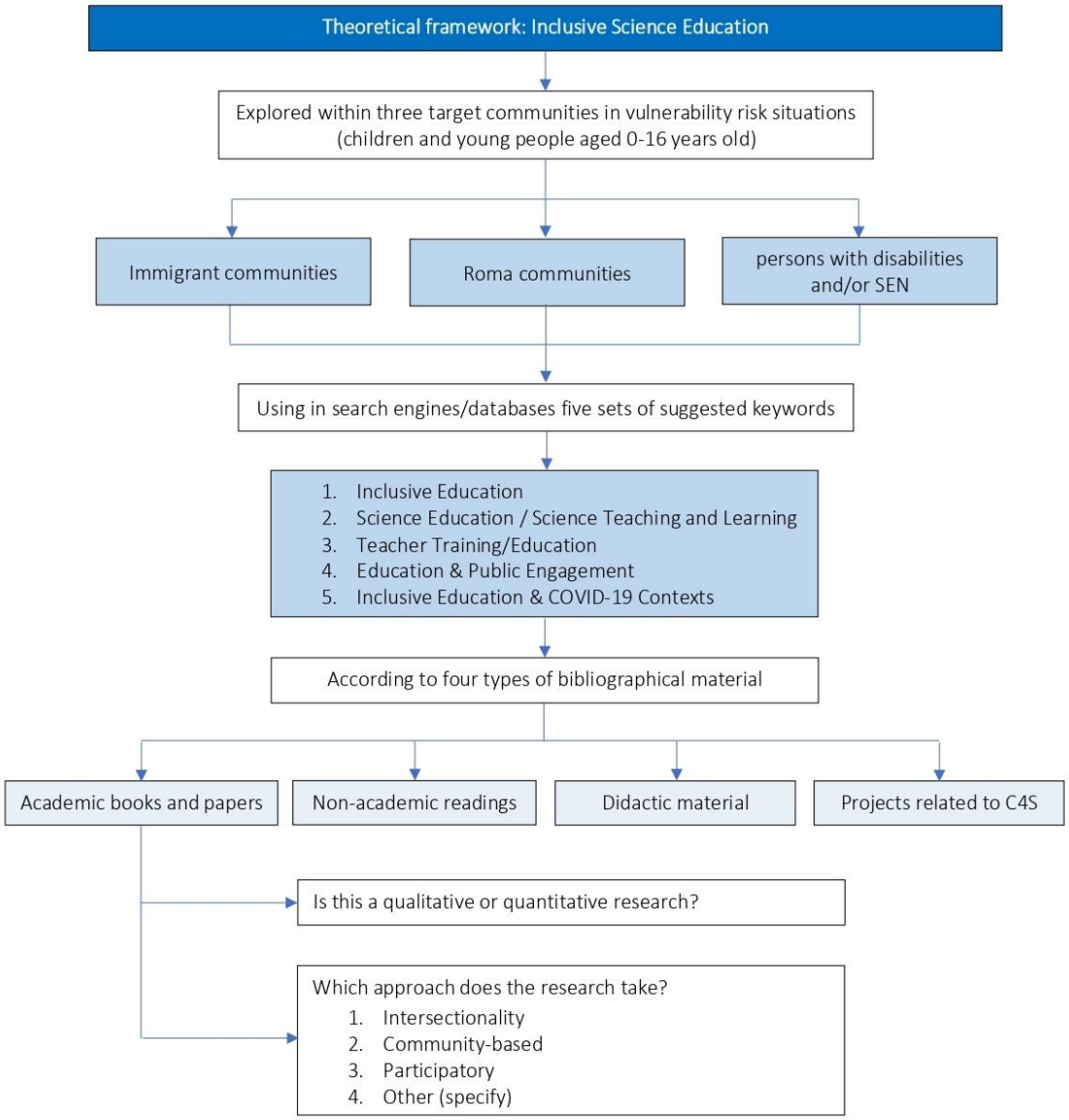


Fig. 3. Overview of the literature research process.

1.2.4 Inclusion/exclusion criteria of selection

The first procedure consists of comparing the partners' Excel files to remove duplicates. Secondly, the bibliographical results found by partners are validated or excluded according to the scale matrix of relevance (see Fig. 2), which is designed in relation to C4S topics and dimensions. These revised Excel files constitute the basis on which each partner will have to write its literature review short report.

1.2.5 Guidelines for short reports

In order to write a short report of its own literature review, each partner has to follow a **template** with a given structure (see **Appendix 2**), which is articulated into three main sections:

1. General information, which includes: partner's professional basic data; local target community in vulnerability risk situations; keywords used to search references; and search engines, database and online libraries;
2. Summary of the main results (max 5 pages), where each partner shall develop a brief general discussion of the main topics / subjects contained in its found readings (see Appendix 2, Fig. 8), taking into account its local target community and in light of the methodological approaches used in the references (see Appendix 2, Fig. 9);
3. Additional comments.

A ***fiche*** is attached to the template, which is a short guide to collect data for an overview of C4S bibliographical results. Each partner shall flag the fields of two tables, related to:

1. main topics / subjects (see also Appendix 2, Fig. 8);
2. methodological approaches (see also Appendix 2, Fig. 9).

Each partner is asked to draft its own bibliography at the end of the report (using APA style) and answer a few questions about the background of the authors of its bibliography.

1.3 Timetable

Deadline	Sort	Who
29/12/2020	Final draft of the LR protocol (already reviewed by FUB, ULUND, and IB)	UNIMIB
08/01/2020	Feedback on the draft of the LR protocol	All partners
11/01/2021	Edition of the LR protocol with the Excel template	UNIMIB
24/02/2021	Workshop on what we mean by science from both a philosophical and a pedagogical point of view	organised by FUB & UNIMIB for the C4S Consortium
15/02/2021	Delivery of Excel templates	All partners
04/03/2021	Inclusion/exclusion criteria of selection	UNIMIB, FUB
	Guidelines and template of LR short reports	
05/03/2021	LR protocol update with the LR short report template and the *fiche*	UNIMIB
20/03/2021	Delivery of LR short reports and *fiches*	All partners
30/03/2021	Final draft of the LR final report and its revision	UNIMIB, FUB
31/03/2021	Edition of the LR final report	UNIMIB

Tab. 4. Timetable of Literature review process deadlines.

2. General information on bibliographical research

The C4S literature review was conducted by different professionals oriented by specific interests and research dimensions, focusing on one or more communities in vulnerability risk situations. In order to conduct the bibliographical research, according to the Protocol illustrated above, each partner used some specific keywords, suggested or new, and summarised its main results, using the search engines, databases and online libraries deemed most functional for their own research purposes. Furthermore, processing the data collected in the fiches, this document will provide a quantitative summary of the C4S main topics / subjects and methodological approaches that it was possible to trace in the results of this literature review, always in relation to the framework of (Inclusive) Science Education.

In addition, a specific research still ongoing was undertaken to explore the cultural backgrounds of the authors involved in this literature review, in order to identify, first of all, if some authors dealing with the C4S issues have a background related to some communities in vulnerability risk situation. This research will be useful to involve researchers, scientists and stakeholders with different and multicultural backgrounds, but also to raise awareness of biased and exclusionary practices that at times may occur in science-related fields, to contrast negative stereotypes and values oriented to construct the concept of the "other".

Therefore, we present some general information about the partners' basic data and how each partner carried out its own bibliographical research. Then we will discuss the findings, organising the results according to the categories considered most significant for C4S purposes.

2.1 Partner's basic data

In this paragraph, we summarise who was involved in the literature review process.

EhB - Erasmushogeschool Brussel (Erasmus Brussels University of Applied Sciences and Arts):

- Annick Biesmans
- Inge Laenen
- Bram Malisse
- Marleen Rosiers
- Bert Wastijn

EUB - Bildungsdirektion Fuer Wien (Board of Education):

- Wilfried Swoboda
- Romy Höltzer

FUB - Fundació Universitària del Bages, Manresa:

- Miryam Navarro
- Maria Lluïss Sort
- Gabriel Lemkow
- Judit Onsés

GALILEO - Galileo Progetti non-profit Kft, Budapest:
- Sarolta Darvay
- Margaréta Rónai

GIOCHERIASESTO - Comune di Sesto San Giovanni (Municipality of Sesto San Giovanni):
- Alessando Porcheddu
- Simonetta Vimercati
- Alessandra Barbanti
- Enrica Giordano
- Alessandra Bai

IB - IB Gesellschaft für interdisziplinäre Studien gGmbH (University of Applied Health and Social Science, Berlin):
- Sarah Scheer

NBU - New Bulgarian University, Sofia:
- Nadia Koltcheva
- Penka Hristova
- Galina Markova

RCE Vienna - Wirtschaftuniversitat Wien (Vienna University of Economics and Business):
- Julia Rusin

ULUND - Lund University:
- Kristina Orban

UNIMIB - University of Milano-Bicocca:
- Luisa Zecca
- Roberta Garbo
- Matteo Schianchi
- Valeria Cotza

UVic - Fundació Universitària Balmes, Vic:
- Salvador Simó
- Berta Vila
- Marta Camps Devesa
- Marianna Piccioli
- Francesca Davoli

2.1.1 Thematic areas of interest

In this paragraph, we summarise which thematic areas / C4S dimensions of interest have guided the bibliographical research of each partner.

EhB. The thematic areas that were explored were the concept of STEAM approaches and art(ful) education, co-creation and the participatory approach and the (lack of) impact of education on the lives of people in migrant communities; some C4S dimensions (inclusion, science education, democracy, equity and intersectionality) formed a common thread through the research.

EUB. The main thematic area was teaching and learning.

FUB. The main thematic areas and dimensions of interest were STEAM, STEM, inclusion, gender, intersectionality, diversity, and migration.

Galileo. The thematic areas of interest were science education / science teaching and learning, inclusive education, and teacher education.

GiocheriaSesto. The guiding topics were inclusive education, science education and learning, and teacher education.

IB. The following questions, contained in the Protocol, led to the literature review results.

- What are the main findings on the effectiveness of inclusive interventions in relation to education and especially to science education, also looking at the involvement of families and surroundings in vulnerability risk situations?
- What are (and/or should be) the main conditions for science education to be inclusive (both accessible and participatory)?
- What are actually the main research gaps in inclusive science education?

NBU. The main thematic areas of interest were pre-school children, Roma children, inclusive education, science education, child participation, empowerment of marginalized communities, and relational reasoning.

RCE Vienna. One relevant thematic area that led the research was the aspect of how to conduct participative research with young people and how to support their learning-process. In specific, the main question is how to engage our target group within our activities / how to include their different perceptions, interests, realities, and experiences within the topic of sustainability to create a real impact. The research aims to integrate theater pedagogy in the activities, because of the connection between theater and science was one further point of interest.

ULUND. The main focuses were inclusive education and science education.

UNIMIB. The literature review was guided by some specific research questions correlated to the main C4S themes and dimensions.

- Science education can create inclusion, in what ways?
- How can science education enable learning in youth with more complex disabilities?
- Does the literature address the social, relational processes in which science education for youth with disabilities is developed?

UVic. The research focused is the access of children living in deprived neighborhoods to the digital technologies, as 3D printing or virtual reality technologies. Further areas of interest / C4S dimensions that have guided our research are inclusive education, science education in early childhood, and teacher training.

2.2 Local target community in vulnerability risk situations

In this paragraph, we summarise which is the target community of reference of each partner and if there were any difficulties and/or special issues to find relevant C4S readings about the community of reference.

Diversity, ethnicity and immigrant (and refugees) communities

Partners focusing on this specific target community are: EhB, EUB, FUB, IB, RCE Vienna, UVic.

EhB. The main actor in the Hub is EBUASA, the training program for future pre-school teachers, just relocated to the center of Brussels. In the new building, the team choose to develop the campus as a center of knowledge, a place of meeting and dialogue and a location of gathering of students, organizations and families who live in the neighborhood. These families come predominantly from migrant backgrounds and struggle in most cases with issues of poverty, social exclusion, unemployment, and low levels of literacy and lack of formal qualification. The research devoted to this community and the struggles they experience on a daily basis is quit readily available, but studies usually limit themselves to describing the phenomenon's and problems, but fail to deliver answers to the complex reality of urban living and education.

FUB. The target community are Immigrant communities. It was unclear, however, on whether the authors had an immigrant background themselves or if they were nationals being themselves of 2nd or 3rd – of further – generation citizens. Also, not always the names or surnames of authors necessarily reflect their immigrant status. This should make us reflect about how to deal in C4S with certain presuppositions guiding the research, especially in relevant issues as find research collaborators or co-participants with immigrant background.

IB. Refugees and immigrants are the local target community of the IB University, but to be more open we included children with disabilities too, to get a broader perspective of inclusive science education. The results for refugees and immigrants have been less represented in our findings than other target groups in vulnerability risk situations. Gender issues are represented in some of the findings as well.

RCE Vienna. The local target group of interest are pupils (6-10 years old) and their families from schools characterized by a high proportion of multiethnic backgrounds. As we want to approach in an inclusive and intersectional – and not integrative – manner, we did not want to focus only on the aspect "with migration background". It was hard to find literature about participation of pupils with the focus on an intersectional/inclusive approach. A further challenge was that the term "inclusive" is mostly related, within the English language, to people with SEN, that are not the target group of RCE Vienna.

UVic. The target communities are immigrant families, but also children (boys and girls) facing difficult socio-economic conditions and children with different needs, in relation to the field of study related to the access to new technologies concretely with children facing socio-economic difficulties. We have found some evidence related to general education, children with special needs, and adults with intellectual disabilities.

Persons with disabilities and/or Special Educational Needs (SEN)

Partners focusing on this specific target community are: GiocheriaSesto, ULUND, UNIMIB.

GiocheriaSesto. Our research found many readings about science education, STEM and inclusion of children with disability, but few research projects about the inclusion in non-formal science learning. We found more articles about science teaching/STEM and Secondary School.

UNIMIB. It was not particularly complicated to locate academic literature about the topic of our interest; indeed, it was difficult making choices to compose the bibliographical research within the long series of papers found. It was more complex identifying non-academic results, projects, and teaching tools.

Roma community

Partners focusing on this specific target community are: Galileo, NBU.

NBU. NBU team has chosen to work with children at pre-school age. There are not many research studies conducted and published for pre-school Roma children and specifically for Roma children in Bulgaria: in fact, it is a field that needs further research and investigation. There are a number of publications related to Roma community exclusion, but still not much research has been done on this specific project topic.

2.3 Keywords

In this paragraph, we summarize which of the suggested keyword (in the above Protocol) or new keywords were used for each bibliographical research.

About Diversity, ethnicity and immigrant (and refugees) communities

EhB

Suggested keywords and new ones: early childhood education (STEAM approach, art education, inclusion, families), ethics and politics (democracy, emancipation, equity, equal opportunities), migrant communities / minorities (co-creation, families, ethnicity, inclusion, intersectionality).

EUB

Suggested keywords: (inclusive) science education, teaching and learning, best practices, teacher training/education, IBSE, hands-on approach.
Most useful: IBSE.

FUB

Suggested keywords: STEAM, STEM, inclusion, science education, early childhood education, early childhood, education, cultural diversity, multicultural, intercultural, inclusive education, intersectionality.
Most useful: STEM, science education, early childhood education, intersectionality, multicultural education, intercultural education, STEAM childhood educa*, intercultural science education.
New ones: immigration, migration, migrant child*, migrant families, STEAM childhood educa*, minority background, critical race theory, racism, etnicity, ethnic lens, transnationality, critical multiculturalism, critical, pedagogies, identity, activism.

IB

Suggested keywords: citizen science, vulnerability AND education, science OR inclusive education, STEM, inclusive education AND disabilities, COVID-19 vulnerable communities.
New ones: immigrants, refugees, didactic material science, didactic material refugee children, inclusive citizen science children.

RCE Vienna

Suggested keywords: inclusive science education, action research, participatory research, intersectionality, citizen science, sustainability.
Most useful: inclusive science education.
New ones: community mapping, theater and science, pupils, learning and neuroscience, learning and teaching styles.

UVic

Suggested keywords: inclusive education, scientific learning, sustainable development, gender, teacher training.
Most useful: inclusive/science education.
New ones: education policies for integration, ECEC (Early Childhood Education and Care), child poverty, deprived children, practical applications of inclusive education, attitude toward sciences, index for inclusion, pre-school & primary school, 3D printing, virtual reality, augmented reality.

About Persons with disabilities and/or Special Educational Needs (SEN)

GiocheriaSesto

Suggested keywords: inclusive education, sensorial/learning/intellectual disabilities, special educational needs, science education/teaching and learning, STEM, learning environment, teacher education, laboratory.
New ones: informal/non-formal science learning/education, astronomy, living labs, deaf-dumb, early childhood, unconventional matters.

ULUND
Suggested: inclusive education (408 references found), science education (447 references found) in relation to Disability and/or Special Educational Needs (SEN) and Immigrants & Ethnicity.
New ones: occupational therapy.

UNIMIB
Suggested keywords: science education, inclusive science education, special educational needs, disability, curriculum, teaching and learning, teacher training.
Most useful: inclusive science education, special educational needs.
New ones: we did not identify additional key words. In some cases, we have attempted to reach out to single categories of disability, among those most problematic from an intellectual point of view (e.g. autism, neurodiversity, trisomic).

About Roma community

Galileo
Suggested keywords: inclusive education, vulnerability/fragility, cultural diversity, intercultural education, STEM/STEAM, learning environment, human and children rights, equality/inequality, science education/teaching and learning, socio-constructivist pedagogy, hands-on approach, free-choice pedagogical approach, teacher training/education, lifelong learning.
Most useful: science education/teaching and learning, STEM/STEAM, learning environment, socio-constructivist pedagogy, hands-on approach, free-choice pedagogical approach.

NBU
Suggested keywords: inclusive education, science education, pre-school children, Roma children, child participation, scientific learning.
New ones: curiosity, pre-school children, motivation pre-school low income, motivation curiosity learning, same different relations curiosity, child participation.

2.4 Search engines, databases and online libraries

In this paragraph, we summarize which research tools were used by each partner.

About Diversity, ethnicity and immigrant (and refugees) communities

EhB. We used some databases (e.g. Eric, PubMed) and search engines (e.g. GoPressAcademic, ScienceDirect) that are available for EhB personnel on the EhB Intranet. Also, Research Gate was a source of recent relevant publications.
The University also provides access to several online archives of magazines, periodicals and journals. Through close monitoring of newly published books, the team was aware of fresh and interesting reading on academic and non-academic writings concerning C4S topics and themes. Articles and writings were gathered, screened, selected/discarded and processed.

EUB. Mainly Google Scholar.

FUB. CRAI UB (a platform from University of Barcelona with access to several databases), Eric, Scopus, Google Scholar, Dialnet.

IB. In the beginning we focused on more generic databases such as Google Scholar, Research Gate and Cochrane Library to get an overview about existing literature resources. Further, we used more specific databases such as Eric, PubMed and Pedocs to identify more specific project related articles. With respect to related projects, it has been very useful to follow the Citizen Science Working Group in Germany, who collect manifold links to citizen science webpages.

RCE Vienna. Google Scholar.

UVic. Google Scholar.

About Persons with disabilities and/or Special Educational Needs (SEN)

GiocheriaSesto. Research Gate, Eric, Cordis platform.

ULUND. PubMed, Embase, Eric, Web of Science, Scopus.

UNIMIB. Google Scholar, Scopus, Eric, Web of Science, PubMed, Cordis and Valor platform.
Finding scientific journals and books specific to inclusive science led us to use the search engines of some of these journals (e.g. Journal of Science Education for Students with Disabilities, Asia-Pacific Science Education). Articles not available in open access were accessed through the databases accessible by the account of University of Milano-Bicocca.

About Roma community

Galileo. Google Scholar, Eric, Research Gate.

NBU. New Bulgarian University databases were used for the literature search:
https://nbu.bg/bg/library/elektronni-resursi/bazi-danni/po-azbuchen-red
Specifically, information was derived from EBSCO. Also search in Google Scholar was done.

2.5 An overview of the results: data, topics and approaches

In total, the C4S literature review has returned 214 bibliographical references as the most important ones; of these, only the most significant were discussed (see § 3. Discussion of the main results and also Bibliography). More specifically, according to the different types of bibliographical material, the following emerges (see also Fig. 4 for percentages):

- Academic books and papers: 135 references;
- Non-academic readings: 31 references;
- Didactic material: 23 references;
- Projects related to C4S themes: 25 references.

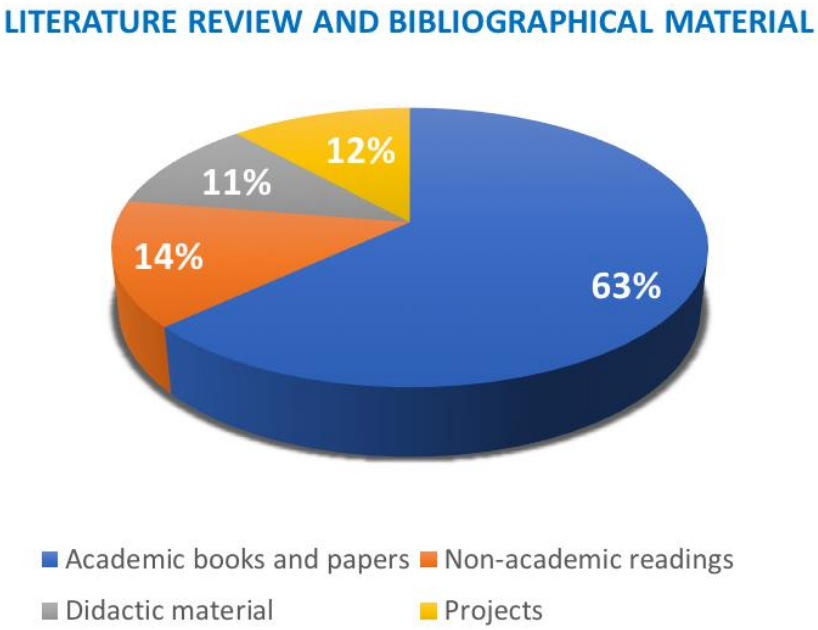


Fig. 4. An overview of the representativeness of the different bibliographical material in the results.

Therefore, in line with the requirements of the Protocol (§ 1.2.3, Step 4), the literature research on C4S topics and dimensions brought to light mainly academic material (63%), followed by Non-academic readings (14%), Projects related to C4S themes (12%) and Didactic material (11%).

In this last paragraph, we propose a quantitative summary of the C4S main topics/subjects and methodological approaches that it was possible to trace among the results found after doing the whole bibliographical search. By processing the data collected thanks to the *fiches* filled in by all partners, we were able to make explicit how many bibliographical results refer overall to certain main topics/subjects and methodological approaches that the Consortium considered upstream particularly pertinent within C4S (see *Fiche*, Appendix 2).

First of all, as shown in the Fig. 5 below, the C4S subjects most present in the bibliographical findings are Early Childhood Education and Teacher Education (both 18%), followed by Primary Education and Disability and/or SEN (both 13%) and Secondary Education (12%). As stated above by the partners dealing with it, the least represented topic is that of Roma community, which appears in only 3% of the bibliographical results.

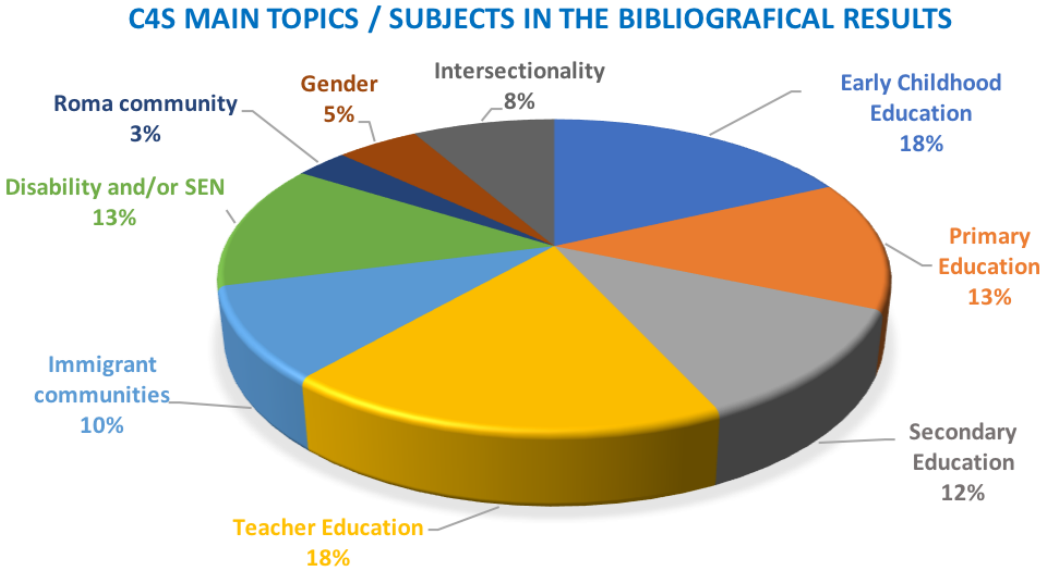


Fig. 5. An overview of the main C4S topics in the bibliographical results.

With regard to the methodological approaches (Fig. 6), the data show that the most frequently encountered approach in the findings is the Empirical one (29%), probably also because of the research questions that guided the bibliographical process, especially focused on interventions, teaching and learning methods and teaching education models (§ 1.2.3, Step 1). So, Theoretical (23%) and Didactic / Teaching (20%) approaches follow, while the other two identified ones, i.e. Instructional Strategies and Narrative Approach, Toolkit, etc., have a much lower percentage (respectively 13% and 10%). According to the partners, only 5% of the references show different approaches than those found as significant for the purposes of C4S: among them, we remember a Meta-analysis, a Debate and a Curriculum Analysis.

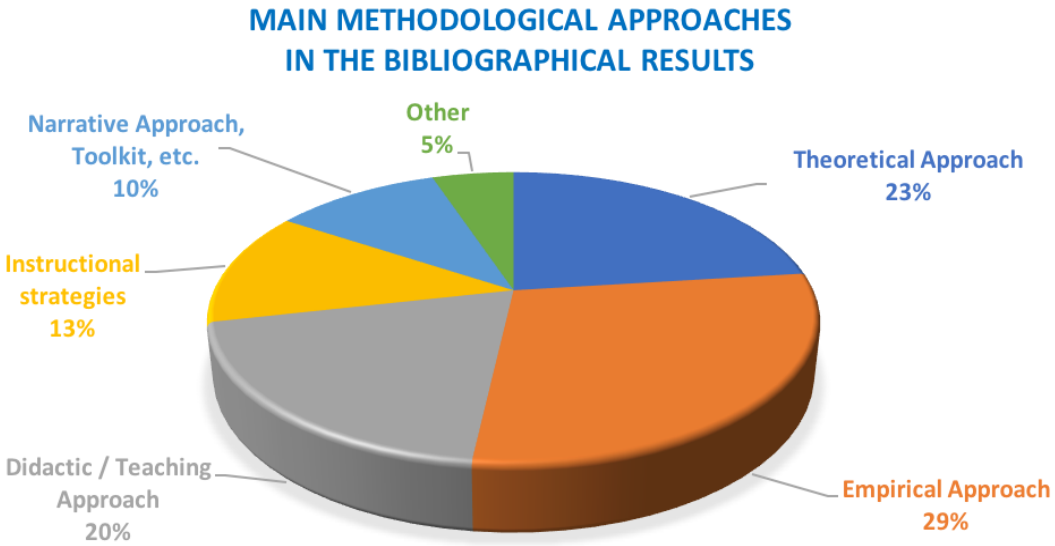


Fig. 6. An overview of the representativeness of the most significant C4S methodological approaches in the bibliographical results.

More specifically, within the Empirical Approach (which has 111 references, 29% of the total), the most widely represented type is the Qualitative one (78 items, 70%), which is therefore the approach that most characterises the whole C4S Consortium (see Fig. 7 below). With much lower percentages, the Quantitative one (20 items, 18%) and Mixed Methods (13 items, 12%) follow.

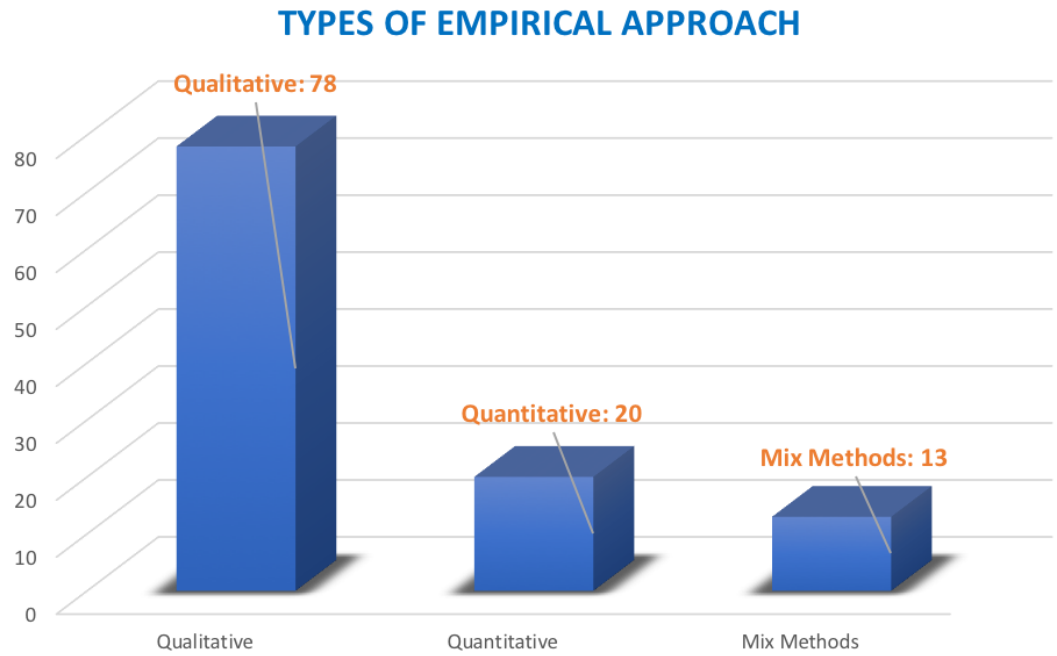


Fig. 7. An overview of the representativeness of the main C4S topics in the bibliographical result

3. Discussion of the main results

The theoretical framework of our C4S project is Science Education, especially in all its inclusive dimensions. During the literature research, this framework, as suggested in the literature review short report template (see Appendix 2), was related to both research topics and methodological approaches considered upstream particularly pertinent within C4S (see above § 2.5).

After the bibliographical research, in the light of the results found and their discussion, some topics and categories emerge as particularly significant to foster an innovative perspective of inclusive science education among children and young people (and their families) from communities in vulnerability risk conditions:

1. Science Education / STEM or STEAM approach:
   - Early Childhood Education;
   - Primary Education;
   - Teacher Education;
   - IBSE approach;
   - 3D printing technologies and virtual reality approach;
   - Diversity, ethnicity and migration;
   - Disabilities / Special Educational Needs (SEN);
   - Roma community;
2. Participation and Citizen Science;
3. Against other forms of discrimination: Gender issues, Intersectionality, Decolonial theories and Social Justice approaches

The topic of inclusive science education in the mid-2010s is scientifically established, as also evidenced by the release of several volumes (Mackic & Abels, 2016; Koomen, Khan et al., 2018). However, the practice of inclusive education is one of the greatest challenges for science teachers as well. Anyway, there is a certain lack of research in science education on how to foster inclusive education of students with different learning preconditions. The possibility of building inclusion and increasing skill struggles to find clear and defined methodologies: some research points the need to start with a reflection on what is happening in the classroom to identify effective strategies for students, with and without disabilities. Some activities using purpose-built robots with the goals of supporting/integrating usual play and social activities seem to benefit all children, including those with severe disabilities (Pennazio, 2015).

Of particular interest, in a logic of inclusive science education, seems the possibility of focusing on the affective dimension in reference to constructs based on feelings such as attitudes, values, beliefs, opinions, emotions, interests, motivation and a degree of acceptance or rejection. This approach may influence students' interest in science topics and the heterogeneity of conditions and the complexity of different forms of learning makes the results less clear overall. Certainly, the idea that an approach in ordinary classrooms is needed is now well established around the world, as some case studies well point out (Koomen, 2016; Asghar & Sladeczek, 2017; Reynaga-Peña & Sandoval-Ríos, 2018).

This approach continually refers, throughout the literature, to the competencies of science teachers, collaboration with teachers specialized in special needs education and more generally

of an inclusive school context (Kaha & Pigman, 2017; Ricci & Persiani, 2019; Tang, 2021). In the face of heterogeneous results not always systematized and in light of the risk that more complex situations of vulnerability stay out of the practices of science, the idea of building a framework of inclusive science more generally arises, i.e. a framework that is able to more fully intersect the concepts of inclusive science with a more general inclusive pedagogical perspective, as signalled by one of the most recent systematic reviews on the subject (Brauns & Abels, 2020).

Therefore, the framework of inclusive science raises significant issues in terms of school learning and social participation of children and young people; in this perspective, as we shall see below, one subject will prove to be particularly pervasive, namely the teacher training/education. The literature review findings highlight all the elements of complexity in this innovative field.

3.1 Science Education / STEM or STEAM approach

In relation to basic readings about STEM approaches, several useful readings have been found: in Davies et al. (2014) the authors provide a general overview of different pedagogical strategies and explanations when doing STEM activities with children, also bringing about different examples of activities (with water, electricity, nature…). Other readings present tips and strategies on how to conduct more specific science approaches with particular materials from an Engineering-Construction form of play (Chalufour & Worth, 2004) or in outdoor/natural contexts to work about issues on environment (animals, plants, ecosystems…) and learning in and through play in natural contexts (Chalufour & Worth, 2003; Born, 2017). Both Chalufour & Worth (2003; 2004) and Born (2017) include some references and advice about how (and why) to do STEM with all children in an inclusive manner, allowing kids to surmount invisible barriers and low-achievement gaps. For a monograph on STEM education with a diversity of topics see also Van Keulen (ed.) monograph on STEM.

Regarding a more focused approach in relation to inclusion in science education/STEM, there are several readings taking into consideration how to promote science in contexts of diversity and or about how science might not be accessible for all due to social or cultural barriers or other forms of discrimination. Thus for example the eco-justice pedagogical approach in environmental sciences seems to be an interesting tool to deal with inclusive science education approaches (Djonko-Moor et al., 2018), in order to provide empowering tools for children from underrepresented communities in science and often from low socio-economic status in so-called “eco-apartheid” contexts. This approach is useful to promote in children to take informed decisions about their daily environments and act in accordance to their daily realities and future contexts.

With the support of the British Educational Research Association (BERA), a review about potential and challenges of STEAM education towards responsive, dynamic and inclusive form of education have been conducted from 2014 to 2016. Three interconnected areas were considered in the review, including the concepts of science and arts and their implications for science education, the connection between formal school science and different access to science apart from the school system and last but not least opportunities of creative pedagogic strategies to ensure inclusive, participatory and interdisciplinary learning in science. Beside the review about theoretical and conceptual discussions regarding STEAM education, the project team hold

discussions with relevant stakeholders, practitioners and educationalists about the topic and summarized all their results in implications for policy makers and practice. Key argument of their project is that STEAM education with creative pedagogic approaches is a possibility to gain experiences and knowledge to address individual learning needs in the 21th century in inclusive educational settings (Colucci-Gray et al., 2017).

La Force et al. (2019) examined in 20 inclusive STEM education high schools in the United States, using an empirical quantitive approach, the impact of STEM education relating to race and gender. Their outcome variables focused, on the one hand, on supportive relationships, problem-solving projects and student culture and, on the other hand, on cooperation and teamwork, student autonomy, interdisciplinary work, etc. The main conclusion of the results is that inclusive STEM education reduces existing gender and ethnicity gaps.

Nasri et al. (2021) tested the effect of Universal Design for Learning (UDL) model and Multiple Intelligence (MI) theory in comparison to traditional STEM programs, using a mixed-method approach with a sampling of 122 students, who experienced STEM Learning through UDL-MI oriented STEM programs (experimental group), and a control group who received traditional classroom teaching. The result of this innovative study showed that UDL-MI oriented STEM program helps the student to get much more interested and motivated about STEM education. So, the Universal Design for Learning model is highly recommended to create inclusive STEM education classes.

Du Plessis (2020) identified the Lived Experience of Out-of-field STEM Teachers. Leadership perceptions and the complexities involved in out-of-field teaching practices in science and related subject areas are investigated through the lens of multiple interviews, observations, and document analyses. Concluding remarks offer recommendations for educational leaders, reflections on improvement strategies and educational policies. Proposals for further research of the out-of-field teaching phenomenon's impact on STEM subject areas are offered.

3.1.1 Early Childhood Education

The main topic of science education needs an in-depth reflection about the attitudes towards science of children in pre-school education that, according to some authors, has not been studied enough even though it is a very important educational stage. Scientific literacy has become an urgent and essential need for the development of individuals and countries. Likewise, through the teaching of science, the learning of other non-specific knowledge and skills is favored. A basic approach to scientific knowledge provides a solid base for future learning and favors the child to have interesting expectations when faces a new activity. Moreover, it takes advantage of and stimulates their innate curiosity, as they are constantly asking questions about the world around them, and they try, with great desire, to explain the things that happen.

Early childhood education and care places increasing emphasis on learning specific subjects: science is one of them (OECD, 2006). Given that young children deserve opportunities to make sense of the world around them (UNICEF, 1989), early childhood educators should be intentional moving forward in order to make science teaching and learning the best possible for young children providing rich and effective science learning experiences for children. When adults purposefully nurture curiosity and support learning, children can be meaningfully engaged in

activities that involve inquiry and design, laying the foundations for science skills and processes (Tippett & Milford, 2017; Greenfield et al., 2017).

In early childhood education, science education must utilize a holistic approach (i.e. for physical, social-emotional, and cognitive development) (Copple et al., 2013). Indeed, children's scientific skills, attitudes, understandings and language are promoted through investigations, observations, values socio-cultural aspects of learning, integrates students' prior experiences, and focuses on place-based experiences with natural phenomena (Larimore, 2020). While content and practices should be intertwined, in order to implement a developmentally appropriate holistic approach, non-cognitive aspects must also be included so young learners can effectively and enjoyably make sense of the world. The emphasis should be on content knowledge relevant to children's socio-cultural and environmental worlds which they can directly experience and investigate.

Early childhood educators should provide young children with frequent, play-based experiences with phenomena that are part of their daily lives, in order to support them "figuring out" rather than "knowing about" science. Early childhood science education which advocated for open-ended experiences that are inquiry-based, integrating content and practices (Larimore, 2020; Campbell et al., 2018).

Comfortable and stress-free environments, where children can enjoy learning about science and feel safe and secure while engaging in exploration, are important to design contexts that do not generate anxiety. The low but necessary impact of an adult who keeps order has also emerged as essential to the maintenance of the feeling of safety, as it averts undesirable situations. It seems that the mere presence of such an adult contributes to maintaining a favorable, safe environment and prevents most of the undesired behaviors. The materials are also important in generating a comfortable setting (Pedreira & Márquez, 2017/2018).

Sustainable Development Goals (SDG) are taken into account – SDG4 Quality education and SDG10 Reduced inequalities, SDG3 Good health and well-being – ECEC (Early Childhood Education and Care) for all children in order to contribute to their development, well-being and educational success. 94.8% of young children in the EU participated in early childhood education and care in 2018 (Eurostat, 2020).

The objective of science at ECEC is not to form a solid foundation for the future acquisition of scientific knowledge. It responds to needs that citizens have to learn about themselves, for personal development, to understand the world around them, to generate healthy habits with respect to the conservation of the environment, and to make decisions in the face of social problems, among other aspects. Studies found that the benefits of a quality early childhood education remained with a child through into adulthood. An important aspiration of education is the development of a supportive environment that supports life-long learning. Early childhood education is a critical time in which experiences that enable and enhance children's disposition towards lifelong learning are established (Cantó et al., 2019; Campbell et al., 2018).

3.1.2 Primary Education

In the context of inclusive science educational activities, there are seven relevant findings regarding the Primary Education. Even if some papers focused on different (age) target groups (one for Childhood Education and two for Secondary Education), they could be relevant for Primary Education too.

One of the main focus of the pilot action will be participative research together pupils of Primary School classes, especially on a participative research strategy (e.g. with theater pedagogical methods and community mapping) accompanied by the following questions of interest: What bores/interests the pupils them concerning the sustainability discourse? How do they understand sustainability? Even if the main focus of the workshop documentation *Nachhaltigkeitsindikatoren und Partizipation* (Wittek & Feindt et al., 2002) are adults, it got included into the literature review as it has thematical similarities with our C4S project aim. The "Leitfaden zur Förderung von Schülerbeteiligung im Eco-Schools-Programm" (Pröpsting & Stroffeva, 2010) had a similar approach and idea, by tackling specifically pupil participation in the context of sustainability and developing a guideline to promote that idea.

The Effective Pre-School, Primary and Secondary Education (EPPSE) (Siraj Blatchford & Taggart, 2014) longitudal study analyzed from 1997-2004 on what works best in supporting elementary school pupils in learning. The results show that – amongst other – (1) teaching resources should be well organized, prepared, suitable and tailored for the individual needs; (2) the concepts and ideas presented within the lessons should be clear and understood by the pupils; (3) collaborative learning; (4) personalized teaching and learning; (5) frequent plenaries at the end of the lessons for self-reflection, discussions and questions; and (6) a good, pleasant and respectful class environment are favorable for good learning-outcomes and the further educational biography.

When it comes to creating a pleasant and good class/peer-group environment, the study *The Integration of Creative Drama Into Science Teaching* from Arieli (2007) about the effectiveness of theater within science teaching showed within comparison groups its positive impact on the creation of a positive classroom environment. In addition to that, the quantitative and qualitative results showed that the drama-methods had indeed a positive impact on a greater understanding of science and self-esteem of the pupils.

3.1.3 Teacher Education

Regarding the implementation of a playful STEAM approach in teacher training programs on the one hand, and in the field of early childhood education on the other, we focus on what might be the main conditions for inclusive science education. When implementing a "STEAM integrated artful approach" where all children find ways to learn, play and develop, readings and research show the importance of "a deep level approach". For the development of this approach, we need to focus on new insights but just as much on learning pathways that support educators and engaged families in the realization of STEAM in a variety of educational contexts (Brown, 2020; De Jarnette, 2018; Monkeviciene et al., 2020).

The text Counsell and Geiken (2019) is a guide for teachers who want to implement a STEM curriculum with children from 3 to 8 years old. The book describes the use of ramps and paths to stimulate children's curiosity and inventiveness and to develop problem solving skills.

The book Porcheddu and Parrinello (2017) also deals with the scientific exploration of natural phenomena through hands-on experiences of children aged 2 to 10. It is the report of the project "Unconventional Matters", carried out in collaboration between University of Milano-Bicocca and GiocheriaLaboratori (with funding from the Italian Ministry of Education). The text focuses on: the different ways of approaching children in nursery, pre-school and primary schools; the use of recycled and unconventional materials; the structuring of learning spaces related to the

exploration of different natural phenomena; the role of adults in supporting children experiences. Within the same project, the article of Giordano and Rossi (2014) focuses on a case study of a teaching/learning experience with 5-year-old children. The case study was focused on the young children's ways to approach objects and materials in a specifically designed setting. The researchers analysed the experience from a physics education perspective through a visual narrative of selected episodes. They show how the possibility to explore a large amount of unconventional material in a non-evaluative setting supports children's insights.

Some general findings about teachers' education in inclusive education should be respected when thinking about inclusive science workshops with stakeholders and representatives from formal and non-formal educational institutions. For instance, principles of dialogue learning can be trained and interviews with teachers conducted after they joined a workshop or course about inclusive education. Results of such studies show that inclusive education trainings promote self-awareness and critical reflection of own teaching methods (Reynaga-Pena et al., 2018; Florian et al., 2010).

Furthermore, the view of education policy documents (published by the European Union and Council of Europe) is relevant for the C4S project in order to analyse and reflect their clearness towards inclusive education and to give some suggestions. General discussions about gender and ethnicity in education and science are important to detect perceptions of vulnerability and to identify gaps which needs to be closed for promoting inclusive science activities (Lähdesmäki et al., 2020; Bianchini et al., 2000).

Also a CIST (Culturally Inclusive Science Teaching) pedagogical approach is considered (Yoon et al., 2016) as a useful tool to critically reflect about the gap between the need of promoting multicultural awareness in teacher training (when doing sciences) and the lack of interest by science teachers on multiculturalism and its outcomes (low achievement by students suffering from social or economic disadvantage, etc.). This reading provide some tips on pedagogical strategies for teacher training modules that could help to overcome such lack of interest and multicultural awareness in science teachers.

Johnson (2019) illustrates that the discussion about inclusion and diversity in STEM education is a challenging task, but particularly important. Lack of knowledge and training are reasons for hesitating in this ongoing discussions: workshops and trainings for STEM/STEAM educators are opportunities to close this gap.

3.1.4 IBSE approach

The systematic literature review has selected nine results mainly dealing with primary, secondary and teacher education which as a matter of course imply a strong focus on teaching and learning methods. Obviously there is not the one and only method fitting for everybody, not even IBSE: teachers should adjust its benefit to learners individual particularities (Škoda et al., 2015). Nevertheless, science teachers' professional competence to use experiments in IBSE is an important part in their training (pre-service and especially in-service), since they are an important issue in students' motivation and have different roles and characteristics (Trna et al., 2012). Our globalised world and economy demands capable scientists and creative thinkers, which requires certain capabilities in the classroom, including reasoning skills, innovative thinking and positive

attitudes, therefore their strengthening in and through education is a vital priority (European Commission, 2014). A hands-on approach, e.g. building a mini-science exhibition with students, is a very appropriate and well-tried way to convey and experience science in a very practice-oriented way – to try out and grasp – and thus one of the most important elements in inclusive IBSE (Science Center-Netzwerk). Children's science activity books as a motivating and helpful didactic tool offer students the opportunity to gain knowledge as well as guidance in their research interest (James, 2019). Two practical didactic examples as a concept for combining vocational preparation and cultural education result in new ways of career orientation for young people, especially for special needs education (Swoboda et al., 2013; Swoboda et al., 2014). Science Centers in informal places of learning serve as a bridge for diverse linguistic and cultural environments and can make an important contribution for interactive science mediation, autonomous learning, social inclusion and intercultural communication (Streicher at al., 2014; Schneider et al., 2018).

3.1.5 3D printing technologies and virtual reality approach

The emergence of additive manufacturing and 3D printing technologies is introducing industrial skills deficits and opportunities for new teaching practices in a range of subjects and educational settings. Research investigating these practices is emerging across education disciplines, but often without reference to studies in other disciplines. Responding to this problem, Ford and Minshall (2019) synthesizes these dispersed bodies of research to provide a state of art literature review of where and how 3D printing is being used in the education system. Through investigating the application of 3D printing in schools, universities, libraries and special education settings, six use categories are identified and described: (1) to teach students on 3D printing; (2) to teach educators about 3D printing; (3) as a support technology during teaching; (4) to produce artefacts that aid learning; (5) to create assistive technologies; and (6) to support outreach activities. Although evidence can be found of 3D printing-based teaching practices in each of these six categories, implementation remains immature.

Buheler, Kane and Hurst (2014) have focused on the arena of special education. Although 3D printing is beginning to infiltrate mainstream education, little to no research has explored 3D printing in the context of students with special support needs. They found that 3D design and printing performs three functions in special education: developing 3D design and printing skills encourages STEM engagement; 3D printing can support the creation of educational aids for providing accessible curriculum content; and 3D printing can be used to create custom adaptive devices. In addition to providing opportunities to students, faculty, and caregivers in their efforts to integrate 3D printing in special education settings, the investigation also revealed several concerns and challenges.

Access to digital technologies is very important to guarantee future job employability. It can be found research related to 3D printing and adults with intellectual disabilities. 60% of adults with intellectual disabilities (ID) in the U.S. are unemployed; this is more than twice the unemployment rate of the general population. Of the adults with ID who are employed, only half receive competitive wages alongside co-workers without disabilities (Buheler, Easle, Hurst and Kane , 2015).

Since the last few decades, virtual reality (VR) and augmented-reality (AR) interfaces have shown the potential to enhance teaching and learning, by combining physical and virtual worlds and leveraging the advantages of both. Augmented reality (AR) is an educational medium increasingly accessible to young users such as elementary school and high school students. Educators from different countries have been experimenting this technology in their education systems. It can be found concrete experiences as Hougang Elementary school in Singapore, that applied an AR program (Zhu, 2016). Although previous research has shown that AR systems have the potential to improve student learning, the educational community remains unclear regarding the educational usefulness of AR and regarding contexts in which this technology is more effective than other educational mediums. Radu (2014) addresses these topics by analysing 26 publications that have previously compared student learning in AR versus non-AR applications. It identifies a list of positive and negative impacts of AR experiences on student learning and highlights factors that are potentially underlying these effects. This set of factors is argued to cause differences in educational effectiveness between AR and other media.

3.1.6 Diversity, ethnicity and migration

In relation to issues of diversity and migration (including the race justice approach) some readings emphasize how education and critical pedagogical research education play a key-role in early childhood by laying the foundation for development in conditions of equity and equal opportunities in lifelong learning – especially for those living in the most disadvantaged conditions (Chan, 2020; Khalfaoui et al., 2021; Zinga & Styres, 2018; Husband, 2019). This is because in pedagogical contexts and realities with a large migrant population (and growing diversity, multicultural pedagogical policies and the management of "super-diversity": Chan, 2020; Rosenberg, 2020), there is a tendency to understand diversity as a challenge or a problem that must be solved, and not as a wealth or valuable resource. Through this pedagogical standpoint, designed from the logic of the dominant society, the conception of education is built from the status quo (Chan, 2020; Zinga & Styres, 2018, Husband, 2019). In such condition the teacher runs the risk of transmitting biased and stereotyped information and highlighting cultures in a discriminatory way without taking into account the background of origin of the children in the classroom (Rosenberg, 2020; Murray et al., 2016, Husband, 2019). This trend towards homogenization also includes certain racial color-blindness, which doesn't help in generating an awareness regarding injustice and discrimination. Thus, many early childhood teachers believe that children lack the cognitive ability to understand the issues of racial marginalization and privilege, when in fact many suffer from individual racial differences in schools in significant and substantive ways on a daily basis. The awareness of skin color, or of the socio-cultural and economic origin, is a philosophical approach to education that openly recognizes its influence on making decisions about programming, policies and curricula in schools and classrooms (Husband, 2019, Chan, 2020; Rosenberg, 2020, Khalfaoui et al., 2021).

Given this, it is important to connect migratory processes from a dynamic conception, beyond cultural identity (Chan, 2020) thus connecting with issues of equity and access to fundamental rights. Exploring the changing relational ties over time and in different places, including transnationally, promotes an understanding of migrants that give meaning to their dynamic relationships. Nevertheless it is important not to forget that these relations are also located within the logics of expulsion in the countries of origin and in the logics of exclusion in the

countries of arrival. Therefore, besides ethnicity, sex, racialization, age, religion and cultural identity, also the traumatic migratory experience, in the case of many refugees, should also be taken into account (Chan, 2020), as part of the baggage to take into account to work on pedagogical practices (Zinga & Styres, 2018, Ryan, 2020), including the racial question (Husband, 2019, Khalfaoui et al., 2021). This inclusion of knowledge and experiences of the families should be taken into account to build a curriculum that embraces diversity in an inclusive and open way. An increase in migration and in diversification of society lead to changes in skills and knowledge in early childhood education, given that these new patterns generate new forms of prejudice and inequality (Rosenberg, 2020). For this reason, it is very important to offer formulas that reflect the entire educational community, and devise pedagogical and structural proposals that could guide teachers to change this trend, and to allow familiarizing their children with diversity from the very first moment.

Focusing more specifically in some of the readings on diversity and migration, in her research in New Zealand, Chan (2020) addresses the need to analyze the educational reality of early childhood education, with the main objective of providing equitable learning opportunities for all by implementing an approach that applies multiple and diverse socio-cultural perspectives, avoiding the folklorisation of other cultural practices. A key aspect for this to happen is raised by Khalfaoui et al. (2021), who, in their literature review, identify the pedagogical and structural practices that promote a positive classroom climate in pre-school contexts. In doing so, they show how the classroom atmosphere is determined by the interactions that take place in the classroom as a whole (including the teacher's behavior) when building a safe and respectful classroom environment and reveal how children's friendships contribute to reduce conflicts.

Also the organization of culturally and linguistically diverse classrooms in heterogeneous groups capitalizes the children and families' knowledge. This strategy has been shown to make inclusion and social cohesion easier, which ends up favoring learning opportunities for the most disadvantaged groups. In addition to this, Murray et al. (2016) stress that the programs where there are professors from diverse cultures, some cultural or geographical backgrounds can be significantly overrepresented to diverse students so that students can identify themselves with their faculty members and offering references that teachers could easily recognize, thus creating inclusive opportunities for learning. Furthermore, as suggested by Husband (2020), teachers can rely on educational materials, such as multicultural picture books, to guide and expand discussions of race and racism with young children, along with critical reflection on how issues of racial oppression, and privilege operate in the world in general and in their lives in particular.

Engaging children and families with an immigrant background or from ethnic minority groups in this educational approach, should be viewed in a broader context of societal and social realities, and in particular in the context of a prevailing neoliberalist discourse. The vision of Vandenbroeck (2020) for theorising and implementing emancipatory practice in early childhood education is an important and pertinent framework. He clarifies the meaning of "ideologies" and propels critical reflection on research results; furthermore, he demonstrates the need for a multi-perspective approach.

The importance of engaging and motivating students from ethnic minority groups in education is gaining more and more awareness by our educational policy makers. Indeed, researchers and philosophers with an immigrant background and from ethnic minority groups are increasingly

demanding a forum and a more prominent role in the debate for divers voices to be heard (Agirdag et al., 2016; Lleshi, 2018; Vesely et al., 2017).

Multilevel analysis revealed that ethnic minority teachers reported higher levels of multicultural content integration than native-white teachers. Also, that teachers working in schools with higher share of ethnic minorities and public (State) schools, incorporated more multicultural education than teachers working in elite-White schools and Catholic schools (Agirdag et al., 2016).

In the context of the C4S project, science education is relevant in relation to immigrants and refugees as humans in vulnerable risk situations.

For immigrants and refugees, education is one of the key factors to become part of the hosting society. Language skills and school qualifications are needed for being an active citizen. Especially immigrant families aim to support their children to be educated together with children of the local community. Inclusive education is suggested to build a relationship with children of the local community (Schnell & Crul, 2014). One concrete science education example is given by MacIssac (2020), who describes that the German Physical Society (Deutsche Physikalische Gesellschaft-DPG) implemented physics educational experiences for refugees offered by volunteers. Physics and other science educational experiences may be valuable opportunities if those experiences are linked with the aim of developing language skills. Boll et al. (2018) suggest to combine experimental educational programs with language skills. In the publication *Lilu's house: Language skills through experiments*, they provide didactic material and tools to develop ideas for those combinations in the classroom.

To reflect about the existing gap for inclusive classroom interventions, the study of Intxausti and Etxeberria (2013) could be interesting, because they explored in their research first-generation immigrant's families' and classroom teachers' expectation. One of the results has been that the expectations of the families were higher than the teachers' expectation, because of the fact that children establish a closer relationship to children of the hosting country. Instead, in comparison to their expectations, teachers believe that children feel more comfortable with children from their country of origin. Further reasons for inclusive education for immigrant families were identified by Isik-Ercan et al. (2017): their publication describes the effect of educational experiences of immigrant children in the U.S. through a multidisciplinary lens. Perspectives from sociology, family studies, education and mental health collected best practice examples from politics and practice to promote a cultural understanding, bilingual competencies, etc.

Most relevant for the C4S project are research activities in direction to immigrants and disability. Poon-McBrayer and Fong (2016) identified the complexity of educational offers for immigrant students with disability when it comes to language, culture and disability collide. Narrative interviews, classroom observations, teachers diaries and other relevant school data, in an inclusive school setting in Hong Kong, were conducted to illustrate and map complex issues for inclusive education from students' and teachers' perspective.

General didactic material for refugee children and young adolescents in different ages are offered by the UNHCR (2017); e.g. Mannigfold material to create a curriculum for refugee children are available to use by teachers in the school system. The material from the UNHCR needs to be reflected, guided by the question: Can the material be used for inclusive education or only for refugee children's education?

Education International (2018) aims to promote inclusive education and offers didactic material for refugees' education in an inclusive context. Additional, UNICEF (2018) should be mentioned, who give online access to didactic and science material for teaching refugees. With regard to all three mentioned didactic material opportunities from well-known organizations, in the context of refugees it is suggested to take a look into materials and use and modify them for own inclusive educational offers. The Science United Project could be an idea provider to develop science education activities for and with refugee' children as well (Gillette, 2021). Local conditions need to be reviewed when thinking about using the material in regional educational settings as well.

The theoretical paper of Delaisse and Hout (2020) is informed by a review of migration studies in the "Journal of Occupational Science". Forty-one articles focusing on international migration and presenting the results of empirical research were selected and analysed. Six non-exclusive groups are presented. The largest group includes articles adopting approaches inspired by grounded theory; therefore, not strongly relying on pre-existing theories in the data analysis. Other groups used concepts related to occupational justice or drawn from theories developed by Bourdieu, Goffman, or Ricoeur, as well as transactionalism as developed by occupational scientists based on Dewey's work. However, there are inconsistencies in the application of theory – some articles did not explicitly integrate any theoretical concepts or, among those using grounded theory, did not all develop a novel theory. We propose Lefebvre's theory of "production of space", originally published in English in 1991, as an example of a useful approach for the study of occupation in a migration context.

In Leadley, Hocking and Jones (2020), much is known about the negative experiences and long-term effects of persistent poverty on the health and well-being of tamariki children. What is less well understood is how poverty affects their participation in and patterns of occupation. There appears to be a transactional relationship between poverty, health, and occupation that is complex, with child poverty associated with risk of occupational deprivation. However, evidence to support these assertions is lacking. Specific cultural advice was sought relating to research with Māori participants. Findings indicate that a tamariki child's participation in and patterns of occupation are disrupted by poverty despite supportive influences such as positive parenting, social capital, and governmental funding. Implications from this research suggest that poverty might lead to occupational deprivation and occupational injustice that in turn might become life-long influences on individual's health and well-being.

3.1.7 Disabilities / Special Educational Needs (SEN)

Early developments in Inclusive Science Education

Ideas and projects for science education intended for students with disabilities began to develop more fully in the early 1990s, especially in the American context.

An initial literature review (Mastropieri & Scruggs, 1992) identifies some lines of development already underway and developed since the second half of the 1970s:

1. Instructional strategies (text adaptations, mnemonic strategies) prove effective in facilitating knowledge of scientific phenomena);
2. Construction of science-oriented curricula according to those activities that promote manipulative skills and abilities about developments in the scientific process.

We are still at the stage of declaring intent and developing ideals. Therefore, science education is considered useful in developing knowledge for some types of disabilities.

From the idea of rehabilitation to the idea of inclusion

In 1998, the "Journal of Science Education for Students with Disabilities" (JSESD) was founded in the United States (New York), under the impulse of the Department of Science & Mathematics of the Rochester Institute of Technology and the National Technical Institute for the Deaf.

It is with the new millennium that a concept of "inclusive science" is more fully developed, linked also to new ways of considering disability, as emblematically indicated by the "Classification of Functioning and Disabilities" (ICF, 2001) and the "UN Convention on the Rights of Persons with Disabilities" (2006). These new paradigms for considering disability intersect with the inclusive dimension at the school level as well. The literature itself brings up the idea of inclusive science in ordinary classrooms. Increasingly, the question of inclusive science for students with disabilities in university is also being raised.

The question of different modes of learning also arises in science: science and social studies are identified as effective tools that enable students with disabilities to access learning and training useful for success in school and in daily life (Scruggs, Mastropieri & Okolo, 2008). Some strategies for students with learning disabilities prove particularly effective: supports for verbal learning of declarative information; processing information in texts; activity-based instruction/experiential learning (Brigham, Scruggs & Mastropieri, 2011).

The concept of science education is becoming more and more established within the ordinary school curriculum, as also stated in the "UN Convention on the Rights of Persons with Disabilities" (artt. 24 and 30). The literature brings up the idea of inclusive science in mainstream classrooms (Mutck-Jones, Puttock & Minner, 2012) also in terms of equal opportunity (Bargerhuff, Cowan & Kirch, 2010) and social justice (Mc Ginnis, 2013).

The effectiveness of this inclusion option, however, depends largely on the teachers' ability to practice inclusion. This issue involves the question of teacher training and the need for them to be supported throughout the school system. This is in fact one of the major themes that runs through all of the identified literature.

Indeed, collaboration between science teachers and special education teachers prove effective in building a supportive instructional context and adapting lesson plans to meet science learning goals for all students in an inclusive classroom. However, this does not often prove to be an opportunity which produces greater teacher knowledge about the link between science content and learning disabilities (Mutck-Jones, Puttock & Minner, 2012).

Issues related to specific functioning such as specific learning disabilities and autism are also addressed.

Argumentation-based approaches, such as the Science Writing Heuristic (SWH), have shown that students engaged in appropriating the language, culture, practice, and dispositions of science have generally improved their critical thinking and knowledge (Villanueva & Hand, 2011). There is a need to better understand how this construct can be applied to disabilities.

How to do scientific inclusion? Between methods and criticalities

The notion of inclusive science education suggests that all students-regardless of achievement or ability-should engage in opportunities to understand the practice and discourse of science. Current teaching practices risk not effectively supporting all students, particularly those with more complex disabilities.

The best results are obtained for high functioning disabilities. Using a single-subject reversal design, for students with autism spectrum disorder, results say that there is an improvement in the ability to comprehend scientific text (Carnahan & Williamson, 2013). A comprehensive review of the literature on teaching science to students with intellectual disabilities and/or autism spectrum disorder reports interesting findings, but raises the question of further research to explore the effectiveness of interventions capable of building science skills in students with more complex disabilities (Apanasionok et al., 2019).

Of particular interest, in a logic of inclusive science education, seems to be the possibility of focusing on the affective dimension in reference to feeling-based constructs such as attitudes, values, beliefs, opinions, emotions, interests, motivation, and a degree of acceptance or rejection. This approach may influence students' interest in science topics and their motivation to persist in learning science concepts (Abels, 2015).

Questions of method pose even more decisive questions: Are science teachers positively inclined toward inclusive education? (Spektor-Levy & Yifrach, 2017). Questions of method and approach for inclusive science are posed to the underlying questions. The literature itself is divided between: a constructivist perspective, with teaching approaches that allow students to build their understanding of scientific ideas and through hands-on experiences of scientific inquiry (inquiry-based learning) (Abels, 2014) and a behavioural model that focuses primarily on teaching more knowledge-based learning programs aimed at achieving mastery of predetermined learning goals, as is also evident in some systematic reviews (Apanasionok, Hastings, Grindle et al. 2019).

There is also a risk that more complex disability situations will be continually excluded. Because of this, it is therefore necessary to identify methods and practices to be tested in the field. Their effectiveness – over a long period of time – in fostering the learning and participation of children and young people whose social conditions and disabilities producing greater exclusion represents the most important challenge in this field. Some identified inclusive science projects are moving in this direction, that are related to:

1. the creation of learning environments for science education, by bringing together and involving all the key communities in the second level science education, including science teachers and educators (academic communities), scientific and industrial communities (industrial communities), young people with their parents (social communities), policy-makers responsible for science curriculum and assessment (governance communities), and science education research communities (research communities) (Establish Project);
2. promotion of school inclusion of students with disabilities through the participation in robotics by classes of Primary and Secondary Schools of the Comprehensive Institutions in the Pistoia area - Tuscany, Italy (Ludic Science Project).

In the discussion about inclusive education, Girma (2011) reflected in his publication the core idea of diversity and equity when it comes to education which is absolutely relevant to promote inclusive education in the society. In the case of Sweden, another trend is occurred which can be a risk for any inclusive ideas in the society. The discussion is about neo-liberal philosophies, e.g.

devolution, market solutions, competition etc. which is problematic for ensuring diversity, equity and inclusion. The example of Sweden can be transferred to other European countries where economic conditions and the welfare system is high as well. In the context of the C4S project, it would be significant to reflect these trends in the partners countries to identify resources and risks for the implementation of inclusive science education activities.

Sustainable inclusive science education needs well-prepared teachers and institutions to address students with different needs (Florian et al., 2010). Well-prepared teacher include sufficient knowledge about diversity in the classroom as well. Qualitative approaches can be used to get insights about the learner's diversity in the classroom from both teacher's and learner's perspective.

Possi et al. (2017) examined in two inclusive secondary schools, diversity regarding language, gender and diversity through open ended interviews, classroom observations and focus group discussions. Further, teachers needs to be qualified in rethinking curricula and traditional school concepts to identify learning resources and needs of students with diverse cultural, cognitive and socio-emotional background. (Zulfija et al. 2013).

Contending with inclusive science education, educators should deal with participation plans, organizational strategies and research-based practices (Kurth et al., 2020). The study of Kendall (2019) underlines that inclusive education needs sustainable organizational strategies according to curricula, pre-services, financial resources, parent partnership and outside agencies.

With respect to the implementation of inclusive education in general, the second edition of the Commonwealth Guide to Implementing Article 24 of the "UN Convention on the Rights of Persons with Disabilities" is highly recommended. The author, Richard Rieser, is a disabled teacher who has more than 25 year teaching experiences in primary, secondary and further education. The guide represents among others, voices and needs of disabled learners of all 19 commonwealth countries, to develop and implement national and international policies about inclusive education (Rieser, 2012).

Associated with the topic of inclusive science education with disabled children, the CLASS project (Creating Laboratory Access for Science Students) could be helpful for developing strategies in teacher education for providing workshops for educators within the C4S project. The idea behind the project is to create and modify science learning activities for students with disabilities (Kirch et al., 2010).

Norris-Shortle et al. (2006) targeted interventions for homeless children at a therapeutic nursery and found the homeless children in the nursery demonstrate language delays, delay in the development of imaginative play, and difficulty in their attachment relationships. After an intervention involving mothers and their children positive development increased over the course of time spent in the therapeutic environment. This result shows the importance and values of support to homeless population.

Ripat and Becker (2012) studied playground usability asking children, the playground users. The findings resulted in three overarching themes. Playground experiences addressed the sensory experiences that children seek at playgrounds, the importance of creating environments that promote imaginative play and the need to provide an appropriate level of challenge. In the second theme, playground usability, participants described barriers that prevent access and features that

promote use. The third theme, inclusivity, focused on equal access and the importance of providing options in design.

Nwokah et al. (2013) studied the use of play materials among children from low-income families. The authors investigate the attitudes, practices, and concerns of early-intervention providers (professionals whose services support young children with developmental disabilities and delay) concerning their use of toys in their work and their worries about poor youngsters without such playthings. The result showed that all providers found that poverty increased the need for related therapist services, for educating parents about play, and for using play materials in therapy.

Alves et al. (2016) focused on how hip hop helped to build identity, awareness and social participation of young people in a socially vulnerable situation. This study aimed to describe and analyse the use of hip hop as a strategy for the construction of identity, awareness, participation and social inclusion of young people in the daily life of peripheral communities from the perspective of cultural rights. This research suggests that hip hop can be a useful resource in socio-educational practices, enabling critical reflection of young people in social vulnerability on their contexts, the rescue of the life course, identity construction and social participation.

Dressel et al. (2017) identified how students shared valuable knowledge and understanding one another's professions have allowed development in interprofessional education (IPE) learning experiences for students to help identify how quality of life could be improved or enhanced for children and their families across two different geographic spaces, one in rural Malawi and the other in urban Milwaukee. This study highlights intercultural understanding.

Fletcher et al. (2018) studied how sensory gallery guides for children with sensory processing challenges improve the museum experience. Results showed combining both sensory "avoiding" and "seeking" gallery guides into one sensory friendly gallery guide can have a positive impact on a child's museum experience. To achieve success, sensory gallery guides must be developmentally appropriate, provide structure for a gallery visit, facilitate active thinking, looking, and discussion, and showcase interesting gallery spaces providing a variety of sensory-rich objects.

Bowden et al. (2018) suggested that health professionals, policy-makers and educators have much to learn from children. Specifically, the need for children to participate in occupations as a way to build resilience. This indicates that a child-focussed approach is needed to incorporate children's perspectives in practice and policy development. The findings suggest that practitioners working with children should incorporate participation in occupation in social, health and education intervention plans with children, as well as use occupation based coping strategies when teaching children skills to manage challenges in life.

Armstrong et al. (2019) studied what makes playgroups therapeutic with an aim to identify the active ingredients of therapeutic and supported playgroups. The findings identified that emotional, practical and informational components of playgroups strongly reflect family centred practice, self-efficacy theory and peer-support principles.

Anaby et al. (2019) recommended practices to organize and deliver school-based services for children with disabilities. Thematic analysis revealed 10 common principles to guide service organizations (e.g. collaborative interventions and support for teachers) and seven implementation strategies (e.g. training and coordination) for employing these principles. Findings can guide rehabilitation professionals, educators, and policy-makers in restructuring well-coordinated collaborative services involving training and capacity-building of school-based

service providers. Such knowledge can contribute to the improved provision of care and, consequently, promote children's school participation and inclusion.

Echsel et al. (2019) highlighted how, in Switzerland, recent changes in legislation have reformed special needs education; more children with special needs are now integrated into mainstream schools. The findings present different approaches for children with special needs to enable their participation in everyday life at school through learning, playing, and being with their peers. The findings are discussed in relation to current international research and with respect to European countries with a similar political and structural context, thus complementing approaches to school-based occupational therapy.

Kirsch et al. (2019) described how the National Institute for Environmental Health Sciences has called for targeted efforts to engage underserved youth in environmental education programs that support environmental literacy and contribute to the development of a diverse workforce pipeline for environmental science-related occupations. The purpose of this commentary is to describe the development and implementation of a high school curriculum on environmental science and environmental justice.

Stewart and Applequist (2019) examined the perceptions of family coaching and culturally and linguistically diverse (CLD) families participating in early intervention (EI). Three major themes emerged from the interviews: (1) coaching can be an effective and empowering form of service provision; (2) although ideal for many families, coaching was not viewed as appropriate for all families; and (3) to be successful, coaching, as a newly implemented model, requires greater state support including substantive preservice and in-service training for team members.

Hodges et al. (2020) studied challenges experienced in Primary School students with ASD (Autistic Spectrum Disorder). Findings from this study highlight that students aged between 6 and 11 years experienced school participation restrictions due to a range of intrinsic (e.g. sense of self and school belonging) and extrinsic factors (e.g. school culture, educator knowledge and skills). It is imperative school-based interventions are developed and implemented in the early primary years, that not only target students' skills, but the range of environmental enablers and barriers impacting student school participation.

Sterman et al. (2020) studied creating play opportunities on the school playground and found that as they allowed the children increased independence while using creative and recycled materials. Children engaged in increased imaginative and social play, and school staff adopted higher expectations of children's capabilities.

Kent et al. (2020) studied sixty-five typically developing peers who participated in a peer intervention for children with ASD were investigated using a randomised control trial. Play sessions of the dyads were scored using the Test of Playfulness. Results showed a significant moderate intervention effect for the peers from pre- to post-intervention; outcomes for children with ASD were not influenced by peer characteristics; and the children demonstrated a similar pattern of play interaction.

Madsen et al. (2020) described the "11 for Health in Denmark" intervention in 10 to 12 years old Danish girls and boys and its effects on well-being-A large-scale cluster RCT. Three thousand sixty-one children were randomly assigned to an intervention group (IG) or a control group (CG). The "11 for Health in Denmark" intervention program had a positive effect on physical well-being in

girls (IG: 48.6 ± 8.5 to 50.2 ± 9.3), whereas the improvement was not significant in boys. The program also had a positive impact on well-being scores for peers and social support.

Finally, Murphy et al. (2021) studied the impact of the COVID-19 pandemic on therapy service delivery for children with disabilities and found that Telehealth seems to be a promising option for continuing high-quality services during the duration of the COVID-19 pandemic and for families who face barriers in accessing services in general.

The article of Villanueva, Taylor, Threin and Hand (2012) presents a review of science education researches related to students with special needs from third through fifth grade (in particular, with mild and moderate cognitive and emotional/behavioural disorders). It analyses the current practical and theoretical perspectives to fill the skills gap that students with SEN show in science learning: in particular, the approaches that emphasize the use of hands-on activities, working with peers, inquiry and debate. The article highlights the importance of the direct engagement in science discourses and practices to enable all the students to have equal opportunities to engage in science. The use of immersive experiences, inquiry approaches and the debate either in small and whole group allow the involvement, the learning of scientific languages and the possibility for everyone to develop ideas about science.

A particular method of investigating phenomena by children aged from 3 to 8 with and without disabilities is considered in the article by Counsell and Geiken (2019). Providing children with structures such as ramps and pathways on which to roll various objects allowed the observation of children's scientific reasoning and, at the same time, the teachers' acquisition of effective teaching practices. Teachers noted benefits in children with and without disabilities in both emotional and language development as well as STEM concepts.

Reich, Price, Rubin and Steiner (2010) report on the experiences of the Center for Advancament of Informal Science Education Access Inquiry Gropu (CAISE AIG). The main question that the report try to answer is: What conditions are necessary to promote inclusion in science education and which actions should be taken in the future?

The theme of inclusion in ISE (Informal Science Education) is addressed in its physical, cognitive and social dimensions; therefore, the experiences have to be realized with an Universal Design Approach: the environment has to be safe and welcoming of the diversity of individuals and their competences, in order to enable learning and social interactions. It is pointed out that in both formal and informal contexts, learning has to be always guided by the interest of the learner and therefore non-linear and open. The report provides descriptions of examples of cognitive and social inclusion in different contexts such as science museums, community youth programs and media.

An informal science learning project with children with disabilities was developed by the museum of Science in Milan by the association L'Abilità Onlus and reported in Leonardo Da Vinci National Museum of Science and L'Abilità Onlus (2013). Instead, Varano (2020) presented experiences in which the learning of astronomy is conceived according to an Universal Design Model to create learning environments accessible to all.

Moreover, Brogna, Canas, Deustua et al. (2021) provides guidelines to promote equity, inclusion and diversity in the field of astronomy and astrophysics, in order to guide policies and programs that ensure access opportunities for everyone.

Finally, the magazine "Effeta" is a periodical publication published by the Gualandi Foundation in Bologna which deals with issues related to teaching and inclusion of children with disabilities, and in particular deaf-mutes. It wants to focus the attention of teachers, policy-makers and citizen in general on the issues, strategies and tools that are most appropriate to make inclusion effective within the schools and social contexts in which children with disabilities live.

3.1.8 Roma community

The CP (child participation) movement/approach mentioned above has been integrated in a number of projects addressing Roma marginalization in Bulgaria.

A team of international child's rights researchers and practitioners have succeeded to promote Roma youth leadership using CP approach to address the culture of non-participation (Percy-Smith et al., 2016; Percy-Smith, 2016). A team of Roma-Bulgarian researchers have stimulated a number of children's-led projects in a marginalized Roma community. The project has resulted in Roma children's successful school graduation, decrease of school drop-outs and early marriages (Markova & Ganev, 2014).

Markova (2021) has suggested that CP in the Roma communities can heal the culture of silence caused by marginalization only if the adults living in those communities feel free to participate as well. Therefore, it is essential that when representatives of the majority population implement CP approaches there they have to apply the Lundy (2007) and Ainsworth principles (2015) in their interventions with the adults as well. Just focusing on the children is not enough. The same conclusion has been drawn when implementing CP at the Bulgarian school system. In order to stimulate CP the teachers have to be freed to participate more authentically (Markova & Gilligan, 2012). Otherwise they would not be able to notice child's motivation to explore, to be curious, to be authentic and would not be the audience the child needs to participate before.

3.2 Participation and Citizen Science

Concerning of promoting participation through Science Education, a study in Finland (Varis, Jäppinen et al., 2018) analysed the effects of a citizen-science project within physics with pupils from a lower secondary class. The results show that one effect of the citizen science project was the students' recognition of the importance of (physical) knowledge as a fundament of decision-making. After the project most of them expressed the readiness of participation within the society and to get active.

Within the non-academic readings, the position paper from social workers / youth workers (Vorstand der Arbeitsgemeinschaft für Kinder- und Jugendhilfe - AGJ 2020) declares the relevance of opening science towards the opinions and perceptions of young people. Therefore, it could be seen as a narrative approach. The paper states that the research process should open a (social) space for exchanging ideas and concerns, as well as for an equitable dialog between young people and scientists. The roles and rights should be clarified transparently and power-sensitively. Finally, young people should be involved into science as it has the ability to empower them by including them as relevant co-creators of their own surroundings and environment.

Neuroscience and learning through play: a review of the evidence (Claire, Lynneth et al., 2017) is a white research summary paper and could be categorized as "Theoretical/Bibliographical

Research". It summarizes neuroscientific and biological perspective and findings about playful learning with children. When working with children it is important to acknowledge their playful and curious nature and to see that as an important key for promoting their learning processes. Learning is emotional, as neuroscientific studies show that learning and cognition is not separated, but rather interwoven. Therefore, joy and the production of dopamine seem to be the most powerful element for positive learning procedures (e.g. for the memory, creativity, motivation, curiosity, plasticity). Further learning-experiences should be meaningful, actively engaging, iterative, socially interactive, in order to conduct a playful and beneficial learning-process for children.

The literature findings with instructional strategies and narrative approach imply a toolkit (Sotiriou, Koukovinis et al., 2017) on how to combine science with theater, focusing on science literacy, teamwork and cooperation, and the development of creating and critical thinking. The other two papers present various way on how to engage children and young people within a research action (Save the Children, 2000; Amsen & Van Wynsberghe, 2005).

Communities for science leads to the reflection about citizen science activities. Publications and projects about citizen science are represented in this literature review as well to collect ideas about how citizens and communities can be involved in participatory research and intervention strategies. The working group or network "Bürger schaffen Wissen" in Germany collect citizen science projects and papers about the topic on their webpage. Furthermore, the working group invites regularly to meetings and workshops to discuss how citizen science projects and activities can be realized. A handbook for practitioners is available on their website as well, which offers hands-on material for citizen science activities in different areas and topics (e.g. citizen science and social science, citizen science and health science, etc.) (Pettibone et al., 2016).

Few citizen science projects were listed in connection to the C4S project. Relevant for any citizen science projects and activities is a toolkit published by the ACTION project. The consortium of the ACTION project consists of representatives from universities, research institutions and non-profit organizations from six European countries. Within their project methodologies, guidelines and tools were developed with the aim of democratizing the scientific process, in order to ensure the involvement of citizens in the process. The toolkit is based on the participatory science lifecycle, which is an applicable framework to start thinking about participatory science activities (ACTION Project, 2021). Two concrete citizen science projects in Germany will be shared in this short report to give an idea about Citizen Science. The first is about a citizen science project in the north-western part of Germany, the "Weser-Ems-Land", where the nitrate pollution of water is high. To monitor the water in this area, schoolchildren and citizens do together with scientists research to protect the water in their region (University of Osnabrück, 2019). The second project is named "Ampel Pilot": the research institute for Ophthalmology, in cooperation with the Faculty of Computer Science at the University of Applied Science, works on an app for smartphones to recognize red and green phases at the pedestrian traffic lights. As far as I understood the webpage of the project and the University, they include their students with visual impairment, to collect data of pedestrian traffic lights all over the country for developing the app (Straßer, 2019).

The benefit of inclusive science education is represented in non-academic publications as well as describes above in the literature review. For instance, the initiative "Future Earth" aims to include perspectives from marginalized groups in the discussion of climate change, to use their thoughts

about the topic as fruitful resources (Polk et al., 2019). This is just one example to understand the value of empowering people in vulnerable risk situations to address global challenges.

For social, emotional and academic learning, and as a prerequisite for students greater achievement in school, better academic performance in school but also success in life, the general CASEL framework (2005) points out the safe, caring, well-managed and participatory learning environments. We will target this element via training teachers into a child participation approach that takes into account the children's understanding of scientific facts and their cognitive abilities and developmental specificities.

Article 12 of the "Convention on the Rights of the Child" says that children are entitled to participate in the decisions that affect them. This key principle's implementation has evolved into an expanding interdisciplinary field and into an international movement called Child Participation (CP). The evaluation of the CP projects show that when children are listened to adults obtain new understanding about their needs which leads to change of policies and practice that protect the children from stigma and discrimination. CP build the children's own self-esteem, helps them find ways to support themselves and others, build better communities for them and for the others (Steinitz, 2009; Smith & Burns, 2013).

Still, even in the social sector where children live in situations of high risk of abuse and neglect, findings indicate that they feel they were not being asked, listened to or heard (Falch-Eriksen et. al., 2021). In the field of early education experts conceptualize CP as an interactional child-adult process and suggest that adults exercise ongoing reflection on the everyday activities of the classroom and playground, in order to truly respond to child's communication and stimulate her/his participation (Theobald, Danby & Ailwood, 2011).

CP is not only an interactional process. It suggest that children and young people freely express their views in their families, schools, communities, and services. To guarantee this, adults have to challenge their attitudes and obtain skills. First, they have to revise their shared believes that children are not aware of their real needs and are able to evaluate their environment. Second, they need to have the skills allowing CP to unfold and guarantees that children's views are not only expressed but also considered important and are acted upon (Lansdown, 2001).

In the field of education in Bulgaria, CP has been implemented through a pilot project in 3 schools and 1 kindergarten. Key principles used as a CP framework in those projects were identified by Mary Ainsworth (2015), who coined the term "sensitive parenting" as a set of behavioural components that a parent should provide in her/his relationships with the child. They are listening, hearing, understanding and responding to the child's messages. When applying those components children develop trust, feel secure and motivated to be curious, explore their environment, maintain their motivation and achieve results. The project resulted in teachers' increased trust in the children who became more active in the academic process, more curious and self-reflective, they initiated a number of activities and were persistent to successfully implement those. For example, a group of the children explored the needs of being informed about politics and set up a radio program at school.

Interestingly enough, Ainsworth's components of sensitive parenting are similar to the ones suggested by Laura Lundy (2007) in her model of CP. Lundy is a Professor of international children's rights at the School of Education at the Queen's University of Belfast, who suggested that CP has to be based on four key elements to be provided to the children to elicit their

participation. They are: space, voice, audience, influence (Lundy, 2007). These elements need to provide the safe space where the child can freely voice her/his needs before an attentive audience that can take actions following what was expressed.

In general, the participatory inquiry was found to increase curiosity, responsibility and academic achievements (CASEL, 2005; Steinitz, 2009; Smith & Burns, 2013; Theobald et. al., 2011). It is argued that curiosity is intrinsically interwoven with scientific thinking by motivating information-seeking, question-asking and deep learning (Jirout, 2020) and in addition may causally affect and be affected by learning itself (Oudeyer, Gottlieb & Lopes, 2016). However, the effect of curiosity upon science education and deep learning, in particular, is not extensively studied. It was reported that the spontaneous curiosity of two-year-olds enhance discovery of the relations between distinct objects and help young children to go beyond specific visual characteristics of objects and to encode them as pairs, related in a specific manner (i.e. same objects or different objects in a pair) (Walker & Gopnik, 2014 cited by Gentner, Shao, Simms & Hespos, 2021). That early form of relational discovery is encouraging keeping in mind the developmental trend of insignificant relational use before 4 years of age, called relational shift.

Moreover, relations are often considered as important ingredients of scientific discovery and transfer of scientific knowledge. If curiosity may shift the onset of relational learning it may be of key importance for early science education. Indeed, too little is known about the impact of curiosity on the scientific thinking mediated by deep learning of pre-school than school-aged children. In addition, the motivation to go beyond the information, to fill in the knowledge gaps, and to integrate is mostly measured within a single scientific domain (Jirout, 2020), whereas the curiosity of pre-school children is rarely driven by one topic or the subject of interest. Also, less is known on how curiosity can be measured (Bustamante & Greenfield, 2019) and in turn may promote deep learning in underrepresented and understudied samples.

3.3 Against other forms of discrimination: Gender issues, Intersectionality, Decolonial theories and Social Justice approaches

In relation to the connections between science/STEM and gender discrimination issues, some useful readings have been found. One possible approach is by studying urban and rural children and youth's drawings by analising their conception of scientists using the DAST (Draw-A-Scientist-Test) method (Ruiz-Mallen & Escalas 2012). The DAST method is a relevant tool to detect biased (gendered and analysed, amongst others) conceptions of science. The authors detected that children follow a general tendency of reproducing stereotyped images of scientists (the majority drawing scientist as a middle-age to old man, wearing glasses and a white coat and working inside a lab) with a high tendency in the correlation of being a boy and having a stereotypical association of a scientist as a white male. The researchers also detected that the older the children the more gender-stereotypes their drawings had, leading to the hypothesis of the influence of media-related images of scientists upon children's construction. In a different line of analyses, Dangelmayer and Hermann (2017) provide a powerful reflection on the gendered bias in STEM

careers and present the "girls-approved" strategy as a counter-movement used to overcome gender barriers in STEM careers through innovative strategies in technological fields.

When providing analysis about gender discrimination issues together with other forms of discrimination, some readings using an intersectional approach in STEM careers/Science Education have been found. Thus, understanding the factors intersecting population (especially women) from minority or indigenous backgrounds (Miller, 2017; Boisselle; 2016; Maina Okori, Koushik & Wilson; 2018) becomes essential, allowing to understand better, Kimberlé Williams Kreenshaw's gender intersectional theories (i.e. the multiple sets of discrimination that women and girls suffer also as members of minority groups or groups in vulnerability risk situation). Miller (2017), on the other hand, reflects about gender and intersectionality by contrasting the success of Afro-Caribbean women in STEM with the difficulties African American women face in STEM careers. She proceeds with her analysis in order to detect what strategies Afro-Caribbean women used in the USA to surmount the strong barriers and stereotypes in biased institutional practices. Based on Ogbu's, Weber's and Banks' ideas, as well as using the Critical Race Theory (CRT) as a guiding framework, the author examines how race-constructs privilege some communities in detriment of others (often following patterns of underrepresentation). Some of the results show the importance of having strong family ties in which the male and female family caregivers would play a central role as well as the relevance of other factors such as being able to self-define their cultural identity, having family environments promoting learning-transferable values, strategies and skills, and being individuals with an important level of self-confidence.

Two other papers on STEM from intersectional and decolonial approaches offer a different perspective concerning the role of science as a non-neutral cognitive-epistemological activity, showing that is never devoid of interests promoting it. While both papers acknowledge the importance of science to discover and explain phenomena and to confront current and future challenges, they also stress the past and present colonial use of science and its effects upon indigenous population. In doing so, they show that science not as a free-floating sets of practices but rather as a set of institutional practices enmeshed with political and economic interests and strategies that may have historically affected negatively certain communities in favor of others. Such approaches show how certain individuals and communities from privileged (colonisers) positions may have in relation to science spaces and practices in detriment of others (the colonised). A detrimental position that in certain cases may still persist. The value of these papers also resides in that have been written by researchers members of indigenous communities themselves and, as such, also affected by colonialism and colonial science practices.

Thus, Maina Okori, Koushik & Wilson (2018) provide ideas, in their literature review, on how to develop an environmental approach taking into account feminist, intersectional and decolonial approaches together with indigenous and other complementary intersectional or environmental perspectives, to provide broader and more up-to-date environmental approaches in actual science interventions against environmental degradations in Environment and Sustainability Education (ESE). On the other hand, Boisselle (2016) presents a paper from her standpoint as Creole Researcher from the island of Trinidad. She reflects about how the colonial and naïve-neo-positivistic version of science is still embedded in the Science Curriculum, thus leading Trinidad teachers to an old-fashioned and naïve version of science that follows the so-called "Standard account of Western Modern Science" (WMS), very similar to how science was naïvely conceived during the colonial period in the XVIth and XVIIth century. As a result, the author reflects on the

importance of promoting a more up-to-date and complex relational and non-reductive science that could be combined with Indigenous science (and contexts) more in accordance with current anti-neopositivistic and anti-reductionistic approaches of science. Grounded on the Bristol's notion of plantation pedagogy, she stresses the importance of reengineering Caribbean classrooms through a decolonising methodology from a community-focus, in connection with indigenous knowledge and interests to co-create an indigenous agenda for science education with social interventions and community services ("place-based science"). This idea of a respectful approach of science, from postcolonial context (and decolonial stance), would also aim at the emancipation and improvement of the local indigenous communities.

Three other papers address specifically intersectionality in more general terms. One of them (Gregoriou, 2013) offers a literature review of research based on intersectionality. And there are two more papers focused on intersectionality in education. One centered in early childhood education (Lee, 2002) and the other in secondary schools (Sáinz et al., 2020). The main ideas arisen are that intersectionality affects educational system in its whole, not only to students but also to parents (Sáinz et al., 2020). For this reason, it is important to promote trainings in gender perspectives for both parents and teachers, as well as including the gender perspective in curricula (Sáinz et al., 2020). There is also a claim for identifying intersectionality – or a lack of it – in our discourses (Gregoriou, 2013) and beliefs (Lee, 2002; Sáinz et al., 2020), as well as to pay more attention to our actions in education in this regard (Lee, 2002; Sáinz et al., 2020).

This reveals the importance of being aware from which socio-political position authors think and write. Also underscores of the "gendered transnational geographies of power" in migrant students (Gregoriou, 2013, p. 181). Following this idea, she also shows the importance of the constitution and reconstitution of student and teacher subjectivities and the different levels of intensity and power depending on the situations and the agents involved (teachers, peers, etc.). In another research (Lee, 2002), it is shown how teachers' also have a stereotyped perceptions of children. They consider boys are gifted in mathematics and science and girls gifted in arts and language. In this line, they imagine children's professional future from a gender-bias perspective thus affecting their interactions with their children. As a result, it appears to teachers as if gifted girls were inexistent to them, thus leading to the idea that the teachers' prejudices create barriers to girls, particularly in mathematics and science. Also in Sainz et al. (2020), it is reflected how the teachers' expectations of pupils performance have an impact on their final scores, leading to the conclusion that gender differences affect youth career choices. In front of this, the authors claim in favour of promoting trainings in gender perspective for both parents and teachers, as well as including the gender perspective in curricula.

Some other international Global Reports are useful to better understand how to tackle issues of inclusion for students with a diversity or disadvantaged conditions or finding barriers in education (UNICEF, 2020), how to promote inclusion for children from a diversity of migrant background in primary education (NCCA, 2005) and on the effects that the COVID-19 had upon children and adults with disabilities and possible interventions (UNICEF, 2020). Also some children's books readings have been found addressing science education (or science related topics such as environmental issues) visibilizing diversity and gender equity as part of its contents addressed to children. Thus in Ada the Little Scientist (Abrahams, 2016), issues of inclusion of gender diversity and cultural diversity in STEM are part of its background conceptualisation. A similar approach from a real biographical story can be found in the children's illustrated book Wangari's Trees of

Peace: A true story from Africa (Winter, 2018) based on Wangary Maathai's life. A book addressing more specifically issues of environmental justice for children with some important women in science is that about Eco-heroes from different communities and countries worldwide (Magrin, 2020). In relation to this, a study about the knowledge of early childhood educators on multicultural literature (Brinson, 2012) could be a useful tool to assess and address and promote inclusive science books in schools and nurseries and to provide teacher's training and tools in this sphere of inclusive children's literature.

Inclusive education emerges as a main topic in the view of the society toward difference (not just considered as special educational needs). In order to implement inclusive education and to advance the inclusive process, it is necessary to be aware of the contextual educational policies and culture. Both inclusive education and the fact of taking into consideration the concept of difference require actions to stimulate, coordinate and sustain efforts based on the idea that changes in learners can hardly happen unless changes in adult behaviours take place. Therefore, the starting point of this never-ending process must always be to involve all professionals working around the educational task, at all levels, expanding their capacity to reflect and imagine what could be achieved, as well as increasing their ethical sense and responsibility in achieving such goal. Teacher training plays a key role in this issue, therefore questioning the conceptions implicit in teaching practices must be included at all levels.

Science education of quality for children from vulnerable groups are promoted in order to help to reduce social inequalities and narrows the competence gap between children from different socio-economic backgrounds (UNICEF, 2011; Bennett & Tayler, 2012; Khalfaoui et al., 2020). Sure Start Children's Houses programme for families was established to promote the physical, mental, social and emotional development of young children (Vandekerckhove et al., 2019). Sure Start recognises the crucial role parents have in the development of their children, and the organisation is keen to involve the parents in education and development from day one.

Vulnerability and marginalization needs to be reflected under the umbrella of the current COVID-19 pandemic scenario. Gaynor and Wilson (2020) examined correlations between social vulnerability and the disparate impact of COVID-19 on black bodies: theoretically the authors illustrate that vulnerable communities have less possibilities and resources to face and recover from natural and human-made disasters. In their research they identifies that the death rates of black people are higher in some regions of the United States than of non-black people. The essay shows that of course the COVID-19 virus does not distinguish between race, gender, religion etc., but because of racism and marginalization a lack of infrastructure maybe given which affects the curation of the infect. Gaynor and Wilson (2020), with regard to other vulnerable communities, show that the disparate impact of COVID-19 needs to be discussed to identify further inequalities in health care.

The work for Social Justice from the early childhood classroom is a political challenge, since openly discussing and challenging issues of racism in the current world can have professional or personal consequences. This exercise can become an emotional, mental and professional effort and an exhausting journey if done individually. To avoid the feeling of loneliness and isolation, early childhood teachers must be willing to work collaboratively with groups, struggling for resistance and combatting racial injustice in schools. They also must be willing to develop interracial alliances and support networks (with parents, community members, colleagues, peers, etc.). This change in consciousness from racial theory and critical pedagogy includes the need of receiving training in social concepts and diversity in the sense provided by Rosenberg (2020), who defends that the first area of social studies where teachers from early childhood can work on issues of diversity is the element of "culture of diversity". It is related to offering children experiences with different origins, ethnicities, cultures, national minorities, indigenous groups and ways of living and thinking. Yet, a recurring approach, however, is to re-contextualize a cultural artefact, or themes in the wrong context that lead to discrimination and exclusion of certain children. Owing to this, a method of highlighting the diverse origins of children is to use cultural artefacts, ingeniously with a critical and non-discriminatory perspective, and to avoid a superficial representation of cultural diversity within a group of children. To be possible, following Ryan (2020), it is necessary to incorporate the stories and drawings of the lives and migrant's trajectories, as they are told by themselves, following Ryan's analysis of the existing social networks and transnational ties.

Finally, as Zinga and Styres (2018) reflect, each of us has our own lifelong learning journey. One of the important responsibilities as educators is to continually and actively pursue our own learning journey, and simultaneously facilitate and challenge students on their learning journeys. The challenge is to embrace the (often messy and tangled) realities of decolonization and anti-oppression. This work leads to a critical and transformative praxis that requires being willing to face how are we involved in relations of power and privilege, creating ethical spaces where we can critically examine those relations of power, tensions and challenges in a meaningful and purposeful way. Thus, it becomes important to ask ourselves whether we are willing to leave (or not) our comfort zone to challenge our taken-for-granted assumptions, and also to ask how we can engage with the reality that would emerge out of the process of reinventing ourselves as critical educators.

Also other publications from the "Nature Journal" and "Associated Press" address issues on inclusion and discrimination in the sciences field (Forrester, 2020; Nelson, 2020; Larson, 2020) as well as other initiatives to promote inclusion in sciences are described in online sites (Scarlett, 2021).

Appendix 1. Preview of the Excel template

Excel sheet of academic books and papers:

		flag the corresponding box; if you answer yes, please specify								flag the corresponding box		flag the corresponding box; if you choose the box "Other", please specify			
Codex	Author(s)	Is the author / Are authors belonging to a target community? If yes, which one?		Year	Title	Place of publication	Link (if any)	Abstract/Summary/Explanation in English	Focus / Keywords	Type of research		Approach			
		Yes	No							Qualitative	Quantitative	Intersectional	Community-Based	Participatory	Other (specify)

Excel sheets of Non-academic readings, Didactic material and Related projects:

		flag the corresponding box; if you answer yes, please specify							
Codex	Author(s)	Is the author / Are authors belonging to a target community? If yes, which one?		Year	Title	Place of publication	Link (if any)	Abstract/Summary/Explanation in English	Focus / Keywords
		Yes	No						

Appendix 2. Literature Review Short Report - Template

[The information that you will summarise in this document and in the attached *fiche* will be collected and reorganized to elaborate the D4.1 on Literature Review.]
[Please write clear statements and follow the instructions below.]

1. General information

[Answer the following questions in relation to your bibliographical research.]

1.1 Partner's professional basic data

[Who was involved in your bibliographical research?]
[Which thematic areas of interest / C4S dimensions have guided your research?]

1.2 Local target community in vulnerability risk situations

[What is your target community of reference?]
[Did you have difficulties and/or special issues to find relevant C4S readings about your community of reference?]

1.3 Keywords

[Which of the suggested keywords from the Literature Review Protocol did you use to conduct the bibliographical research?]
[Which ones were most useful to find results for C4S?]
[Did you use some new keywords? If so, which ones?]

1.4 Search engines, databases and online libraries

[What research tools/strategies did you use?]

2. Summary of the main results

[Develop your bibliographical summary taking into account your local target community in vulnerability risk situations.]
[Attached to this template there is a *fiche*, i.e. a short guide which could be useful in order to organise your findings and then write your summary.]

Please, **follow this structure** in order to write your summary:

1. Group all your found readings by **main topics / subjects** (see **Fig. 8** below); keep in mind that a reading can fit into different topics / subjects (in this case, explain to which topics /areas of interest it refers to);
2. For each topic / subject give a **brief general discussion** of the readings it contains, also examining the findings in light of the methodological approaches which are used in the bibliographical references (see **Fig. 9** below);
3. Within the same topic / subject, some readings might also be **subgrouped** together depending on their similar (or opposite) results (see the examples below);
4. In case that there are some readings **specifically interesting or dealing with very specific C4S ideas**, please describe them in more detail (with a brief clarification or specification);
5. Use the **APA style** for bibliographical references:

https://apastyle.apa.org/style-grammar-guidelines/references.

Inclusive Science Education OR Science Education AND:
- Disability and/or Special Educational Needs (SEN);
- Roma Community;
- Immigrants & Ethnicity;
- Gender & Intersectionality;
- Early Childhood Education (0-6 years old);
- Primary Education (6/7-11/12 years old);
- Secondary Education (11/12-16 years old);
- Teacher Education.

Fig. 8. List of main topics / subjects (see *Fiche* § 1).

One or more of the above topics / subjects AND:
- Theoretical / Bibliographical Research (methodological speech, policies, etc.);
- Empirical / Practical Approach:
  - Qualitative (interviews, focus group, narrative inquiry, observations, etc.);
  - Quantitative;
  - Mix Method;
- Didactic / Teaching Approach (i.e. classroom interventions);
- Instructional Strategies (citizen & science);
- Narrative Approach (i.e. experiences), Toolkit, etc.;
- Other.

Fig. 9. List of methodological approaches (see *Fiche* § 2).

Below there are **two examples** of paragraphs summarising some of the found readings.

Example of writing 1 (SciShops Project, D2.1).

The guides for conducting CBPR and establishing science shops (NEF, 1998; NIEHS, 2000; Teodosiu, 2005; Shallwani and Mohammed, 2007; Sparks, 2016; O'Mahony et al., 2013, Steinhaus et al., 2013) should be considered in future work of the SciShops.eu project, since they cover organisational, financial, and topical issues. The challenges with CBPR and science shops discussed in the reviewed literature (Banks et al., 2013; Weiner and McDonald, 2013; Wolfson et al., 2017) should also be an important topic in the process of planning new science shops; the experienced partners in this area are expected to help the new ones. […] The literature reviewed extensively discuss the issue of participation. Caution is raised regarding a term "engagement", which may not reflect the true form of public participation in science (Rodríguez, 2011). Gathering the public and members of the scientific community does not automatically mean the engagement of citizens with science in agreement with the most relevant dimensions to deal with the issue. Provided that science shops release annual statistics or reflect on their past projects, the multidimensional concept of engagement may be analyzed in order to know what kind of participative conditions are offered. This would turn abstract concepts like 'participation' or 'engagement' into more pragmatic and manageable ideas.

Example of writing 2 (Multi-Act Project, D1.4).

The systematic literature review has selected 49 studies (published in English between 2016 and 2019) on patient engagement in health research and development, 14 of which are dedicated to patients with MS or other brain diseases. The reviewers then provided preliminary answers the 5 research questions posed by the Consortium on the basis of the literature examined. Answering the research questions serve as basis to develop the MULTI-ACT Patient Engagement guidelines. […] For patients with rheumatology, for example, attempts are being made to develop a framework to advance patient engagement reporting (Jennings et al., 2018; Hamilton et al., 2017). However, some authors have tried to develop methodologies to measure RoE. For example, Zhang et al. (2017) followed the GRADE approach to integrate patient values and preferences into health decision-making and the development of practical guidelines. Adams et al. (2017) have demonstrated in their Stepmethodology approach that there are metrics to assess the impact of patient engagement at each stage. Kreindler and Struthers (2016) developed a Patient Participation Tangible Effects Assessment Sheet (STEPP) to assess the organisational impact of patient engagement, as reported in the previous chapter on results.

Summary text [max 5 pages]
[Write here the summary of your main results, organised by topics and following the style writing of the above examples.]

Bibliography
[List your bibliographical references in alphabetical order using APA style.]
[This bibliographical section does not count in the page limit.]

3. Additional comments
[Write here any comments or information you find useful for the literature review.]

Try to respect the given structure as much as possible.
Be aware that we will use this information for the final literature review report, so it is important that all partners follow the same structure.

Fiche - A short guide for an overview of C4S bibliographical results

[Flag the fields in the following tables. Several fields can be flagged simultaneously.]

1. Main topics / subjects

Reading Codes	Inclusive Science Education OR Science Education AND								
	Disability and/or SEN	Roma Community	Immigrants	Gender	Intersectionality	Childhood Education	Primary Education	Secondary Education	Teacher Education
[FUBAc01]									
[FUBNon-Ac01]									
[FUBDid01]									
[FUBProj01]									
Total									

2. Methodological approaches [if detectable]

Reading Codes	**Theoretical** (methodological speech, policies, etc.)	**Empirical** (i.e. perceptions / beliefs)			**Didactic / Teaching Approach** (i.e. classroom interventions)	**Instructional Strategies** (citizen & science)	**Narrative** (i.e. experiences), **Toolkit, etc.**	**Other** (specify)
		Qualitative (interviews, focus group, narrative inquiry, case study, observations, etc.)	**Quantitative**	**Mix Methods**				
[FUBAc01]								
[FUBNon-Ac01]								
[FUBDid01]								
[FUBProj01]								
Total								

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