

Erasmus+ KA3 – Support for policy reform

## SPEM – Schools Plastic Free Movement

621506-EPP-1-2020-1-IT-EPPKA3-IPI-SOC-IN

# D 5.1 Inclusive pedagogical model for gifted, migrant and disable students

Partners:



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### DOCUMENT CONTROL PAGE

Document name and Deliverable:	Inclusive pedagogical model for gifted, migrant and disable students (D5.1)
Document responsible Organization:	P07 – University of Burgos – UBU (Spain)
Document collaborating Organizations:	<p>P01 – Istituto Comprensivo di Bosco Chiesanuova – Polo Europeo della Conoscenza - Europole (Italy)</p> <p>P02 - Regional Directorate of Education Castilla y Leon – JCYL (Spain)</p> <p>P03 - Panevezys Provincial Educational Centre – PRSC (Lithuania)</p> <p>P04 - Make it Better – MiB (Portugal)</p> <p>P05 - Turkish Ministry of National Education -MoNE (Turkey)</p> <p>P06 - Friends of Education – FoE (N. Macedonia)</p>

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### DOCUMENT HISTORY

Version	Date	Editor(s)	Changes
0.0	09/10/2021	Ileana Greca, Miguel Corbí y Jairo Ortiz-Revilla (UBU)	
0.1	18/10/2021	Ileana Greca; Miguel Corbí y Jairo Ortiz-Revilla (UBU)	Revised version after partners' suggestions
0.2	8/11/2021	Ileana Greca, Miguel Corbí y Jairo Ortiz-Revilla (UBU)	Proof-reading version
1.0 Final version			

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# 1 Introduction

Schools Plastic free Movement – SPEM is a co-financed project within the Erasmus + program (KA3 - Social inclusion and common values) with the grant agreement number 621506-EPP-1-2020-1-IT-EPPKA3-IPI-SOC-IN. SPEM project aims at answer to the priorities of the European Commission to develop and implementing innovative methods and practices to foster inclusive education and promote common values, in particular enhancing the acquisition of social and civic competences, fostering knowledge, understanding and ownership of values and fundamental rights.

To address these priorities the project will develop and implement, through the creation of a movement of educational organizations, a new inclusive pedagogical model addressed to children aged 5 to 13 in particular to those at risk of marginalization and underachievement (migrant, disable, high potential and gifted pupils). In this way the project will develop an educational strategy to prevent early school leaving and to improve the motivation to approach the studies of STEM subjects and the scientific careers as a paradigm and tool for a social change to a sustainable future.

The challenge of this project is to inspire pupils so that they follow the idea of a possible scientific career from an early age to give their contribution to the protection of planet earth. SPEM, starting from the ecological consciousness that young people have shown in these years, wants to create a pedagogical approach that gives them the awareness that by studying they can change the world. The project will create a Schools Plastic Free Movement gathering all the involved institutions at European level to boost concrete actions to reduce the plastic pollution and to promote scientific careers as an important contribution to protect the earth.

The movement aims to educate future generations in respect for the environment and to encourage children to experiment with the many and varied ways of replacing the use of plastic with alternative, sustainable, and biocompatible materials. Spreading pro-social values among children and young people will pave the way for a future society that is respectful towards the environment.

This deliverable presents a suitable pedagogical framework for reaching these objectives. SPEM framework is based on the available scientific evidence and it addresses three core themes:

- 1) inclusion,
- 2) behavioural change, and
- 3) the pedagogical model that teachers can apply.

From the several theories and models of behaviour and behavioural change, the SPEM partnership has adopted Social Practice Theory, in which is it proposed that non-human ‘actors’ have a role in causing certain behaviours. The pedagogical model starts form the theoretical framework for integrated STEAM education. Integrated STEAM (Science, Technology, Engineering, Arts and Mathematics) is an educational approach that focuses on solving relevant and authentic problems close to the everyday life of students. It is considered an ideal approach for inclusive education, staying close to students’ interests, focusing on skills development (and not only on concept learning), and making use of learner-centred, hands-on and collaborative methodologies. This theoretical framework helped to define a coherent inclusive pedagogical model for change behaviour at school, characterized by three steps: Problematization, Understanding, and Action. Finally, as examples of good practices, the deliverable introduces two didactic sequences that have been implemented with a total of four groups of students, with gifted Primary School students.

## 2 Inclusion at school: a European right

The concept of inclusion has changed over the years and, at present, the European Union is firmly committed to educational inclusion, as evidenced by the various documents and resolutions that have been drafted. Inclusive education in the European Union is considered a right.

Some of the recent milestones that stand out in this regard are the Joint Report of the Council and the Commission on the implementation of the strategic framework for European cooperation in education and training -(ET 2020)- (European Union, 2015), the European Pillar of Social Rights (2017) and the Council Recommendation of 22 May 2018 on promoting common values, inclusive education, and the European dimension of teaching (2018).

The Joint Report of the Council and the Commission, ET 2020, (European Union, 2015). highlights the need for EU member states to ensure equal access to high-quality education, reaching out to the most disadvantaged groups and integrating people from different backgrounds into the educational environment. Among the main challenges identified within the priority areas of the report, the following is affirmed: “inclusive education, equality, equity, non-discrimination and the promotion of civic competence” (p. C 417/27).

In the strategic framework for European cooperation in education and training (ET2020), it is proposed to address student diversity and access to inclusive, quality education for all students. The importance of active citizenship and the need to pay attention to the growing diversity of students is pointed out. It also places special emphasis on certain groups such as disadvantaged groups, students with special educational needs, immigrants, and gypsies. Moreover, it includes the need to address such problems as discrimination, segregation, violence, and stereotypes. Regarding this last aspect, it includes a particular issue aimed at promoting more gender-balanced educational options, and the need to address the problem of gender differences in education and training (European Union, 2015).

Finally, ET 2020 is committed to continue working on active and innovative methodologies, interdisciplinary teaching and collaborative methods for the development of skills and competencies, especially among disabled and disadvantaged learners (European Union, 2015).

The European Pillar of Social Rights (European Union, 2017) establishes education, training and lifelong learning as the first of its 20 principles, where it specifies that “everyone has the right to quality and inclusive education, training and life-long learning in order to maintain and acquire skills that enable them to participate fully in society and manage successfully transitions in the labour market” (p. 11). This same document includes the right of all children to receive adequate education and the inclusion of people with special needs.

The European Union Council Recommendation (European Union, 2018) to member States is to promote inclusive, quality and lifelong education. This recommendation includes the need to provide “the necessary support to all learners according to their particular needs, including those from disadvantaged socioeconomic backgrounds, those from a migrant background, those with special needs and the most talented learners” (European Union, 2018, p. C 195/4).

### 2.1 Diverse schools and profiles

Over the years, the treatment of educational needs in schools has varied. In the 1970s, the first approaches appeared that were aimed at the normalization of disability. They replaced the old

framework of impairments for the special needs framework and led to a series of educational reforms in Europe and the United States (García-García et al., 2019).

The Salamanca Statement (UNESCO, 1994), a framework of action for special educational needs, sets out how children should learn together, whenever possible, regardless of their difficulties or differences. Educational policies and approaches have been progressively updated in different countries, moving towards inclusive education along the lines proposed in the Salamanca Statement.

The Salamanca Statement affirms that “the fundamental principle of the inclusive school is that all children should learn together, wherever possible, regardless of any difficulties or differences they may have. Inclusive schools must recognize and respond to the diverse needs of their students, accommodating both different styles and rates of learning and ensuring quality education to all through appropriate curricula, organizational arrangements, teaching strategies, resource use and partnerships with their communities.” (UNESCO, 1994, p. 7).

In 1996, The European Agency for Special Needs and Inclusive Education was created at the initiative of the Danish government and with the support of the ministers of the EU member States, as an independent agency to provide a permanent and systematic structure for inclusion within Europe (Ramberg & Watkins, 2020).

According to the European Agency for Special Needs and Inclusive Education (2015), the different countries of the European Union are committed to working on inclusive education systems, although they do so in different ways according to their contexts and history. According to the agency itself, the purpose of inclusive systems "is to ensure that all learners of any age are provided with meaningful, high-quality educational opportunities in their local community" (2015, n.p.).

Currently, most European countries operate a mixed schooling system that combines regular or ordinary schools and special-needs schools (Ojeda et al., 2019). A commitment to education in the member States has seen the opening of special schools in many countries, for attending to special needs. Nevertheless, most countries are making the transition to inclusive schooling (Ebersold et al., 2011).

Ramberg & Watkins (2020) reported differences between countries in terms of the identification of students with special educational needs and their response to inclusive education. The data analyzed by the authors show that standard schools coexist in most European countries alongside some type of independently operated specialized school. No country has enrolment rates in inclusive settings of 100%; an average of 98.2% inclusive schooling in 2016 and oscillations between countries ranging from 92 and up to 99.5%. The data point to an upward trend towards inclusivity in recent years.

The change taking place in schooling is an evident fact, with increasingly heterogeneous groups of students in terms of abilities, needs, and interests, and the emphasis is currently placed on favouring the inclusion of all schoolchildren, especially during the compulsory stages of education (Santamaría Conde and Corbi Santamaría, 2020).

The commitment to inclusive schools requires interpreting individual differences as opportunities to improve learning rather than as problems to be solved. Thus, inclusive policies and schools should value the achievements and contributions of all students, regardless of their personal or contextual characteristics, tending to reduce inequalities (UNESCO, 2017).

Inclusive schools should aim for students to learn to be, live, and participate in society, working with the community and taking on a social projection that goes beyond the strictly educational context (Santamaría Conde and Corbi Santamaría, 2020). In short, it is necessary to bet on a school that promotes inclusion and equity, attending to the needs of each child and the diverse realities that can

be found in schools. In addition to working on approaches that involve all students, in order to achieve participation in society.

On all these grounds, our proposal tends to work for the enrichment of the interventions based on the special characteristics of people at risk of exclusion. Thus, we can say that diversity is a tool to enrichment and not a problem of adaptation.

## **2.2 Children at risk of exclusion due to gender; socioeconomic, and cultural differences; cognitive, motor & sensory disabilities**

Coexistence has been somewhat inherent to human beings, in so far as our relationships with other human beings is among the biggest differences that distinguish the human population from any other species. There have always been some individuals with greater adaptative capacities than others when exercising this coexistence. Nonetheless, society has at the same time promoted behaviours that have left some people struggling to count where they have the right to count, somehow turning them into victims of the mainstream. It is here when we can talk about exclusion or risk of exclusion, because of multiple, varied reasons. In Europe, since 2015, there has been the reception of unprecedented numbers of migrants, mostly from war-torn areas in the Middle East and Africa (OECD, 2015). With the predictions on global climate change issues, we can consider that we are close to a new era of mass migration, which will further enhance the presence of diversity within European societies. In this day and age, the diversification of societies requires acculturative processes, both for immigrants and non-immigrants from the host society, to achieve positive inter-ethnic relations and long-term social harmony among culturally diverse citizens (Schachener, 2019).

It has previously been mentioned that European Union documents (European Union, 2015; 2018) lend special attention to the situation of vulnerable groups within education, in view of their socioeconomic, cultural, and gender-based situation and are committed to address aspects such as discrimination, segregation, and inequality, thereby enabling the development of active citizenship for all.

The risk of exclusion in childhood is present in several countries of the European Union, although it is not evenly distributed among the different states. Inequality is conceived as one of the main causes and consequences of social exclusion. Various socio-cultural factors may be involved in inequality, which can lead to social exclusion, such as birth and residence in disadvantaged environments, educational and employment levels of parents, and being the offspring of migrant parents. The risk of exclusion and the combination of different factors means that these children start their lives in disadvantaged situations. Their access is more limited than their peers to such basic services as health and education, to which other limitations may be added, such as language barriers in the case of immigrants (Save the Children, 2014).

Exclusion can manifest itself in different ways with the involvement of personal and social factors. Garcés-Delgado et al. (2020) referred in their work to four characteristics that determine the risk of exclusion among children. Children who:

- Were born or grew up in families with low levels of both education and economic support.
- Have few social support networks
- Are part of a culture that is either in a minority or socially excluded from itself
- Have had family or personal breakdown, or both.

Therefore, for Save the Children (2014), contextual and family aspects have a strong association with the risk of child exclusion. The lack of parental education is usually related to jobs with lower income levels that increase the risk of poverty and exclusion among children, although it in no way implies the lack of caring and loving relationships between parents and children. Similar situations are reported for the children of migrant parents, who often have access to lower paid jobs in the host country. In addition, they may encounter greater difficulties when accessing basic services and other barriers such as language barriers. Also pointed out as factors that affect the risk of exclusion in childhood are family aspects, such as the composition of the family home. Some examples are the increase in single-parent families and large families, with at least three children dependent on the parents.

We should not forget factors such as economic crises, where low-skilled, low-wage and fewer stable jobs are hit with greater virulence. To this we must add the migratory crisis with the increase of refugees arriving in the European Union in search of asylum (Czymara, 2021) and the effects of the COVID 19 pandemic (Lidegrant et al., 2021; González & Bonal, 2021).

In addition to the previously mentioned implications over access to education among the most disadvantaged groups (Save the Children, 2014), there are other challenges such as absenteeism and early school dropout, which occur more frequently among children at risk of exclusion (Veland et al., 2009; Lavrijsen & Nicaise, 2015). Also, as a result of the pandemic and the telematic educational attention carried out in many countries, other situations have worsened, such as those derived from the digital divide that occurs among the most disadvantaged groups (Martínez-Pérez & Lezcano-Barbero, 2020).

Gender segregation is another problem of concern in the European Union. There is an underrepresentation of women in STEM professions that has persisted for decades despite attempts to change this situation. The Organisation for Economic Cooperation and Development (OECD) echoed this female under-representation in STEM professions, with decisions starting in adolescence and indicated the importance of gender stereotypes at the school stage and the implications they can have on future choices for studies and career options (OECD, 2017). Stoet and Geary (2018) suggested that, in addition to advancing science education and gender equality for girls, it is necessary to incorporate intervention approaches that encourage women to join the STEM pathway.

## 2.3 Characteristic of inclusive schools: setting guidelines for action

Despite all the previously discussed legislation on inclusion within Europe, the reality of schooling is not always ideally suited to an inclusive focus, due to the large number of factors, dependent on very many variables, that can be summarized by the importance of two pillars of inclusion: knowledge and experience. Even so, according to Nargis and Tikly (2010), there are some points to be evaluated and developed, in order to lay the groundwork for good and effective interventions for supporting inclusion.

### ◆ Developing leadership for inclusion and diversity

The inclusion proposal must rely on a shared vision that the leadership team has to be capable of creating for a culturally inclusive school. This group has to be actively involved in recognizing the situation and the milestones to work on. The action of this group will be determined by policies and plans, but there will also be action plans for policy implementation. The leadership team must



comprise staff, learners, governors, and parents, that is, the responsibility for implementation operates across all levels of the school.

#### ◆ **High expectation and achievement for all**

Expectation and achievement in a culturally inclusive school are focused on all the students, not only on those at risk of exclusion. A clear description of a plan for inclusivity has to be drawn up and monitored throughout the duration of the project. Data are used to set targets for the school, department, and individual pupil level. In this way, the development of an accurate picture of student progress despite different realities will help to identify areas for interventions.

#### ◆ **Respond positively to diversity**

New trends in inclusion tend to liken diversity to a great opportunity to educate, and not as a problem that needs to be adapted. The reality at school reflects the reality of society and vice-versa, so school may be considered as a seedbed for a better future. School is a welcoming place for students and families from different backgrounds and is responsive to the needs of newly arrived learners, while diversity enriches the school environment for all.

#### ◆ **Encouraging innovation and change**

Facing the risk of exclusion, the school will almost always introduce innovative change. Once a school starts to turn into a culturally inclusive centre, innovation and change is bound to follow. Those changes must be deeply studied and all necessary resources be available. Change must be considered a tool to test new policies, that may be changed again in case of negative results.

#### ◆ **Learners' voice**

Schools that have decided to go down the road of inclusion will need to know, to understand, and to take the views of young people at school seriously, as well as their aspirations. Since the learners contribute positively to the culture of the school, their voice also plays an important role in school decision-making. It is recommendable for learners to have an opportunity to participate in wider activities including a governing body.

#### ◆ **Ethos of respect**

An inclusive school must be a safe learning environment, free from bullying. Bullying incidents must be monitored and dealt with efficiently and effectively according to the national policies. Although all staff must apply the policy fairly and consistently, the main way to promote respect for diversity must be knowledge of other people's cultural realities. This knowledge is acquired not only in class lessons, but from the whole school environment.

#### ◆ **Culturally inclusive curriculum**

Curriculum is one of the most important ways to develop an inclusive school. An understanding of cultural, status-related, linguistic, and religious diversity is the key to inclusive behaviours at school and their development. Schools must promote the acquisition of knowledge facilitating teaching and learning through proper contents, but even more importantly, through experiencing the advantages of this understanding. The curriculum needs to reflect the contribution of different cultures and realities throughout different historical epochs for an understanding of the modern world; practices that can be shared in both formal and informal sessions.

#### ◆ **Engaging parents, carers, and families**

All the actors must be included in the inclusion proposal. Thus, parents and carers must be part of the learning process, so the schools can provide them with continuous communication, but also with support for them to nurture their children's learning. It may be done with learning opportunities for parents including training on inclusion and diversity.

### ◆ Staff learning for inclusion and diversity

Another important aspect is that the school managers can no longer take the inclusive training of their teachers for granted. Thus, a strategy for training teaching staff in inclusivity appears very important. For example, leadership programmes for headteachers to incorporate issues of inclusion and diversity. As we are living in a changing world, this training must be regular, providing a range of learning opportunities for educators, including participation in complex processes to improve professional practice.

## 2.4 Integrated STEAM Education for inclusion

Given the characteristics of inclusive schools, we wish to present an educational approach here that has proven its effectiveness at developing inclusive curricula: integrated STEAM. Integrated STEAM (Science, Technology, Engineering, Arts and Mathematics) is an educational approach that focuses on solving relevant and authentic problems close to the everyday life of students. It is considered an ideal approach for inclusive education, staying close to students' interests, focusing on skills development (and not only on concept learning), and making use of learner-centred, hands-on and collaborative methodologies, (EU, 2015).

Because of its integrative nature, distanced from the traditional compartmentalized pedagogical treatment of disciplines, the use of interdisciplinary and transdisciplinary approaches is preferable, although there are other more basic levels of disciplinary integration (Gresnigt et al., 2014) that could also have a place. On the one hand, integrated STEAM education shares a common basis with its predecessor, STEM, that mainly seeks to encourage scientific-technological vocations. On the other hand, it contemplates the inclusion of the arts, which favours the achievement of comprehensive competence development, social inclusion, public participation and sustainability (Colucci-Gray et al., 2019; Ortiz-Revilla et al., 2018; Zeidler, 2016). According to Quiley and Herro (2016) "The goal of this approach is to prepare students to solve the world's pressing issues through innovation, creativity, critical thinking, effective communication, collaboration, and ultimately new knowledge" (p. 410).

Within a still unexplored and relatively recent panorama, there are some authors who have proposed certain theoretical frameworks to support and to guide the application of STEM and STEAM approaches, generally from a purely methodological viewpoint. In this report, we turn to the theoretical framework of Ortiz-Revilla, Greca and Arriasecq (2021), as it is the most sophisticated and holistic so far, in terms of the aspects that are at stake, whether epistemological, psychological, and didactic, and their contemplation.

Specifically, this theoretical framework constructed for integrated STEM and STEAM education is based on the epistemological position of the American philosopher of science Larry Laudan (1977), for whom scientific progress is determined by the number of problems a theory can solve, i.e., its problem-solving effectiveness. The theoretical framework adopts the triadic network of justification, in order to embrace this maxim in the integrated STEAM education approach, (Laudan, 1984), a model that implies an epistemological analysis of scientific development composed of three levels of scientific commitment to the same status that interact in a complex way and whose modification is not always simultaneous: commitment to theories, to methods, and to aims (see Figure 1). Thus:

- Methods justify theories, while theories constrain methods.
- The aims justify the methods, and the methods show how the aims can be achieved.
- Finally, theories and aims must be harmonized.

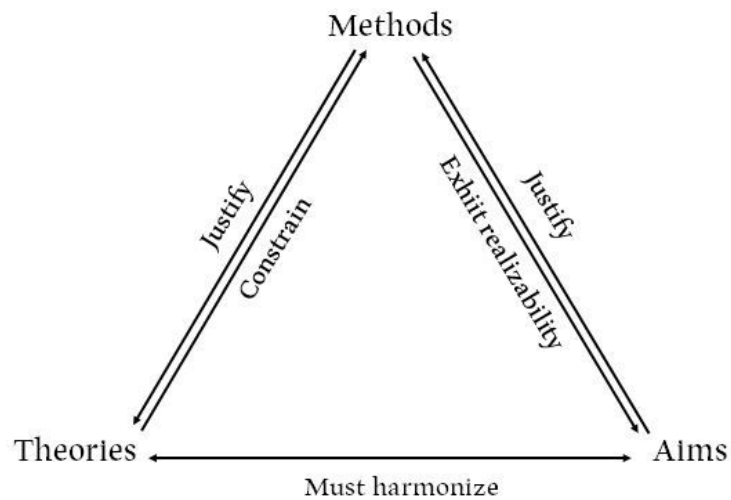


Figure 1. Triadic network (Laudan, 1984)

In this sense, the viable methodologies to be used are restricted by the theories that were adopted on the basis of the choice of objectives. Thus, the aims of integrated STEAM education from the framework to which we adhere is the integral competency development of all the students, not reduced to a compressed vision of the old conceptual, procedural and attitudinal knowledge, but assuming a much broader perspective in which various dimensions converge (Ortiz-Revilla, Greca & Adúriz-Bravo, 2021). Given this complex and encompassing nature of the competency framework, it is logical to think that the range of disciplines that integrated STEAM education embraces and its integrated nature can nurture the various dimensions of competency in a more significant way. It is presented as an appropriate approach for the development of student competencies at higher levels of development, which is valuable for all students (Ortiz-Revilla, et al., 2018). Hence, it is necessary to employ an appropriate methodology that makes this objective possible. In line with the view that science represents a permanent problem-solving activity and with the definition of STEAM that has been adopted, the use of active methodologies is proposed. Thus, the repeated insistence on the use of certain methodologies in the framework of integrated STEM and STEAM education is justified by the aim that is pursued.

In addition, theoretically speaking, certain lines related to epistemological, psychological and didactic issues have to be considered, the articulation of which completes a robust framework that is adjusted to the proposed aims. As will be seen below, the choice of theoretical constructs for each line is determined both by their internal consistency and their coherence with the other two levels of the triadic network.

It is worth stressing that this framework is supported by methodologies that are flexible, interactive, interdisciplinary, experience-based, and activity-oriented —as described below-, introduced in STEM interdisciplinary learning environments, in line with United Nations Educational, Scientific and Cultural Organization (UNESCO) Guidelines for Inclusion (2005a).

## 2.5 Inclusive methodologies

Based on the previous section, there is a set of viable and active methodologies to be used in the integrated STEAM framework. Among the wide range of viable active methodologies, in this case we have chosen Inquiry-Based Science Education (IBSE), engineering design, design thinking and socio-scientific inquiry-based learning, as they provide the most opportunities for inclusion.

In this sense, we take the proposal of Greca and Ortega-Sánchez (2021) on STEAM didactic methodologies for citizenship education, in which critical thinking skills, reflection on scientific processes, and integrative social and ethical processes are required, in addition to reducing the gender gap. The following methodologies were identified for this study:

### ◆ Inquiry-based science education

One of the most beneficial methodologies for the development of 21st century competencies. It is a complex process of constructing meanings and coherent conceptual models where students formulate questions, investigate to obtain answers, understand and construct new knowledge and, finally, communicate their learning. The authors point out that this methodology requires activities that involve observing, formulating researchable questions, seeking information from various sources to learn about existing knowledge on the subject matter that is addressed, identifying variables related to the question, designing, planning and conducting experiments, collecting and interpreting data, reviewing ideas based on scientific evidence, developing explanations and models considering alternative explanations, and communicating results and conclusions. This process is similar to the various ways in which scientists study the natural world and propose explanations based on the evidence (see Figure 2).

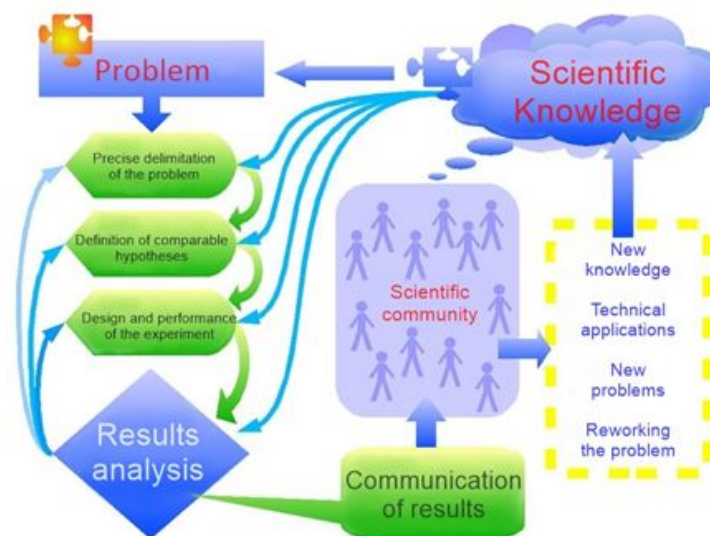


Figure 2. Scientific work (J. F. Melero, 2007)<sup>1</sup>

According to their observations, when students work with this methodology, their engagement in scientific activities and thought processes allows them to develop knowledge of scientific ideas, as

<sup>1</sup> From "Cycle of scientific investigation", de J. F. Melero, 2007, Wikimedia Commons (<https://commons.wikimedia.org/w/index.php?curid=2449935>). CC BY-SA 3.0.

well as an understanding of the way scientists work. Inquiry-based science education is considered an inclusive teaching-learning pedagogical approach, provided that the teacher uses structured and guided instruction that reduces the strong cognitive load usually associated with science learning; and can therefore achieve not only learning goals, but also intrinsic motivation and epistemic beliefs (Aditomo & Klieme, 2020).

### ◆ Engineering design

This application is among the daily activities of engineers and technical professionals, i.e., focused on the design, analysis and solution of complicated problems with the aim of meeting social needs, either through new developments or the improvement of what is already available. Generally, these professionals address interdisciplinary problems, so the types of challenges they address are usually unstructured and open, involving a number of interrelated factors such as the problem, knowledge, availability of resources, potential users, as well as a variety of social, political, etc. aspects. In the school environment, the authors point out a circular process with stages or phases in which this methodology is organized (see Figure 2): problem statement, problem investigation, development of possible solutions, selection of the best possible solution, construction of prototypes, evaluation of solutions, communication of solutions and redesign.

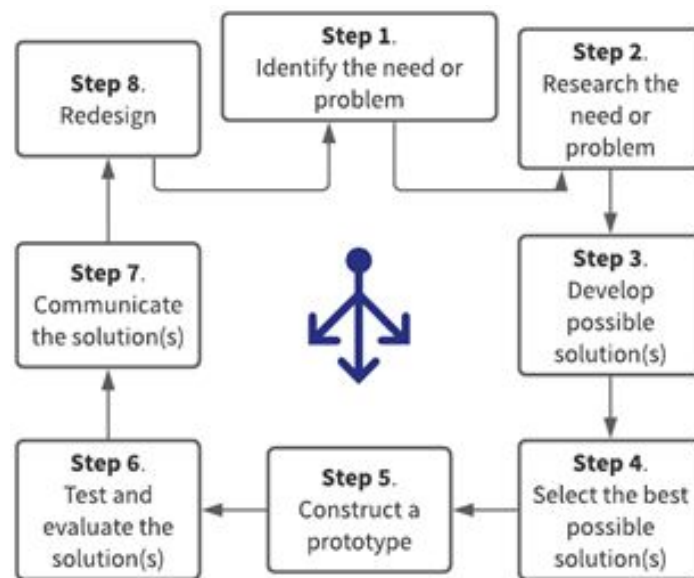


Figure 3. Engineering design process (Greca & Ortega-Sánchez, 2021).

The potential of this methodology for employment in an integrated STEAM approach has previously been noted in the literature (Chien & Chu, 2018). The inclusive potential of this methodology is linked to the fact that diversity implies much more relevant group solutions.

### ◆ Design thinking methodology

A holistic problem-solving process using various techniques with great visual and plastic content. It is defined as a methodology focused on solving problems in an innovative way, with the focus on users

and technological possibilities. This methodology allows the development of humanistic perspectives and, although the similarity of working with a systemic thinking as the engineering design, the latter adds emotional elements to the design, such as the affinity of the product for the users and its efficiency. The authors pointed to five non-linear stages through which this methodology passes (see Figure 4): empathize, gain a deep understanding of users' behavior and needs; define, to create coherence from the information gathered to retain relevant information; ideate, to brainstorm to get a good number of possible solutions; prototype, to turn ideas into reality; and test, to prove the feasibility of solutions. As design thinking cultivates the expression of one's own identity and cooperative impulses, it is presented as a powerful methodology for inclusion.

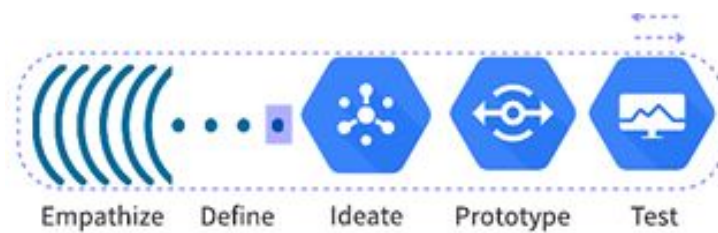


Figure 4. Design-thinking methodology (Greca & Ortega-Sánchez, 2021).

#### ◆ Socio-scientific inquiry-based learning

A relatively recent methodology that connects the mechanisms of the inquiry methodology described above, socio scientific controversies, and education for citizenship. It is based on the premise that the educational system has to be a fundamental pillar for students to move towards awareness and active social engagement. Its central idea is the investigation of a problem, usually in the form of a dilemma or controversy, leading to an improvement of local and global conditions, and the production of democratic actions based on scientific knowledge (see Figure 5). In this sense, the solutions found to the problems posed often lead to new questions, with which a new cycle of inquiry can begin, helping to enhance reflection. The democratic nature and the ethical component with which this methodology operates are two strong pillars for fostering inclusive environments.

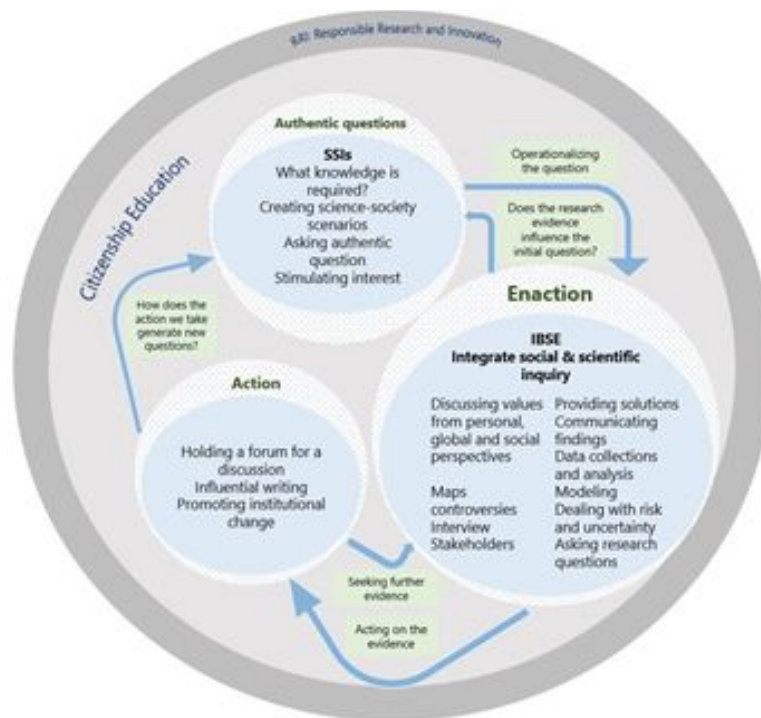


Figure 5. Responsible Research and Innovation (Greca & Ortega-Sánchez, 2021).

## 2.6 Wide scope of action for inclusion (students, teachers, and families)

Schools are the reflection of society and vice-versa. It is not possible to understand one without the other. Thus, not only do schools need to be supported by an enabling legal, policy and financial environment, but they will also be influenced by the interaction of the different actors. At same time, the educational centres are sources that disseminate most of the features for a better society. Several conditions have to be met for such a source to exist, involving the educational system, teachers, and families.

### ◆ Legal framework and policy

The first step to ensure the success of inclusion is undoubtedly to count on a legal framework for raising and addressing issues of inclusion and diversity. Implementation of a suitable legal framework is required through national policy, but a clear intention for working on inclusion will be reflected by targeted funding. Besides this first step, a long-term plan with intermediate objectives is also required.

### ◆ The curriculum

One of the main actions of governments when working towards an inclusive environment is the presence of certain contents in the academic curriculum. As occurs with other contents, these should be oriented towards the integral development of the student for future performance in society. However, they should also perform an integrative function for the present, facilitating the development of an inclusive character, on the one hand, and to facilitate the inclusion of at-risk students, on the other. For example, while the development of good language and communication

skills is essential for the future of any primary school pupil, it is also a key element of inclusion for migrant pupils.

The practice of these actions is based on national law, but also serves for their evaluation and modification if necessary. On the other hand, we must be aware that in some countries there is a gap between what the law states and how it is applied. The analysis of curricula and competences related to inclusion should also be evaluated and monitored on a regular basis.

#### ◆ **Teacher training**

When schools are becoming more inclusive, one of the first matters to be tackled is teacher training. The realities of students at risk of exclusion are so diverse that it is very difficult to have specific training for all of them. However, there are common guidelines to all situations of exclusion which must be studied and assimilated by the teaching staff. Nowadays, it is still usual to have people with a similar cultural background in academic teams, therefore, schools have to provide their teachers with the necessary cultural training, to be able to identify and to remedy situations that entail a risk of exclusion.

#### ◆ **Regional support**

At a local level, the important role of regional support raises the achievement levels of all learners, so that they become more diverse in their outlook. The schools can receive assistance from the regional level in the labours of monitoring, advising, and evaluation such as those which facilitate the identification of people at risk of exclusion, promoting innovation and disseminating good practice, and establishing prosperous links between schools and society.

#### ◆ **Parental engagement**

Parental engagement is crucial when developing and maintaining schools of an inclusive character. Parents Associations usually organize participation in several activities (academic, cultural, leisure time, and administrative, etc.) and are often called upon by schools to take part in a wide variety of responsibilities.

The inclusive school must provide parents with opportunities to support their children's learning about inclusion, as they do with any other curricula content. This resource not only aims to provide parents with tools to attend to their children, but it is also a way to influence the family context. Parents become, at the same time, active and passive objects of the inclusive learning process. It may well be expected that this measure will help to turn the closer environment into a more inclusive space, with the corresponding influence on society.

## **3 Change of environmental behaviours**

As many philosophers and scientists have noted, we are living a new era in which the human being has become a transformative force with a global and geological scope. This new era is called the Anthropocene, a term coined in 2000 by the Dutch chemist Paul J. Crutzen (1933), winner of the 1995 Nobel Prize in his field for his contributions to the chemistry of ozone in the Earth's atmosphere. In the Anthropocene, humanity's combined impact on the Earth equals or exceeds the power of natural forces (geological and biological). An impact that is accelerating global warming and biodiversity loss, both central global issues. Although there is no single solution, nor any common consensus for solving these incredibly complex problems, it might appear relevant to rethink the society/nature nexus from a relational perspective- In this sense, the ethics of care and ecofeminism open possible avenues. Their contributions can help us to rework the links between the



human and the non-human, to question the reductionist vision based on the idea of autonomy and individualism. The ethics of care offers another entry point by placing the notion of interdependence at the centre, which in terms of the crisis of civilisation should be read as eco-dependence. These notions imply a radical shift in our environmental behaviour and in our self-perception. Following our line of argument, in the following sections, we are going to discuss how such a change of environmental behaviour could be promoted within inclusive school settings.

### 3.1 The environmental problems of plastics

From the many global issues that human beings have caused during the Anthropocene era, plastic pollution has become one of the most pressing environmental issues, as rapidly increasing production of disposable plastic products overwhelms the world's ability to process them as waste. Plastics define the way we live today, although their use and production were not widespread until after the Second World War. They transformed medicine with life-saving devices, lightened cars and airplanes, opened the skies to space travel, saving fuel and reducing pollution, saving lives with helmets, incubators, drinking water cleaning devices... Plastics are cheap processable materials that improve the quality of life for millions of people all around the world and make our lives easier, safer and more pleasant, while they are crucial to speed up European evolution towards a low-carbon circular economy where resources and energy are utilized in the most effective way (García J. M., 2014).

The success of plastics can be attributed to the combination of a number of factors, including a reasonable price according to their application, low density, great versatility for the preparation of goods of different shapes and sizes, as well as chemical inertia. So, plastics can be found in almost every sector, in building and construction, in textiles, consumer products, transportation, sports, electrical and electronics and industrial machinery, medicine, food industry, packaging, etc. With such high demand for so many different applications, global plastics production in 2019 reached almost 370 million tons.

Currently, most plastics have a useful life of 50 years or more. However, the convenience of plastics and their widespread use has led to a throw-away culture where single-use plastics represent almost 40 % of all plastic produced each year. In general, these plastics are related to packaging, and particularly in the food industry. These products have a lifespan of minutes, hours or days, while they remain in the environment for hundreds of years. Out of the total of plastic waste ever produced globally, 9 % is recycled, 12 % is incinerated to produce energy, and the remaining 79 % is either stored in landfills or released to the natural environment (d'Ambrières, W., 2019).

Plastics are generally cheap to manufacture, and they are chemically resistant, so they degrade slowly. Billions of tons of plastics have therefore accumulated in the environment since their manufacture. Most of the plastic floating in the oceans comes from the land or from major rivers, and once in the ocean can be transported all around the world. This way, the most common findings in coastal clean-ups are cigarette butts, plastic bottles and caps, fishing nets, straws, plastic lids, grocery bags... and they come both from irresponsible individual behaviour and from poor waste management systems. Plastic pollution is a pressing environmental issue challenging the world's ability to deal with it. The pollution associated with the extensive use of polymers is a technical matter, and it is related mostly to social, cultural, political and economic aspects. Plastic pollution is more visible in developing countries in Asia and Africa, due to an absence of or inefficient garbage collection systems, but also in countries with low recycling rates (Plastics - the facts, 2020, d'Ambrières, W., 2019). Disposal of a single-use plastic bag or a polystyrene tray is a problem, which

increases if the user does not separate it, sort it, and properly dispose of it in an adequate waste container.

Plastic waste can be sorted by size. All plastic items of 5 mm in dimension or larger are macroplastics (chairs, shoes, bags, vehicle parts, fishing nets, etc.) and anything smaller is a microplastic. Microplastics can be primary, if they were manufactured at those sizes, or secondary if they were formed by the disintegration of larger plastics (wind, sunlight, and sea waves degrade large plastic waste into small particles) (see Figure 6). Microplastics can be further broken down and plastic microfibers have been detected in municipal drinking water and in the air. Wastewater is filtered in treatment plants where (both primary and secondary) microplastics have been found and over 98 % of microplastics are removed in the treatment process. However, due to the large amount of water being treated, the final effluent still contains microplastics.

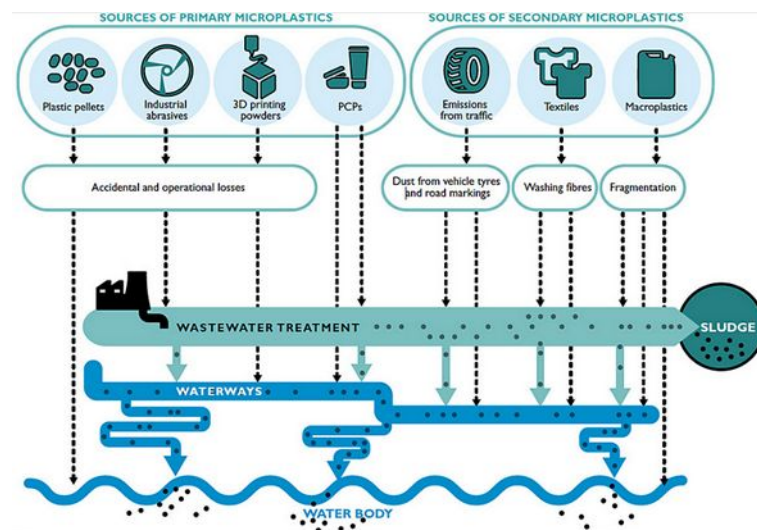


Figure 6. Land-based sources of microplastics and their pathways<sup>2</sup>

Most attention has been paid to the evident effects of larger plastic objects helped by the images of marine mammals entangled in six-pack rings, fishing lines, and plastic bags. Plastic items have also been found blocking the breathing passages and stomachs of a number of different species, as plastic bags may resemble jellyfish in the ocean, which explains their ingestion by turtles or dolphins mistaking them for food. Macroplastics can also exacerbate natural disasters, such as in the case of the devastating floods in Bangladesh in 1988, which caused several deaths, due to plastic litter that had obstructed waterways and clogged drains (Hossain, S. et al., 2021). In developing countries with few regulations on solid-waste management, plastics can also block sewage systems and create breeding grounds for pests, increasing the risk of vector-borne disease transmission.

Microplastics can also cause serious problems for a number of species. In fact, they have been found in the gastrointestinal tracts of perch larva, and fish, but also in land-based animals, including elephants, zebras, and many other large mammals. The ingestion of plastics can cause health problems. In many cases, microplastics pass through the digestive system and are then expelled without any consequence, but sometimes they block the digestive tract or pierce the organs, killing the animals. Also, the ingestion of plastic instead of food is harmful to the nutritional health of the animal, and so too across various trophic levels (OECD, 2018). Also, the release of substances

<sup>2</sup> Source: SYKE policy brief 2017; modified from the original by P.J. Kershaw). From <https://www.blastic.eu/knowledge-bank/sources-and-pathways/pathways/>

present in the plastic formulation can affect physiological processes, by acting as endocrine disruptors for example, disturbing hormonal regulations both in animals and humans.

It is almost impossible to retrieve plastic waste from the ocean, and only large pieces of plastic are ever removed from the high seas. So, the only solution is to prevent plastic from entering rivers and seas. A reduction in the environmental impact of plastics could only be accomplished through appropriate waste management systems, through the reduction of single-use plastics, through recovering, reusing, and recycling plastic goods, together with a better product design that considers the short life of disposable packing, (OECD, 2018).

## 3.2 Targeted solutions for plastic pollution

Plastics have been closely related to economic and industrial development in the last century. They are cheap, lightweight, abundant, resistant, and above all, very versatile, and found extensively in applications related to packaging, transportation, aeronautics, health, biomedicine, agriculture, food industry, construction etc. Plastics were developed as alternatives to other materials such as glass, wood, paper, cotton and silk, ceramic and metals, due to their better characteristics (mechanical properties, chemical and thermal resistance, barrier properties and compatibility), lower density, easier transformability and price. They are a unique solution to replace almost all forms of natural resource-based materials. For example, plastic packaging is cheaper and easier to produce than glass or ceramics; deforestation was reduced when plastic replaced wood and paper; used in food packaging, plastic reduces food spoilage to barely 3% in Europe while in countries where plastic is not so widespread, the percentage rises to 40%; in medicine, plastic is found in protective equipment, surgical tools, special bags, catheters, artificial arteries, syringes, blood bags, prosthesis, sutures, blisters, where flexible, resistant, durable biocompatible materials are needed; the presence of plastic parts explain around 25-35% fuel consumption reduction when used in vehicles or aeronautics since plastic components are lighter; the use of plastics for isolation in construction leads to a saving of 250 times the energy used to produce them... etc. (García J. M., 214)

Plastics were developed to meet certain properties, to be resistant against light, extreme temperatures, air, micro-organisms, etc., and their durability and strength provides them with an extraordinarily useful life, also a problem in itself, if they are not effectively recycled. By the end of the 70s, the production of commodity plastics (often single use plastics) in the form of disposable items increased, becoming a source of waste, which will not degrade for centuries. Overfilled landfills and littering meant that plastic was increasingly obvious and has now emerged as an environmental issue following the confirmation of plastic micro-particles polluting the water supply.

Quite certainly, it is not the material properties but our attitudes towards disposable items, inappropriate waste disposal, and our carelessness when throwing away litter, that were the causes of plastic pollution in the early 1970s and in most cases has yet to change. Plastic manufacture is still increasing, and nearly half of the production in Europe (40 %) is used for packaging (Plastics – the facts 2020). However, in a single year, the amount of plastic waste will not always match the amount of plastic production/consumption, because the use phase of most plastic items is between 1 and 50 years, the decisive factor in when they may be treated as waste.

Plastic waste disposal after domestic and industrial separation and classification in treatment plants can be treated in three ways: it can be sent to landfill, it can be recycled, or it can be used for energy recovery. In 2019 in the EU, 42.6 % of the collected plastic waste was used for energy recovery, 32.5 % for recycling, and 24.9 % was sent to landfill. These percentages differ greatly from the global

values; evidence of the differences between countries, and their social, economic and cultural development (Plastics – the facts 2020).

Obviously, the problem of plastic pollution requires different targeted strategies, including reduction, reuse and recycling. Reducing the use of unnecessary plastic items is of course the first strategy to be implemented. Single use plastics have a number of benefits, including food safety and hygiene, reduction of food waste, reduction in packaging weight in transit with the consequent savings in energy and emission reductions, which make them difficult to be replaced. However, some ready packaged items are still unnecessary such as fruit packaging, single-use plates, straws and single-use bags. The reuse of plastic products is also a favourable solution, although it is not possible in most cases. One of the best options to reduce the problems associated with plastic is to increase the recycling rate to transform the residues into new plastics. This strategy implies reductions in raw materials, energy, and emissions, contributing to a circular economy and generating employment (Ragossnig, A. M. et al, 2021). Even though chemical knowledge is needed, it is not enough in itself for this purpose, as adequate waste management infrastructure is still needed, as are landfill restrictions, social attitudes, and new policies at both a national and an international level to enforce the flow of waste towards reuse and recycling. Nevertheless, both technical and economic barriers still remain, before the recycling rate may be increased (Tomar, V. et al., 2020):

- Many different types of plastics are used, of different qualities, and not all of them can be mixed to obtain good quality products.
- Recycled plastics usually show lower properties, due to degradation in the recycling process.
- Many different types of plastics are currently manufactured, and when they are mixed, lower performance items are obtained. An appropriate separation of the residues is necessary, making the process more expensive. Some types of plastic are produced in small volumes, so it is not profitable to separate and to recycle them.
- Some plastics cannot be recycled, because the process is very difficult or very economically unfavourable, including polluted materials. Also, multilayer films are very difficult to recycle.
- Recycled plastics show variable characteristics, since it is difficult to assure a continuous supply of homogeneous products, which is a problem for manufacturers who want to use recycled plastic.

An alternative to all these procedures is the preparation of either degradable or biodegradable plastics, for economic production with reasonable life cycles before their natural recycling. These plastics should have a life cycle adequate to their function. However, their mechanical and barrier properties still need to be improved, to meet the strict requirements of the food packaging industry.

In general, plastic waste treatment is a technological opportunity associated with the success of a selective reception. Moreover, it is important to consider the treatment costs and recovery of the residues when compared to other materials, but also the production and transport costs of the materials, considering an energetic balance of the complete cycle, which is not generally performed. In this sense, the low density of plastics, as well as the low temperatures needed and the efficient transformation systems are key points in favour of their global energetic and economic balance (Ragossnig A.M. et al., 2021).

So, a very important point is to change our behaviour in relation to our use of plastics. In the following sections, we will discuss some theories that can help to design effective educational programs and actions for improving our environmental behaviour.

### 3.3 Social Practice Theory

From the several theories and models of behaviour and behavioural change, we adopted Social Practice Theory (SPT). SPT uses elements from science, technology, and society studies (STS studies); in particular that non-human ‘actors’ have a role in causing certain behaviours. The central insight of SPT is the recognition that human ‘practices’ (ways of doing, ‘routinized behaviour’, habits) are themselves arrangements of various inter-connected ‘elements’, such as physical and mental activities, norms, meanings, technology use, and knowledge, which shape people’s actions or ‘behaviour’ as part of their everyday lives (Reckwitz, 2002). So, from the perspective of SPT, we need to focus not on individual behaviour for understanding and changing environmental conduct, but also on social practice - and on the interaction of people’s practices and their material contexts (Morris et al., 2012). This situation leads to our reflecting upon why certain practices are done (‘produced’ and ‘re-produced’), how and why others are prevented, and considering the role of technology in how they are done and how they evolve. So, if we are to understand behaviour, we must consider the relations between **material objects** (that make it easier to perform certain activities in specific ways); **meanings** (concepts associated with activities that determine how and when they might be performed); and **procedures** (competencies that lead to activities that are performed in certain ways) (Morris et al., 2012). Figure 7 shows some of the possible objects, concepts, and competences that should be considered, in order to change our behaviour related to plastic use and abuse, from the perspective of SPT. For example, we need to understand how plastics and polymers in general shape our life, particularly as regards food and energy consumption; which are the drawbacks to their mass use; the existing regulations on their usage as well the available technology to reduce their use and replace them for a healthier life and a sustainable planet for all. We also need to understand – or to understand anew – such concepts as accessibility, sustainability, one health, etc. Finally, interrelated with objects and concepts, is our need to develop new skills and procedures to reshape our lives with fewer plastics: cooperation, problem solving, and digitalization are some of these new competences we have to develop, in order to succeed in our efforts to reduce the use of plastic.

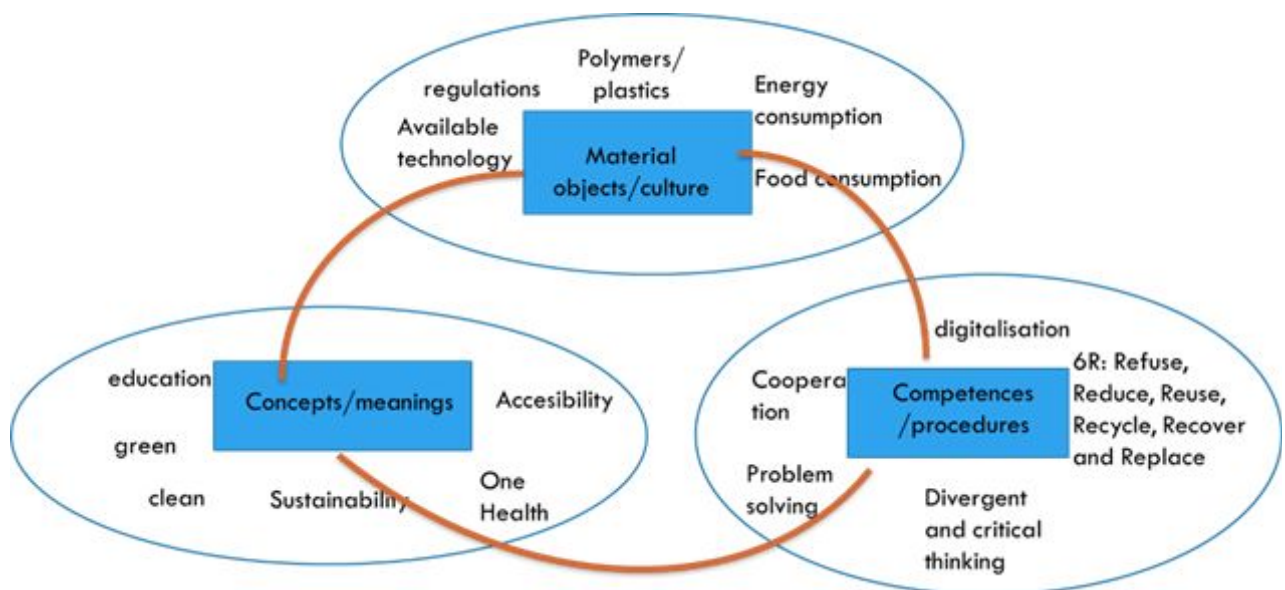


Figure 7. Concepts for modifying behaviours.

This theory goes beyond the understanding that a change of behaviour will follow an increase in knowledge and positive attitudes. Without critical reflection on how the individual practices are connected to norms, meanings, and certain technological uses, and the acquisition of new meanings and skills, a change of behaviour is doomed to failure. In the case of plastics, it is necessary to promote, through social interaction, critical reflection on how plastic objects shape our daily life and to develop knowledge of different materials and new skills and meanings, in order to be able to change their behaviour to reduce/replace/recycle plastics.

### 3.4 Characteristics of an effective plan for changing environmental conduct

The recent past has been marked by increasing effort to foster sustained ecologically responsible behaviours, although the programmes that were developed hardly appear very effective (McGuire, 2015). McGuire argued that what is wrong is to base all the programmes on transmitting the notions of knowledge and attitudes as the main targets of environmental education. From his point of view, the environmental education programmes should address two facets of human decision-making: conscious awareness and the automatic processes which provide an immediate reaction (positive, negative, bias) when confronted with a situation or a stimulus. So, environmental education should target not only our knowledge and attitudes, but also our overall identity and subconscious, to convince human beings that sustainability is a part of their identity. This attitude is aligned with SPT, since the critical reflection proposed by SPT should lead to an increased awareness where new meanings and new skills have significant roles.

McGuire proposes several criteria for an environmental education programme, among which the following:

- ◆ **Engage students' social and personal identities in as many behavioural domains as possible to increase the influence exerted on global self-identity**

That is, students should be presented to many examples (not just recycling or reduced water consumption), in order to develop a wider frame of sustainability, usable in all situations of life.

- ◆ **Address behavioural domains with which students most identify, using experiences and activities as authentic to each student as possible**

The activities should focus on students' interests, in order to create an environmental identity, and should be tailored to personal and cultural circumstances. For example, if students are interested in travelling, activities should be focused within this area, addressing the ecological problems related to them.

- ◆ **Support students for them to discover, to question, and to develop their own environment-centric reasons for participating and acting in sustainable activities** Address behavioural domains with which students most identify, using experiences and activities as authentic to each student as possible

That is, the idea is to make external justification (coming from teachers, parents, etc.) for participating in those activities as low as possible, turning each student into an actor in the development of a sustainable identity.

- ◆ **Emphasize affect toward the particular object of thought**

Teachers should emphasize their own enthusiasm and interest in sustainability and so demonstrate that sustainability is appropriate, positive behaviour.

Aligned with these ideas is the wise advice of G. Marshall (2015) *Don't Even Think About It: Why Our Brains Are Wired to Ignore Climate Change*. We adapted some of his recommendations, that are relevant for designing problematic situations and classroom activities that will be at the core of the pedagogical model proposed:

- Emphasize that the waste of plastic is happening here and now.
- Design activities that enable conversations on long-term preparedness.
- Develop a narrative of positive change with students – for creating a fairer and equitable world.
- Create a narrative with recognizable actors, motives, causes and effects.
- Maintain simple frameworks and be open and help students to be open to new meanings.
- Ensure that students are aware that a wide range of solutions is constantly under review.
- Build a narrative of cooperation (not unity).
- Be honest about the danger.
- Encourage positive visions.
- Activate cooperative values rather than competitive values.
- Recognize the role of your own role and the students' role in the problem.
- Work with students on the idea to never assume that what works for you will work for others.

### 3.5 The n-R strategy

As explained earlier, plastics and new materials from the 20th century have transformed our lives, solved a variety of problems, and are an advance for society. However, the accumulation of waste in landfills and in these materials, as well as their disposal, has become a problem that needs to be addressed (Thompson et al., 2004).

At the beginning of the 21st century, the non-governmental organization Greenpeace devised the 3R rule —reduce, recycle and reuse—, although it was during the G8 Summit in June 2004 that Japan's Prime Minister, Junichiro Koizumi, championed and promoted the 3R rule globally. The proposal, called the 3R Initiative, sought not only to lay the foundations for building a society that could manage waste more sustainably, but also to promote greater awareness and responsibility when using resources and materials.

The 3Rs encompass the actions of reducing, recycling, and recycling, three actions that directly affect the production of waste, thus protecting the environment. By now, this initiative is widely known in the ecological-environmental field. However, there are aspects that require qualification. In the three Rs of ecology, the three actions have hierarchies and are not equally important to each other.

Thus, what is fundamental and most logical for the benefit of the planet is to start by reducing the consumption of energy and material goods. We are talking about steering conscious and environmental consumption away from the pathological consumption that afflicts today's society. This first action must be taken into account, since it is the best way to prevent and to minimize environmental impacts. The second strategy, reuse, consists of giving a second use to a product after its primary function has ended. In this way, its useful life cycle is extended, and the creation of waste is slowed down. Reuse implies greater reflection and creativity when recovering these materials and resources for a second use. Finally, recycling is proper waste management, so that new products may be recovered from others. Recycling is the most widely accepted action among the population, due to the different awareness campaigns, so that it is common to think exclusively of recycling when it comes to providing solutions to ecological-environmental problems. However, not all materials can be recycled, and many others have a limited number of recyclable materials. Moreover, materials that have already been recycled lose quality compared to the original material. For this reason, reducing and reusing are much more important in curbing excessive waste production and are the most encouraged actions within European policies. In fact, taking a more radical stance on this issue, recycling might not even be necessary, if hypothetically these two waste prevention actions were firmly implemented.

More recently, these 3Rs have been joined by another long list of actions to engage society more firmly in responsible and sustainable action. There is no concrete consensus on all possible actions to minimize our environmental footprint. However, some of these actions are extremely important to support and to complement the 3Rs initiative. One of them consists of repairing. In a society accustomed to the practice of "throw away and buy", materials that are damaged and that break can be repaired and can be used for the same use for which it was designed, thereby avoiding its replacement and conversion into waste. This initiative is closely linked to that of renovation, which sustains the importance of updating an old material to return it to the primary function for which it was designed. Another strategy that has to do with good practice is that of redistributing the planet's resources, seeking an equitable way to meet the needs of its inhabitants. Through this initiative, a flow of consumer goods that are no longer useful in one area and those that can be useful for other populations takes place. It is also important to reflect on our consumption habits, their impact on the environment and whether there are more sustainable alternatives. Added to the above actions, strategies such as rejecting products from non-sustainable production, that use resources of temporary use or that have a great environmental impact; redesigning products by introducing ecological design, in such a way that possible environmental consequences are considered in the manufacturing process. There is even talk of the responsibility we have as consumers to reclaim political and business decisions that support more sustainable initiatives or projects.

Although there are many strategies to curb the environmental crisis, the fundamental idea behind them is not to change attitudes towards different situations, but to raise awareness so that all our actions and decisions in our lifestyles consider sustainability and doing good for the planet.

### 3.6 Children as a force for change

The pedagogical and transformative nature of education cannot go unnoticed when seeking to solve problems that afflict the global population. For this reason, it is not surprising that, for decades, education has been considered an essential means to solve environmental problems.



The term environmental education emerged in the mid-twentieth century in relation to human development and the environment. However, the International Seminar held in Belgrade, in 1975, was the first meeting to launch the so-called International Environmental Education Program. As a result of this meeting, the Belgrade Charter was drafted, a document that linked environmental education with ecology as a possible solution to the environmental crisis. Since then, one of the strands of environmental education has focused on the transformation of the individual in decision-making, in order to solve socio-environmental problems and to promote sustainable development (dos Santos et al., 2017). As a result of this new conceptual definition, numerous proposals related to environmental education emerged, whose results fell far short of expectations. In this sense, most of the proposals carried out in the classroom have addressed peripheral issues and have not established an interdisciplinary approach (Bybee, 1991). Thus, UNESCO (2005b) declared the decade 2005-2014 as the Decade of Education for Sustainable Development where the need to introduce the perspective of sustainable development in all educational fields was addressed.

In this way, it has been advocated that environmental education cannot be taught as an independent subject, but in a much more cross-cutting manner (UNESCO, 2005b). To this end, the need for sustainable development has to be understood as the greatest educational challenge, and it cannot be understood that environmental education continues to be understood as something complementary and, moreover, not understood as a critical approach for the development of a more sustainable society.

One of the problems is that the vision of sustainable development in most educational proposals is described as a process driven by expert knowledge, where the role of students is passive; generally developing proposals to modify actions that only have short-term results. However, Environmental Education should focus on preparing students to take responsibility by fostering their ability to analyze, question alternatives, and negotiate decisions (Vare & Scott, 2007), within a protagonist. Therefore, Environmental Education must transcend small daily actions and empower people with critical attitudes wishing to reach solutions that advance the goal of sustainability; an education that promotes the integration of the best traits of individuals and that, as an instrument of socialization and critical attitude, adopts valid responses to the challenge of global change that humanity is facing (Novo, 2009).

In short, schools, and thus all children, play a fundamental role in the challenge of curbing the environmental crisis and, definitively, in the "change". Children are the future on whom decisions and actions that promote positive actions and solutions for the environment will fall. Teachers and educators have the duty to promote knowledge, to foster attitudes and values, so that these children of today not only become problem solvers, but also problem seekers and solution creators (Davis, 1998).

## **4 Inclusive steam model for changing environmental behaviours**

### **4.1 A three-atep pedagogical model: Problematization, Understanding, and Action**

For defining the pedagogical classroom model for changing environmental behaviour within inclusive school settings, we are going to apply the theoretical framework defined in section 2.4 Integrated

STEAM Education for inclusion. According to the Social Practice Theory and McGuire’s proposal, discussed in the previous sections, the aim should go beyond the acquisition of knowledge; we must pursue awareness raising among children and young people of environmental problems related to plastics, leading to a transformation in the consumption and choices we make, both for them and for the adults around them. So, we can redefine the triadic network as shown in Figure 8.

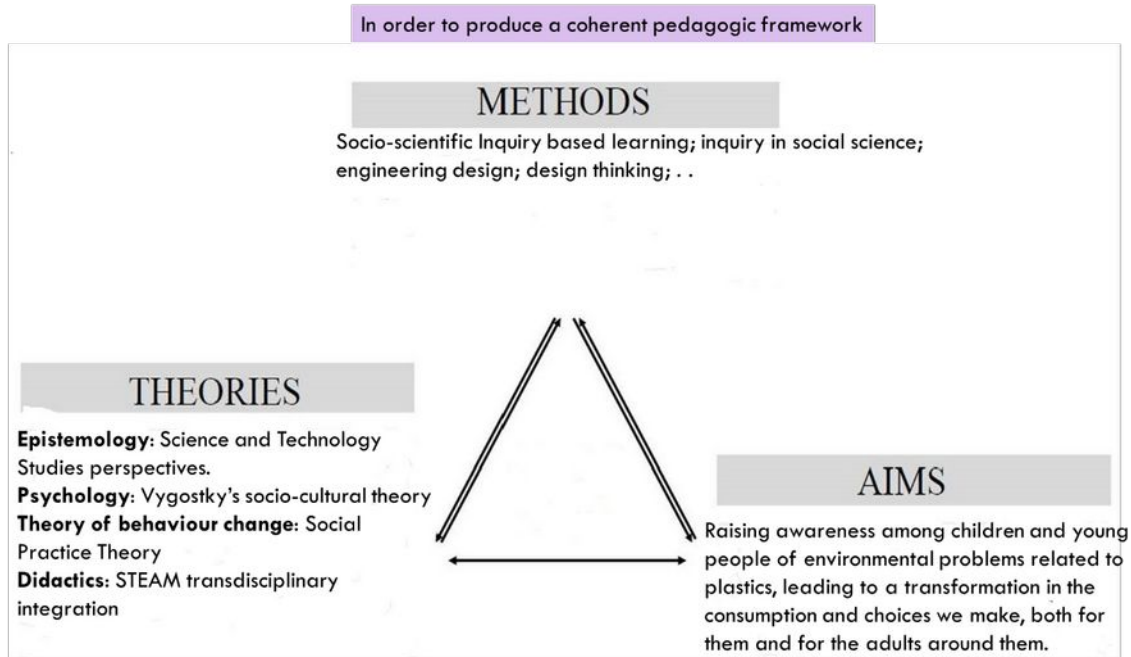


Figure 8. Triadic network

In this triadic network, the aims can be achieved using active and investigative methodologies, which offer students the possibility to study real problems and become involved in the development of creative solutions, in our case related to environmental problems in general, and plastics in particular. It is coherent with McGuire’s criteria of departing from problems that are not close to children and letting them discover and question, in order to develop their own environment-centric reasons for participating. These methodologies, as previously mentioned, promote social interaction among students and teachers; the development of skills and meaning; and, depending on the problems that are selected, critical reflection.

The underlying theories that justify the effectiveness of these methodologies are, on the one hand, the epistemological view offered by science and technology investigation that studies how society, politics, and culture affect scientific research and technological innovation, and how these, in turn, affect society, politics, and culture. From the psychological point of view, we adopted the theory of Vygostky, who views interaction with peers as an effective way of developing skills and strategies and, in our case, critical reflection. As already indicated, in order to develop didactic approaches that enable children and young people to change their behaviour, we consider it important to adopt the SPT reference framework described above.

Finally, from the didactic point of view, i.e., from the point of view of transposing these elements to the classroom, we position ourselves in STEAM transdisciplinary integration, in which we start from

real problems and encourage the students to take action in their environment. It should be noted that the adoption of these theoretical positions restricts the possible classroom methodologies - it is clear that helping students to become environmentally aware cannot be done from traditional methodologies. Nor do such approaches enable inclusive classroom environments, as we will discuss later.

This theoretical framework defines a coherent pedagogical model, characterized by three steps: Problematization, Understanding, and Action. In other words, we need to start from problems that have the characteristics described by Marshall (2015) as well as McGuire's criteria: Initial problems should be as authentic as possible to each student; have different possible solutions, involve different "points of view" for the search of solutions, be at once recognizable to children, children's contribution to the problem should also be recognizable, and cooperative action should be mobilized. We need to propose several problematic situations, not only relating to "obvious" aspects of plastics, such as recycling, in order to engage students' social and personal identities in as many behavioural domains as possible, to increase the influence exerted on global self-identity. This allows us to problematize our environment and the customs, habits, etc. that we have.

These problems must be tackled using active, collaborative, and learner-centred methodologies that enable them to understand the current environmental situation and to acquire new knowledge, new skills, and new meanings through social interaction with their peers, their teachers, and their social environment. Thus, these methodologies will facilitate critical reflection, helping students to understand how plastic objects shape our daily life; and the ways to reduce/replace/recycle plastics, through the knowledge of different materials and the development of new skills and meanings.

The solutions to the problems found by the children should be applicable, enabling students to become agents of change and empowerment in their environment. This model is summarised in Figure 9.

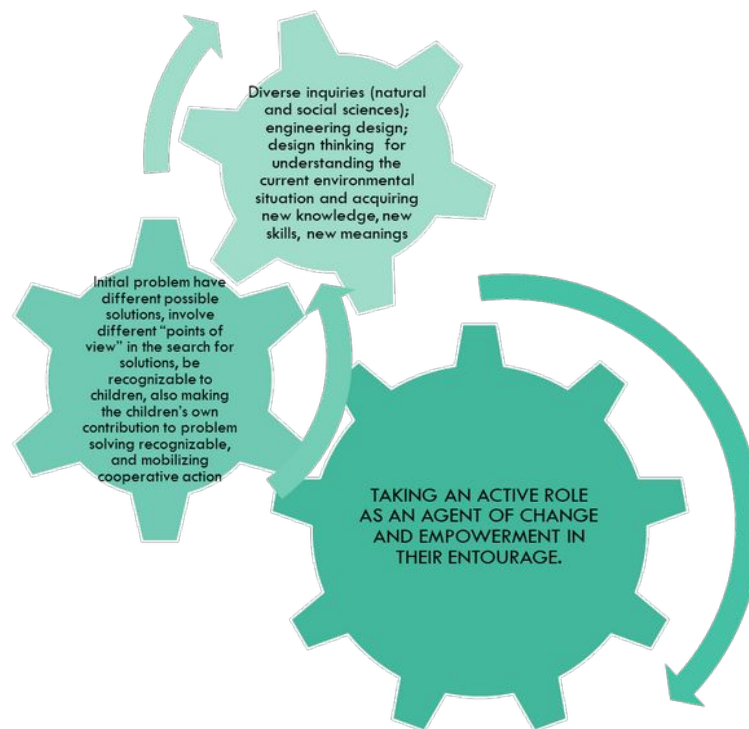


Figure 9. The three steps pedagogical model (personal source).

## 4.2 Cooperative learning experimentation

Collaborative and cooperative learning have different definitions among authors. For some, collaboration emphasizes joint participation in the task, intellectual interdependence, and the co-construction of knowledge, whereas cooperation emphasizes task distribution and often involves isolated individual contributions that are later synthesized to form a single product or outcome. For others, the opposite is true: cooperative learning is understood as a method of learning that relies heavily on student interdependence between each other, and, although the roles are clearly mapped out, they can be negotiated. The most important part of cooperative learning is accountability. This meaning, aligned with the ideas on environmental educational, is the one we adopted in our theoretical framework.

Cooperative Learning helps to improve student achievement; it builds positive relationships that are important for creating a learning community that values diversity and provides experiences that develop both good learning skills and social skills. Several studies have shown that cooperative learning also improves intrinsic motivation, and leads to higher self-esteem, and greater social support. Research on cooperative learning has also shown how it can be effectively used for designing teaching proposals, for analysing different social problems, among which diversity (racism, sexism, inclusion of people/persons with disabilities); and sustainability issues such as changes in ecosystems and climate, sustainable consumption, and production, etc. (Colomer et al, 2021).

Because of these characteristics, in our framework cooperation and cooperative learning are needed for addressing three different challenges: for learning, for inclusion and for raising awareness and action over-environmental problems.

### ◆ Cooperation for learning

Based on Vygotsky, who views interaction with peers as an effective way of developing skills and strategies, in cooperative learning exercises less competent children develop with help from more skilful peers - within zones of proximal development.

### ◆ Cooperation for inclusion

The social inclusion of children with special educational needs or at risk of exclusion still constitutes an area of concern: a number of studies have shown that children with SEN and at risk of exclusion are less accepted by their peers and have fewer friends than their non-SEN peers. As these authors indicate, based on a contextual perspective, it is important to provide opportunities for meaningful peer contacts and cooperative learning is one of the possible strategies. So, teachers need to address peer attitudes and friendships by creating inclusive classroom norms, modelling positive peer relationships, and giving all children positive feedback (Huber et al., 2018).

### ◆ Cooperation for raising awareness and solving environmental problems

As Colomer et al. (2021; p. 3465) highlighted, “learning about sustainability issues and solving real societal challenges are strongly tied to the promise of cooperative learning and when applying its principles social relationships can be established, along with personal involvement and individual responsibility”. This personal involvement is the one needed for raising awareness; and looking for solutions to sustainability issues requires the close involvement of the partners, driven by intrinsic motivation.

The main methodologies proposed in this framework - inquiry based learning, engineering design and design thinking - are all methodologies that use and promote cooperative learning. Nevertheless, it is worth stressing that cooperation demands careful preparation, because some students may not view peer-interaction or group work as a form of viable learning at all, but as a game. So, teachers need to promote effective communication in peer interaction, that also involves shared norms regarding turn-taking; shared perceptions of the appropriate amount of overlap in verbal contributions and shared norms for the acceptance of different point of views, to reach consensus and to continue onwards.

### 4.3 Adaptations for inclusive school environments

The recent history of education shows how much effort has been invested in inclusive work for different groups at risk of exclusion. Most of the initiatives have been described with a view to adapting the standards imposed by the curriculum to the different realities with which the students were concerned. However, in line with other trends aimed at greater educational efficiency, the new currents are moving away from adaptations that lead to integration, to focus on enrichment of activities that lead to inclusion. The kernel of this enrichment is in the response to the special needs and the realities that the different groups at risk of exclusion present, but it is finally developed, in order to add value to the usual activities in favour of an undistinguished group.

The STEAM model offers this enrichment in a natural way. The incorporation of illustrative content, and the fact that it is based on experimentation, provide the necessary motivation for the student to assimilate the concepts from a friendly and practical point of view. These characteristics are especially interesting for students at risk of socio-cultural exclusion (gender, racism, xenophobia, etc.), as they leave room for personal development to such a degree that cooperation with their peers favours their interpersonal relationships. On the other hand, the great variety of degrees of complexity means that work is at several levels, giving space to students with very different characteristics within the same objective, so it is also suitable in an environment with people at risk of exclusion due to functional diversity. In this sense, it is especially interesting for groups in which there is the presence of gifted students, who tend to find the activities very motivating, as they can test their capacity for reasoning and logic without overlooking social skills and cooperation with peers.

On the flip side, the STEAM model meets the three steps of the pedagogical model presented in this document. First of all, every activity requires the acquisition of new knowledge that will be put into practice later on, emphasising the student's enquiry and autonomy, in order to reach the proposed objective. The period of practice favours the assimilation of concepts while allowing students to reflect on different uses and variants related to their daily lives. Indeed, the proposed activities must be related to an area that is familiar to the students in a pragmatic way. The aim is not to learn for the sake of learning, but to relate concepts and skills to the problem at hand. The natural cognitive evolution brought about by practice and the skills developed will lead to the modification of behaviour. In this sense, this modification primarily affects the Primary School student's immediate environment, but it also has a major impact on the family environment and, therefore, on the community.

In sum, the STEAM model is a modern methodology that perfectly matches the principles that underpin inclusive education, presenting itself as a suitable alternative for a large variety of social groups at risk of exclusion.

## 4.4 Examples of good practices

Two didactic sequences have so far been implemented with a total of four groups of students. These took place within the framework of two extracurricular workshops with gifted Primary School students, promoted by the Consejería de Educación through the educational and multi-disciplinary guidance team for educational equity of Castilla y León in the city of Burgos (Spain).

The structure of these interventions started with two sessions, to develop concepts and experimental procedures and results, followed by one session to settle the contents, and one last creative session to develop a means of dissemination on the messages that had been learnt. Each of the workshops is detailed below:

### ◆ “A plasticized planet”

Carried out with two groups of students in the fourth grade of Primary Education (9-10 years old), the sequence consisted of four sessions. This didactic sequence begins with the story of young people working for the planet, one of them, a teenager, is involved in designing ways to cleanse the oceans from microplastics. The following three sessions developed the “understanding” part of the pedagogical model. The first session, entitled “Recycling plant”, aimed to pass on knowledge of plastics and microplastics to the students, so that they become aware of the existence of microplastics and experiment and discover microplastics in water. The second session, “Plastic islands”, was intended to raise awareness of the existence of plastic waste in nature and its consequences, to raise awareness of the importance of reusing, reducing, and recycling plastics and to experiment with procedures to understand how nature works and the effects of human actions. The third session is an escape room, “Mr. Plastic’s shop”, which seeks to settle the contents previously worked upon in fun and challenging environments and to experiment to find two true and one false statement related to plastics. Finally, for the “action” part of the model, in the fourth and last session, “Leave your print”, a shadow theatre was performed to handle audio-visual resources and create dissemination material. A short video inspired by a story related to the knowledge acquired in the previous sessions is also planned in class. All this, with the aim of developing critical thinking.

### ◆ “Detectives for sustainability”

Carried out in two groups of 10 fifth and sixth grade Primary Education students (11-12 years old). This sequence also consists of four sessions. “Plastic identification” is the title of the first session where our use of plastic is problematized. In this session, students identify plastics from everyday life, become aware of the importance of reusing, reducing, and recycling plastics and differentiate the types of polymers according to their application, density, physical appearance and flame behaviour. In the next two sessions, students learn more about plastics. So, the second session, Plastic hunt, is about students acquiring knowledge of what constitutes a polymer and differentiating between biopolymers and artificial polymers, creating a biopolymer and becoming aware of the uses and advantages of using polymers of natural origin. In the third session, an escape room called “The polys” is constructed where students learn the contents previously worked upon in a fun and challenging environment and experience the creation and properties of different polymers such as wafer, Kevlar, polypropylene, and nylon. In the fourth and last session, the “action” is taken through creativity. In “Detectives for sustainability”, audio-visual resources are used to create material for dissemination, in this case a \*.gif related to the knowledge acquired in the previous sessions. As in the previous case, the idea is to develop and to promote critical thinking.

## 4.5 Evaluation tools

Different strategies could be used to evaluate the effectiveness of the sequences and through which the proposed theoretical framework. One of them is Design-Based Research (DBR), based on the implementation of successive iterations. Within this methodological design, we propose the following evaluation instruments:

### ◆ Evaluation of teachers' appreciations through an observation sheet

This includes issues related to organization (classroom distribution, groupings, etc.), times (loss or lack of time in the different activities), theoretical issues (students' understanding of the contents, need for reduction, extension or changes, etc.), methodological issues (possible changes on how the activities are carried out) and issues specific to the group (critical nature of the students, participation/interaction, aspects of inclusion/diversity, etc.). Possible changes for the next iteration of the sequence are agreed upon.

### ◆ Questionnaire on the use of plastic

We used the questionnaire of Ferdous and Das (2014). The test has three dimensions, knowledge, attitude and behaviours, with five, six and four items, respectively, and a five-point Likert-type scale to indicate the degree of agreement (Annex I). It provides useful insight into possible attitudinal and behavioural change among children and knowledge-related changes.

### ◆ Perceptions Inclusion Questionnaire (PIQ) student version (Venetz et al., 2015)

Composed of 12 Likert-type scale items, each with four response scales. The questionnaire serves as a tool for measuring three dimensions of subjectively self-perceived inclusion in school: emotional well-being at school, social inclusion in the classroom, and academic self-concept. It is designed to be used by students from third to ninth grade and can be self-administered.

### ◆ Student Attitudes Toward STEM (S-STEM) Survey (Unfried et al., 2015)

Validated for use in grades 4 through 12, the S-STEM survey is administered to measure changes in student confidence and efficacy in STEM subjects, 21st century learning skills, and interest in STEM careers. The survey consists of four dimensions, Math, Science, Engineering and Technology, and 21st Century Learning, with eight, nine, nine, and eleven items, respectively, posed with a five-point Likert scale to indicate degree of agreement. It also has another twelve items on future work, this time with a four-point Likert scale to indicate degree of interest. The survey results helped to arrive at decisions on possible improvements to the program.

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## Annex I - Evaluation - Use of Plastic

### Questionnaire on the use of plastics

With the following questionnaire, we wish to measure your opinion on the use of plastics. To do so, we will use the Likert-scale method, whereby you will have to indicate the degree to which you agree or disagree with the statements that are presented where 1 is strongly disagree and 5 is strongly agree.

You must circle the option that most closely matches your general thinking.

**Name:** \_\_\_\_\_

**Sex:**      I'm a boy                      I'm a girl

**Age:** \_\_\_\_\_

**Last grade you finished:** \_\_\_\_\_

		Totally disagree	Disagree	Neither agree nor disagree	Agree	Totally agree
<b>KNOWLEDGE</b>	'Reuse' of plastic bags is good	1	2	3	4	5
	Awareness is essential for saving our environment from plastic hazards	1	2	3	4	5
	In the ground, plastic materials are sustained for a long time and degrade soil quality	1	2	3	4	5
	Chocolate, snacks, and biscuit wrappers have no effect on environmental pollution, so we can throw them away anywhere.	1	2	3	4	5
	To keep the environment beautiful, we need to be free of plastic products	1	2	3	4	5

		Totally disagree	Disagree	Not agree nor disagree	Agree	Totally agree
<b>ATTITUDE</b>	It is not right to throw plastic products anywhere after use	1	2	3	4	5
	People should be aware of using plastic products	1	2	3	4	5
	Plastic that is thrown away damages the environment	1	2	3	4	5
	Plastic products are more user-friendly than any other products	1	2	3	4	5
	Everyone needs to aware of their use of plastic products	1	2	3	4	5
	School environments can be plastic free	1	2	3	4	5

		Totally disagree	Disagree	Not agree nor disagree	Agree	Totally agree
<b>BEHAVIOUR</b>	We should recycle rather than throw away all used plastic materials	1	2	3	4	5
	We should REUSE plastic bags	1	2	3	4	5
	We should replace plastic bags with jute bags or similar	1	2	3	4	5
	It is not essential to accept a plastic bag when buying something from the shop	1	2	3	4	5