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Analysis and proposal to respond to diversity in the science classroom

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Resumen

El presente trabajo, de carácter empírico, trata sobre los retos, estrategias y adaptaciones para atender a la diversidad en ciencias desde un enfoque inclusivo. Estas temáticas son abordadas en el marco teórico. En el estudio de campo han participado 40 docentes de educación ordinaria y atención a la diversidad de la Comunidad Foral de Navarra. Sus testimonios se han recogido a través de cuestionarios elaborados ad hoc, en los que también se ha introducido una actividad de indagación con sus respectivas adaptaciones. Además, en un colegio con programa PAI de Pamplona se ha implementado una propuesta adaptada centrada en el desarrollo de destrezas científicas básicas en dos grupos de cuarto curso de Educación Primaria con diversas características y 7 estudiantes con NEAE. Los resultados apuntan a: 1) coincidencia con previas investigaciones en la falta de formación y recursos para desarrollar actividades experimentales inclusivas; 2) beneficios del enfoque indagatorio para aprender de forma cooperativa y práctica y 3) impacto global e individual de las adaptaciones en el progreso de aprendizaje y mejora en la comprensión de los estudiantes. Las conclusiones señalan las implicaciones y posibles futuras prácticas educativas para avanzar en la necesidad de proporcionar una respuesta inclusiva en esta disciplina.

Palabras clave: Indagación; Adaptaciones; Retos Educativos; Ciencias Naturales; Educación Inclusiva.

Abstract

The present empirical study encompasses the challenges, strategies and adaptations to respond to diversity in science from an inclusive approach. These topics are developed in the theoretical framework. 40 subjects from ordinary education and attention to diversity from the Foral Community of Navarre participated in the field study. Their evidence was gathered through questionnaires designed ad hoc, which also included an inquiry-based activity with its respective adaptations. Moreover, in a school with a *PAI* program of Pamplona, an adapted proposal centred in the development of basic process skills (BPS) was implemented in two groups of fourth grade of Primary Education. There were learners with diverse characteristics and 7 students with Specific Educational Needs (SEN). Results indicate: 1) a correlation with previous investigations in the lack of training and resources to develop inclusive experimental activities; 2) benefits of the inquiry model for learning by practice and cooperatively and 3) a global and individual impact of the adaptations on learning progress and on students' comprehension. Conclusions highlight the implications and possible future educational practices to provide an inclusive response in this discipline.

Keywords: Inquiry; Adaptations; Natural Sciences; Inclusive Education; Educational Challenges.

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List of Acronyms

AAAS: American Association for the Advancement of Science

AAIDD: American Association on Intellectual Development and Disabilities

AAMR: American Association for Mental Retardation

ADHD: Attention Deficit Hyperactivity Disorder

BPS: Basic Process Skills

CREENA: *Centro de Recursos de Educación Especial de Navarra*

IBSE: Inquiry Based Science Education

IPS: Integrated Process Skills

OECD: Organisation for Economic Co-operation and development

PAI: *Programa de Aprendizaje en Inglés*

PISA: Program for International Student Assessment

NARST: National Association for Research in Science Teaching

NEAE: *Necesidades Específicas de Apoyo Educativo*

NGSS: Next Generation Science Standards

SAPA: Science-A-Process Approach

SEN: Specific Educational Needs

SLD: Specific Learning Difficulties

SPS: Science Process Skills

UDL: Universal Design for Learning

UPNA: *Universidad Pública de Navarra*

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INTRODUCCIÓN

La Educación Inclusiva es sin duda uno de los objetivos principales de las prácticas educativas. El cuarto Objetivo de Desarrollo Sostenible (ODS) hace referencia a una educación de calidad basada en las oportunidades de aprendizaje para todos y todas. Asimismo, las políticas internacionales y la LOMCE (2013)-próximamente LOMLOE (2020)-, enmarcadas en la Declaración de Salamanca (1994), tienen como fin el horizonte hacia una educación más inclusiva. Además, en la actualidad, es común encontrar investigaciones educativas con el objetivo de atender a las necesidades de aprendizaje. Como indica Echeita (2020), la educación inclusiva no es una tendencia, sino un viaje permanente hacia una educación que garantice la equidad y la presencia, participación y aprendizaje de todo el alumnado, en el que "podemos hacer mucho para ver <<un mundo mejor>> "p.15.

No obstante, en España, la atención a la diversidad en educación se ha centrado principalmente en lenguaje y matemáticas y no se ha puesto el foco en ciencias, así como en otras áreas disciplinares (Arnaiz, 2009). Los estudios apuntan que la ciencia es una de las asignaturas donde se tiende a proporcionar el apoyo dentro del aula, esto es, a no sacar al alumnado al aula de apoyo (Norman et al., 1998; Villanueva et al., 2012). Pero, al mismo tiempo, esta disciplina es una de las que más inseguridad provoca entre el profesorado. La literatura indica que uno de los mayores problemas a la hora de atender a la diversidad en ciencias es la falta de formación. Por un lado, los docentes generalistas no se sienten preparados para atender a las diferentes necesidades en el aula. Por otro lado, los profesionales de atención a la diversidad no dominan los conocimientos de ciencias naturales (Kirch et al., 2005; Villanueva et al., 2012).

Por esta razón, se crea la necesidad de comprobar si se está proporcionando una atención ajustada a las necesidades del alumnado que asegure su participación y que llegue a ser competente: la alfabetización científica básica, cuya finalidad en la etapa de Educación Primaria es formar ciudadanos y ciudadanas conscientes y comprometidos con el mundo (Pujol, 2003).

Esta situación de partida y falta de preparación del profesorado originan unas cuestiones que sirven como motivación esencial para la presente investigación:

- ¿Cuáles son los retos y qué respuesta proporciona el profesorado a la diversidad en el aula de ciencias?
- ¿Qué métodos favorecen la inclusión de todo el alumnado en el aula de ciencias?
- ¿Qué intervenciones y adaptaciones se pueden llevar a cabo en ciencias para lograr un aula más inclusiva?

Por ello, además de examinar los retos docentes a la hora de dar respuesta a las diferentes necesidades en esta área, el actual trabajo pretende testar el impacto que genera una intervención diseñada según los principios de atención a la diversidad en el aprendizaje y participación de los niños y niñas.

Se presenta un marco teórico que recoge los conceptos básicos sobre educación inclusiva, las dificultades específicas de atención a la diversidad en ciencias, así como los métodos experimentales e indagatorios y las adaptaciones que se recomiendan para hacer frente a distintas necesidades. El estudio empírico describe la efectividad de una propuesta de indagación y los retos actuales a los que se enfrenta el profesorado para proporcionar una respuesta inclusiva en esta materia. En las conclusiones, además de lo anterior, se enfatiza la labor del profesorado para proporcionar adaptaciones y apoyos a todo el alumnado dentro del aula.

1. THEORETICAL FRAMEWORK

1.1. Basic notions of Inclusive Education. A Midsummers' Night Dream

Echeita (2020) defines inclusion using the metaphor of a dream, which is referred to the right of giving an equitable response, participating, learning and feeling recognised that all students have. Every dream involves a journey towards a horizon, in this case, a more inclusive education. In order to move in this direction, navigation cards and travel guides are required; these aids will be examined in this section.

1.1.2. Navigation cards for Inclusive Education. Conceptual framework

The navigation cards involve acquiring a clear concept and model of Inclusive Education that allows moving close to the dream of providing an educational response where all students can be present, participate and learn.

First, in general terms, examining the navigation cards of inclusion implies assuming that everyone, being children, young or adult, needs to be included; that is, valued in their context of reference, such as family or school (Stainback, 1992). Thus, regarding social inclusion, being conscious of social exclusion and inequality in the current society has led to the emergence and use of the term *inclusion*. Moreover, human rights and equality of opportunities claim for the right of education for all children (Blanco, 2006).

Therefore, a specific level of inclusion refers to educational inclusion. This concept emerged after studying and analysing the concept of *integration* in the school setting and having understood the necessity of a terminological evolution. But integration processes have entailed that students with special needs receive education inside the mainstream, but have to accommodate to the curriculum, organisation and functioning of the school designed for 'normal' students (López Melero, 2001). Thus, currently, there is a tendency of abandoning this term, which is starting to be replaced by *inclusion* (Giné i Giné, 2001). Inclusive education proposes a unique system for all, adapting the educational context to the diversity existing in students (Arenas, 2016). Indeed, the concept of inclusion is extremely relevant because it implicitly involves accepting diversity as a positive and enriching aspect of the group (Serra, 2000).

Echeita (2020) holds that it is necessary to be clear about the concept of inclusion. For that reason, the author defines a model of inclusion framed in the analysis of four concepts.

- *Inclusion is a process*. In other words, inclusion should be approached as a constant improvement to respond to the diversity of students. Assuming that the journey of inclusion is a process entails making small steps and changes to achieve the dream of a complete educational inclusion (Echeita & Ainscow, 2011).

- *Inclusive education seeks three fundamental dimensions* that are related to teachers' competences: presence, participation and learning.
  - *Presence* is understood as the place where students receive schooling, since children need to be present in all the activities of the classroom and centre. Thus, it is necessary to learn how to be with others and with diverse people, so this dimension is contrary to segregation of students by gender or any other factor (Sarto & Venegas, 2009).
  - *Participation* is a complex element since it requires going further from access or presence. As Puig et al. (2012) state, participation implies the recognition of students in a) learning with others and collaborating in the lessons and classes b) active involvement in learning and c) concern about personal and social wellbeing of children, which is a requisite for meaningful learning (Echeita, 2020).

Actually, participation is not a desire or whim, but a recognized right by the Convention on the Rights of the Child (1989) promoted by UNICEF.

- *Learning* is related to a concern that all pupils in the school perform as well as possible in the different areas of the curriculum. This concept goes beyond achieving good test results and is in turn associated with the student's progress in relation to the development of basic competences that will facilitate their social and labour market inclusion (Booth et al., 2015). Therefore, participation and learning are interconnected dimensions becaus, cognition is not possible if there is not recognition and provision of learning opportunities (Puig et al., 2012).

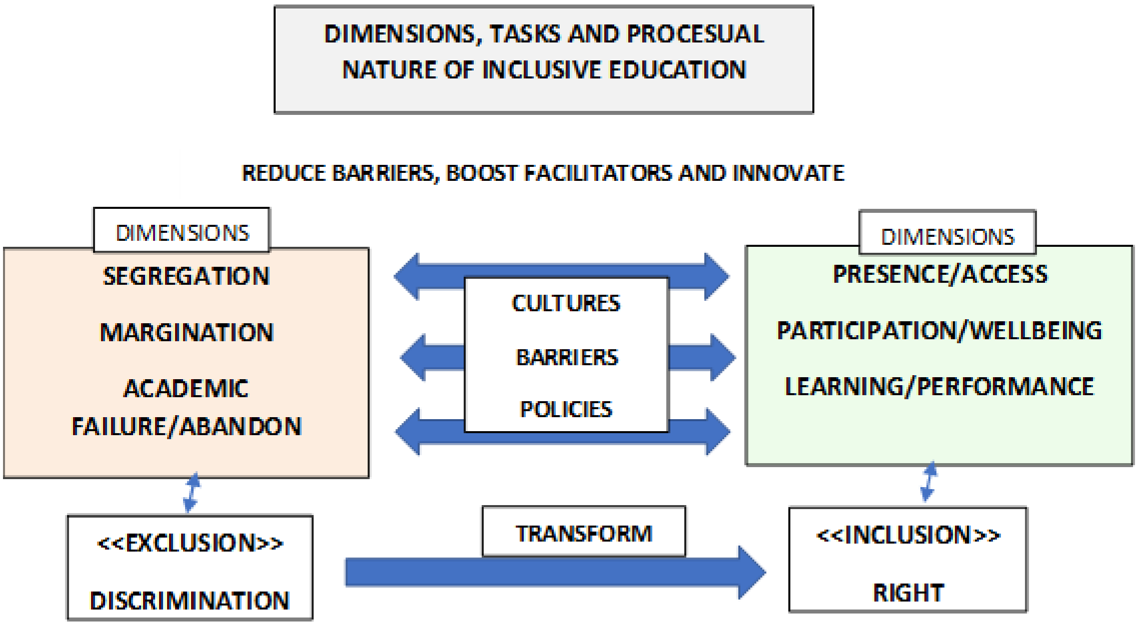
- *Inclusion specifies identification and elimination of barriers*. The previous dimensions serve to understand inclusion as a concept linked to educational exclusion. In fact, inclusion is connected with segregation because the advance to a more inclusive education is produced when the barriers that hinder presence, participation and learning are eliminated (Ainscow et al., 2002). These barriers are generally understood as beliefs and attitudes that people hold towards this process and are identified taking into account the three school settings that Ainscow & Booth (2012) defined in the *Index for Inclusion*: school culture, policies and practices. When these levels interact with personal, social or cultural conditions of some individual or groups of students, they lead to exclusion, margination or school failure (Echeita & Ainscow, 2011).
- *Inclusion makes emphasis on some groups* of students that could be at risk of school dropout or segregation. Thus, although inclusive education addresses all students, in this work a special focus is put on students with Specific Educational Needs (SEN). Article 14 of *LOMCE* (2013), based on *LOE* (2006), conceptualises students with SEN referring to those children who require a different attention to the ordinary due to special educational needs, specific

learning difficulties, Attention Deficit and Hyperactivity Disorder (ADHD), high intellectual abilities, late entry into the education system, personal conditions or school history. Inclusion pays special attention to examining the opportunities and barriers so children with SEN can develop personally and academically.

Taking this conceptual analysis as a reference, Figure 1 shows the concretion of inclusive education in a school: the areas of the school life, the antagonistic values of the different dimensions considered, together with the barriers and facilitators (Echeita, 2020).

Figure 1

Concretion of Inclusive Education in an Educational Centre



Adapted from Echeita (2020), p. 54

All in all, the navigation cards entail the concept and model of inclusion that enable travel towards the horizon of the journey: a more inclusive education. Inclusive Education is based on a process to meet the demands of the diversity and needs of all students and reduce exclusion outside the educational system. So, in order for them to be present, participate, and learn, that is, achieve a more inclusive education, school needs to give specific support to those who require it (Elizondo, 2017). Consequently, this leads to the provisions for the journey: The *Supports Paradigm*.

1.1.2. Provisions for the journey. Supports Paradigm

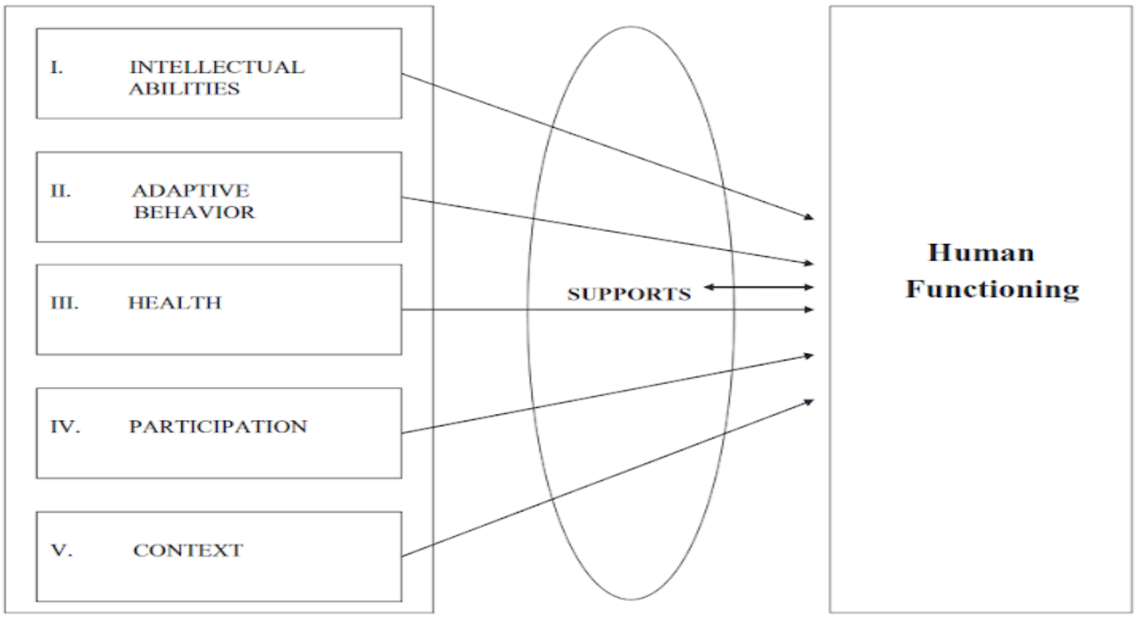
The *Supports Paradigm* emerged as an evolution of a new way of thinking, which is related to the evolution of the concept of Intellectual Disability (Stainback, 2009; Verdugo, 2003).

Firstly, the 9th edition of AAMR (1992) gave a new definition of *mental retardation,* which implied a change of paradigm. The new term stated to leave the deficit of a person aside and suggested to put a focus on understanding the individual in interaction with the context (Schalock, 2004; Verdugo, 2010). As a consequence of this multidimensional model, the concept of *supports* emerged, which is understood as “resources and strategies that aim to promote the development, education, interests, and personal well-being of a person and that enhance individual functioning” (Luckasson et al., 2002, p. 145).

After this new change of approach, the term of mental retardation progressed to *Intellectual Disability*, which was proposed by AAIDD (2010). The current model of support conforming to AAIDD (2011), which is represented in Figure 2, takes the concept of support as reference, and involves examining the types and intensity of support that an individual needs to improve personal outcomes and functioning (Thompson et al.,2009).

Figure 2

Conceptual Framework of Human Functioning



Schalock et al.,2010, p. 287

The different types of support emerged from the 9th edition of the AAMR (1992) and are specified in Table 1.

Table 1.

Types of supports

Intermittent	Episodic nature. Punctual support.
Limited	Necessary support needed in an environment for a limited time.
Extensive	Necessary support needed in an environment for an unlimited time.
Generalized	Necessary support in more than one context for an unlimited period of time.

Adapted from Schalock (1995)

As Schalock (2009) states, the consideration of different types of support within the Supports Paradigm led to educational implications that affect the way of responding to diversity in the school. Practices are centred in detecting the types and intensity of support a student needs to improve learning outcomes. In addition, with the Supports Paradigm, the level of intensity of a person's support needs is used as a basis for programming and planning. Consequently, setting individualized supports has originated practices of person-centred-planning (Schalock et al. , 2007).

Furthermore, the Supports Paradigm personalises learning and this means adjusting to the individual needs of all students. This approach is contrary to the integrative model, which implied that support specialists provided attention outside the classroom and the curriculum was modified on basis of students' demands. Thus, the Supports Paradigm, in line with inclusion defends a multilevel teaching to meet the needs of all students, or in other words, a Universal Design for Learning (UDL) (Verdugo, 2003; Elizondo, 2017).

1.1.3. Travel guides. Towards a more inclusive horizon: Inclusive School

Once the navigation cards (concept and model of inclusion) and provisions for the journey (Supports Paradigm) have been examined, a travel guide is needed to bring us gradually closer to the destination: a more inclusive education. The destination of this journey is defined by the *Salamanca Statement,* which declares that ordinary schools should adjust learning to all children, no matter their physical, intellectual, social, emotional, linguistic, or any other condition (UNESCO, 1994). The definition of inclusion in education given by UNESCO (2008) captures presence, participation and success of all learners. Indeed, Inclusive Education is today acknowledged as a right, also for people with disabilities (UN, 2006).

In order to obtain a more inclusive education, the travel guides suggest different paths to inclusion, which depend on the style and perspective of the author. Nevertheless, travel guides that are focused on inclusive education aim to transform learning barriers to opportunities for all students (Constantino, 2017). Among all the guides, one specific is *Index for Inclusion*. The Index provides guidelines for evaluating the inclusiveness of the cultures, policies and practices of a school

(Ainscow & Booth, 2011). Moreover, these manuals are also based on implementing school improvements and educational innovation, that can be scaled up and ultimately affect the elements that make up an education system (systemic character).

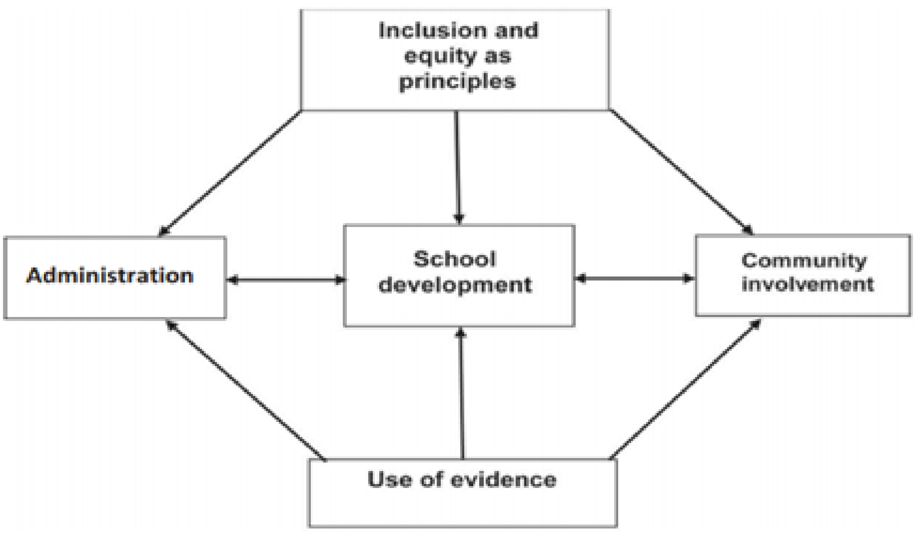
However, there is a current resistance to change as well as to the introduction of improvements towards a more inclusive horizon. This reluctance to incorporate changes may stem from different causes:

- *Lack of coordination across levels*: In many schools there is a weak degree of teacher collaboration from preschool to university because there is generally no time for coordination in education systems (Ainscow et al., 2013).
- *Scarcity of material resources and materials* (Echeita, 2020).
- *Lack of trained human resources and specialized professionals* (Echeita, 2020, Azorín et al. 2019). Teachers' training was a noticeable obstacle to address the diversity of needs because the preparation that is offered to educators is deficient to respond to the diverse needs of students (Azorín et al., 2017).

But, considering all these challenges, what can be done? The answer is quite complex, because, as it was mentioned, an inclusive reform should be holistic, affecting all the elements of the Educational System. Ainscow & Booth (2020) proposed a model to boost inclusion and equity in educational systems (see Figure 3).

Figure 3

A Holistic Approach for a More Inclusive Education Horizon



Ainscow & Booth, 2020, p. 9

Following this construction, the principles of inclusion and equity can be applied at three levels: the school culture, the classroom culture, and the practices that teachers design in the classroom.

- *SCHOOL CULTURE*. There are some beliefs, perceptions, relationships and attitudes of an educational institution that support the model of Inclusive Education. They involve:
- *Forming a Community*. The journey towards a more inclusive school occurs when educational agents, including families and teachers, participate and share a vision of equity in the school. Thus, forming a community is a key element to form a more inclusive school (López Melero, 2012).
- *Involving administrations*. Educational administrations also need to be involved in providing support to schools and in making a shared effort with students, families, teachers, institutions and society in order to ensure quality education (Sarto & Venegas, 2009).
- *CLASSROOM CULTURE*. Student-centred methodologies can boost the journey towards the destination of Inclusive Education in the classroom setting. Making students feel part and participate in learning include selecting multiple ways of giving meaning to what is learned through real and practical experiences, researching, and experimenting, solving problems, carrying out projects of various kinds and providing opportunities to develop all the intelligences according to the ages of each year and stage (López Melero, 2012).
- *CLASSROOM PRACTICES*. There is a need of including a variety of opportunities to interact and cooperate with peers to think together, dialogue, and feel in the teaching-learning process (Echeita & Ainscow, 2011).

Therefore, embarking on the journey towards a more inclusive school and classroom is not understood as a task that corresponds only to support professionals, but a broader and joint action of the whole school. For this reason, in this work we focus on how to support the different needs of students in the ordinary classroom, around natural sciences.

1.2. Adapting natural sciences to the Diversity

1.2.1. Specific difficulties of science

Once the starting point of this work, as well as the scope of attention have been analysed, in this section the specific difficulties that students often present when learning natural sciences in Primary Education are discussed.

First of all, children often struggle with understanding the symbolism and abstract concepts of sciences. Sometimes, due to the developmental level of learners, they are not able to comprehend abstract ideas unless they are made accessible to their senses (AAAS, 1993). Moreover, scientific concepts are sometimes not adapted to their emotional and cognitive development, presenting concrete examples that are accessible from their experience. On top of that, these challenges to understand abstract concepts are often masked by the ability of students to memorize and recite scientific terms that they are unable to understand but can create an illusion of comprehension (Parker et al., 2016).

Another obstacle of learning natural sciences is that this discipline possesses its own specific and specialized vocabulary, which is required to talk and understand sciences (Villanueva & Hand, 2011). Children are often challenged to grasp, learn, say and write scientific words (Harlen & Qualter, 2018). These difficulties are also present when storing these terms in the long-term memory, which implies recalling scientific concepts (Wellington & Wellington, 2002). Additionally, vocabulary issues can be even of greater concern in Content and Language Integrated Learning (CLIL) contexts, or with students with language difficulties (Melber, 2004).

What is more, language hazards might hamper the union of different words to form complex sentences creating meaningful explanations, as well as skills required in science learning such as making descriptions, measurements, and comparisons (Roseberry & Warren, 2008).

Apart from that, one of the main features of science is that it is made in community, so working with peers will be needed in the classroom (Pujol, 2003). Consequently, insufficient social communication and interaction can be a challenge when teamwork is required, since scientific speech allows questioning and discussion in collaborative learning (Dawes, 2004). Thus, this can have an impact on children's participation, one of the core principles of inclusive education (UNESCO, 1994; Harlen & Qualter, 2018).

Another concern is that learning science involves acquiring scientific skills that require different modes of thinking (analytical, computational, deductive, or inductive, among others). However, not all children have the same cognitive and thinking development. Therefore, didactic transposition is a necessary mechanism to enable learning of all students in the classroom. This process of teaching has the challenge of considering the different emotional and cognitive features of children in order to adapt the teaching-learning process (Pujol, 2003).

As shown, learning science entails specific difficulties that are characteristic of the discipline. Considering possible obstacles to learn science creates a need to study how educators respond to challenges students might present. What is the educational response that teachers are giving to meet the demands of diversity in natural sciences? Which obstacles are present when adapting and responding to students' diverse needs?

1.2.2 Teachers' obstacles when responding to diversity in the science classroom

As previously analysed, there is a demand of developing inclusive practices that bear in mind students' difficulties with science. However, science education is not commonly being adapted to the different needs and struggles students might face while learning in this area. Indeed, adapting science instruction to the necessities of learners is not an easy task and teachers report general obstacles to provide an inclusive educational response.

1. *Training*. Firstly, one of the most notorious aspects is teachers' unpreparedness to respond to the diverse needs of students in the science classroom. While Primary Education teachers do not feel well prepared to provide attention to students with different needs, Educational Therapists feel unprepared to teach science (Villanueva et al., 2012). In a study from Kirch et al. (2005), educators did not usually receive specific guidelines about inclusion in the science classroom in their courses. At the same time, research reveals that overall professionals of attention to diversity do not receive specific training in natural sciences (Vavougios et al., 2016).
2. *Collaboration*. Secondly, in line with inclusion, in order to provide attention to a big group of students with diverse needs, supports should be organised inside the classroom (Intxausti et al., 2016). This way of arranging resources implies being more than one teacher inside the class. However, different studies in different times reported high rates of students in class (Norman et al., 1998; Arnaiz, 2009). Therefore, collaboration among teachers in the ordinary setting is required so as to provide a more individualized attention in the classroom to design support measures (organising groups, splitting the class…) and share information about the students (Arnaiz, 2013).

Moreover, educators also encounter challenges that are specific of science.

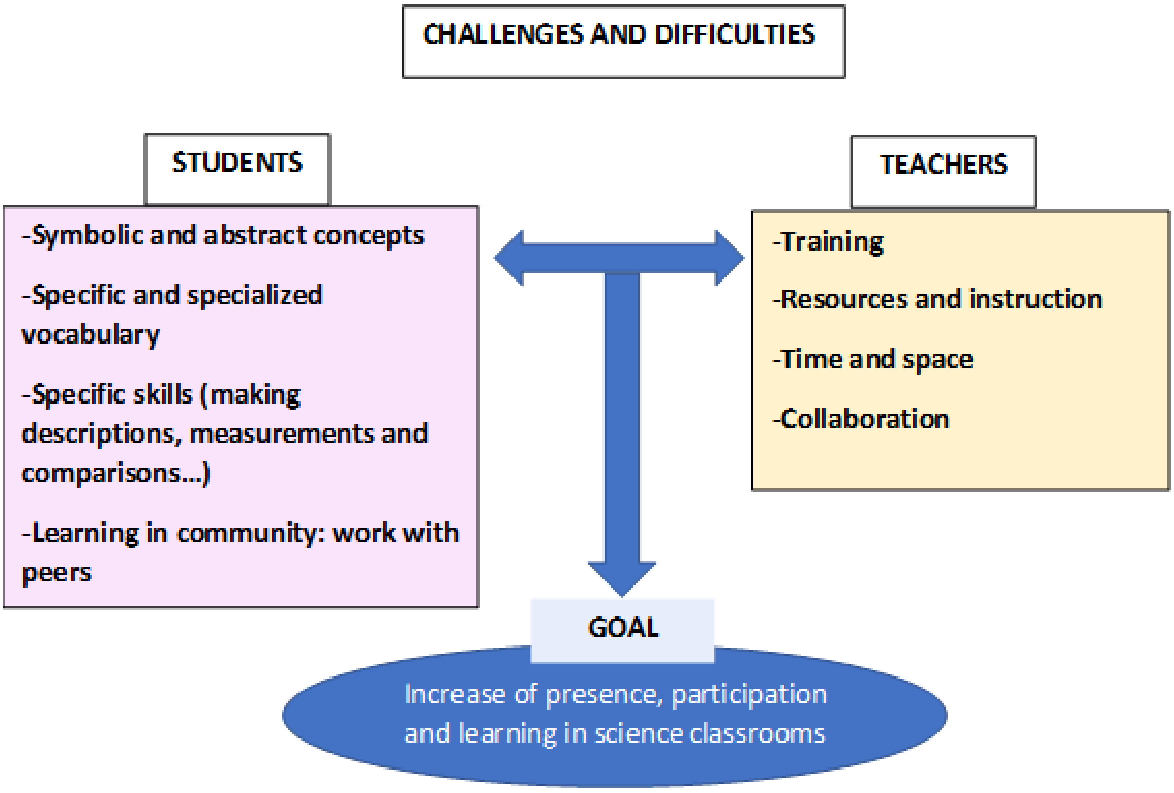
1. *Resources and instruction*. In addition to training, traditionally, science teaching has been centred in textbooks and worksheets as main resource and methodology. This approach requires that students have reading and writing skills and thus the success and opportunities of learning sciences for those with reading and language difficulties might be affected if the necessary adaptations are not implemented (Cawley et al., 2003). Hence, there is a need of becoming familiarised with alternative strategies for those who require substitute learning strategies in sciences (Villanueva et al.,2012).
2. *Time and space*. Furthermore, investigation indicates various obstacles when making adaptations in this particular area. Arnaiz et al. (2013) and Gómez-Zepeda et al. (2017) conclude in their studies that teachers lack time for making individualised adaptations. On

top of that, the previous authors and Kirch et al. (2005) also mention the need of room and materials to diversify the curriculum properly.

Consequently, the present Final Degree Project takes teachers' difficulties as a starting point, analysing educators' real obstacles and challenges to attempt to provide an educational response that adjusts instruction to students' obstacles to learning science. They are reflected in Figure 4.

Figure 4

Teachers' and Students' Challenges for Responding to Diversity in Science Classrooms



As seen before, sciences possess embedded difficulties, and research also indicates that teachers present some complications when addressing the diversity of needs in the science classroom. Taking this into account, which methodologies foster science learning for all? Which adaptations can be carried out in this area to ensure presence, participation and learning in Primary Education? Methodologies, strategies and different adaptations will be covered in the following section.

1.3. IBSE as an approach to respond to diversity in the science classroom

1.3.1. Conceptualization of IBSE

As it has been reflected in the previous section, textbook-based instruction does not boost learning from all students due to the high demands of reading and writing, the requirement of high levels of abstraction and the difficulty to adapt to students' interests (Scruggs & Mastropieri, 2007). In contrast, constructivist methodologies make easier to adapt science teaching to the different needs in the classroom. Particularly, Inquiry Based Science Education (IBSE) is one of the constructivist methodologies to respond to diversity in science (Melber, 2004; European Commission, 2007).

The pioneer of *inquiry*, John Dewey, supported that imagination, curiosity and the need to inquire are essential for students' learning. Dewey's model was extended, leading to the establishment of numerous models and definitions of inquiry. The term "inquiry" has received wide attention, and has evolved to become polysemic, encompassing many types of school investigation. Indeed, inquiry has been used as a synonym of discovery learning, completely structured experimentation (recipe-like experiments) and true inquiry (Couso, 2014).

The European Commission (2007) provided a definition that reflects the meaning of *inquiry* in this work: "Inquiry is the intentional process of diagnosing problems, critiquing experiments, and distinguishing alternatives, planning investigations, researching conjectures, searching for information, constructing models, debating with peers, and forming coherent arguments" (p.10).

Moreover, authors as Harlen & Qualter (2018) claim, IBSE proposals imply on the one hand, experimentation activities based on concrete phenomena that motivates learners, and, on the other hand, generalisation of big ideas, so students can extend their learning to similar situations (Cañal de León et al., 2016).

Among all the approaches to learn science, IBSE guarantees that as many learners as possible reach their maximum (ENCIENDE Report, 2011). It also appears to be one of the most appropriate methods to deal with diversity in the science classroom, and its implications are discussed in the next section (NRC, 1996; Melber, 2004; Scruggs & Mastropieri, 2007).

1.3.2. Implications of IBSE for an inclusive science classroom

The implications of IBSE to meet the demands of the diversity in the science classroom refer to four aspects: learning by practice, connection of science with real life and increasing students' interests and learning cooperatively.

1. *IBSE INVOLVES LEARNING BY PRACTICE*. First, Couso et al. (2020) hold that practicing is the best way of learning science. When students work through IBSE, they become engaged in the teaching-learning process and construct knowledge actively. In other words, they learn the ways of doing, talking and thinking science in the classroom. Consequently, children are likely to participate and enhance their learning through activity-oriented experiences.

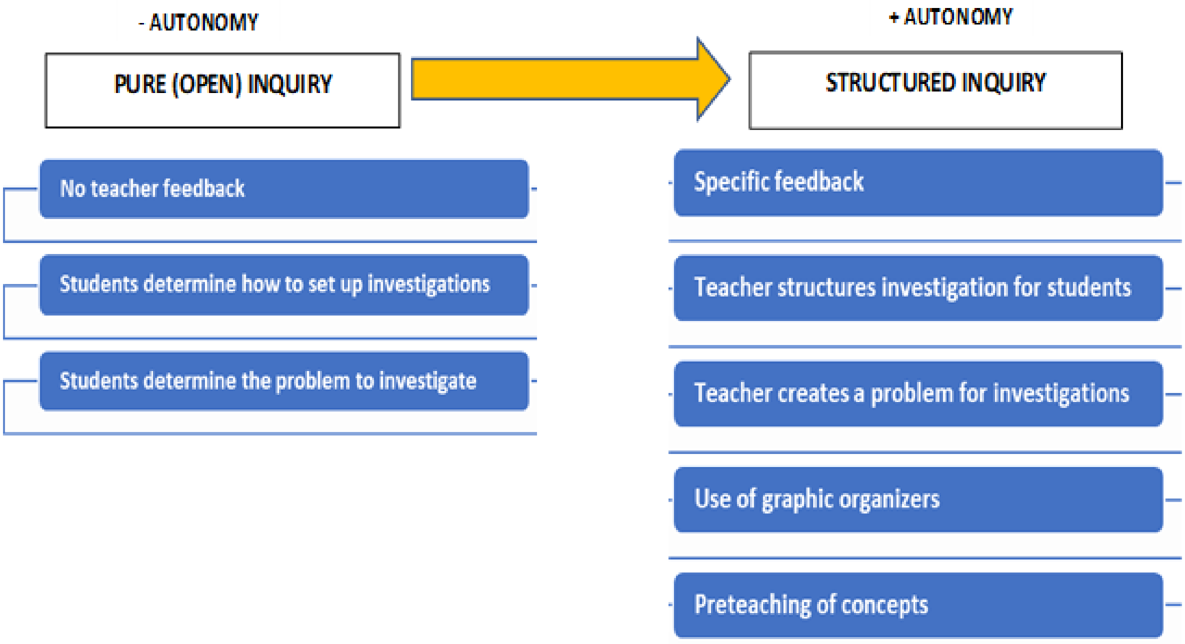
2. *IBSE ALLOWS CONNECTING SCIENCE WITH REAL LIFE*. Moreover, IBSE is activity oriented, so students spend more time learning through interaction with real-life objects and acquiring meaningful experiences. Consequently, activity-based lessons imply less demands of writing and reading skills, favouring students with language difficulties (Vavougios et al., 2016). In this way, focusing on the process as well as on active learning helps children to retain information with more ease (Scruggs & Mastropieri, 2007).
3. *IBSE USES STUDENTS' INTERESTS AS A TRIGGER OF LEARNING*. Another key point of this methodology is that students' interests become the centre of learning. Questions are part of scientific thinking and are used to construct knowledge and to generate students' interest (Martin, et al., 2005). Moreover, IBSE implies learning science while observing authentic phenomena. In consequence, if students see a personal connection of science, they might be more motivated to learn in this subject (Vavougios et al., 2016).
4. *IBSE FOSTERS STUDENTS' INTERACTIONS WHEN LEARNING SCIENCE.* Knowledge in science education and inquiry-based learning is constructed by exchanging opinions, doubts and errors. Therefore, IBSE requires that students learn to work cooperatively so all can construct their own knowledge in interaction (Crawford, 2000; NRC, 2000). Fostering an environment of active listening, respect to express ideas and difficulties leads to a possibility of all students to participate and exchange different viewpoints, acquire complementary roles and value the difference (Pujol, 2003).

Additionally, several studies relate the benefits of inquiry-based learning for students with Specific Educational Needs (SEN). Students with Learning Difficulties (LD) (Mastropieri et al., 2001), visual impairments (Erwin et al., 2001) or hearing impairments (Borron, 1978) were able to participate in the inquiry process and explain their results. Also, students with high capacities benefit from proposals that integrate elements of IBSE (Mendioroz et al., 2019).

Probably this high suitability is related with the flexibility of the method: IBSE allows teachers to give guidance and adapt and accommodate the teaching-learning process to students' needs when necessary (Mastropieri et al., 1997). Consequently, inquiry-based teaching can vary in the amount of structure, guidance, and adaptations that teachers provide. The degree to which educators provide adaptations is sometimes mentioned as *guided* versus *open* inquiry (NRC, 2000; Watt et al., 2013), as it can be seen in Figure 5.

Figure 5

Degree of adaptations in IBSE: open vs guided inquiry learning



Watt et al., 2013, p. 41

Taking as a reference different elements of guidance in which teachers can provide scaffolding from Figure 5, Harlen & Qualter (2018) propose different guidelines of support in an open IBSE (see Table 2).

Table 2.

Elements of support in IBSE

Guiding component	Application
Guiding the structure	Especially in complex processes, as IBSE, guides that include the structure of the inquiry process can help to reduce the cognitive load of the activity (NRC, 2012).
Guiding questions and hypotheses	Napal & Zudaire (2019) hold teaching the syntax of a hypothesis, making exercises of incomplete sentences or create some structures to guide the formulation of the hypothesis.
Guiding and identifying the variables of an experiment	This particular guidance can vary depending on the autonomy of children. The teacher can both a) identify and select the variables b) guide students through questions, discussions and tables to help learners to differentiate between dependent and independent variables in their investigation or, if the degree of autonomy is very high, c) make students specify their variables and help them to use them in their inquiry process (NRC, 2000).
Structuring the task to carry out analysis, interpretations and explanations	Planning the topic of the lesson, providing time and opportunities, using students' results throughout the inquiry process, encouraging identification over statements and discussing new acquired knowledge are actions that support learners to focus on the learning goals (Hmelo-Silver et al., 2007).
Guiding vocabulary and talk	In line with Polias (2016), new terms should be defined as part of the lesson planning. According to the author, the introduction of new terms is appropriate as long as there is a clear need to describe something that has been observed. In relation to talk, "the teacher needs to monitor group discussions, listening in without intervening, before deciding whether 'thinking aloud' is going on usefully or whether it needs to be encouraged" (Harlen & Qualter, 2018, p.46).

In conclusion, providing a range of support is a perfect marriage for success of students with diverse needs (Watt et al., 2013). Therefore, this project is carried out as a culmination of training to provide students with the necessary guidance in the science classroom.

1.3.3. Science Process Skills as a requirement of IBSE

IBSE requires understanding Basic Science Education as concepts and knowledge (products) and a group of skills (process), which are inseparable (Furman, 2008). When learners interact with the world in a scientific way, that is, learn through IBSE, they are asked to observe, question, hypothesize, predict, investigate, interpret, and communicate. These are often called the process skills of science.

The "Science-A Process Approach" (SAPA) project by the American Association for the Advancement of Science (AAAS) defines Science Process Skills as "a set of broadly transferable abilities, appropriate to many science disciplines and reflective to the behaviour of scientists" (as cited in Padilla, 1990, p.1). Science Process Skills are grouped into two types: Basic Process Skills (BPS) and Integrated Process Skills (IPS). BPS are the simplest abilities and set the basis for developing complex skills, and thus should receive special attention in Primary School. BPS and IPS are named in Table 3.

Table 3.

BPS and IPS in science education

BASIC PROCESS SKILLS	INTEGRATED PROCESS SKILLS
• Observing	• Controlling variables
• Inferring	• Defining operationally
• Measuring	• Formulating hypotheses
• Communicating	• Interpreting data
• Classifying	• Experimenting
• Predicting	• Formulating models

Adapted from NARST, 1990

The processes of science play an important role in facilitating that students produce scientific knowledge and learn the nature of science by investigating issues actively (Harlen, 1999). Currently, Next Generation Science Standards (NGSS, 2019), PISA (OECD, 2003) and curricula in many countries highlight the progressive development of Basic Process Skills (BPS) across all Primary Education. The Foral Curriculum of Navarre 60/2014 also reveals the importance of implementing process skills in the classroom.

The role of the teacher is essential to guide the development of BPS in the classroom. Among all the actions, it is stressed the relevance of creating meaningful contexts, since children learn better in defined and significant settings (Pujol, 2003; Ortiz & Cervantes, 2015). Moreover, it is also a task of the education professionals to select effective teaching strategies to implement BPS, and authors prove efficient a) applying guidance for making predictions b) using activities to teach graphing and organising information and c) combine explanations, practice, discussions and feedback while making observations (Osman, 2012).

Apart from selecting methodologies, instruction should be adapted to the different needs in the classroom. Currently, the science classroom is characterized by diverse learning needs, so educators need the skills to provide teaching to all students (Villanueva et al., 2012). Therefore, not only the methodology is determinant, but the teaching-learning process should be designed so everyone benefits from learning (Kirch et al. 2005).

1.4. Strategies and adaptations to respond to diversity in the science classroom

Understanding education within an inclusive framework entails that students' needs must shape instructional design. Thus, apart from the methodology, a teacher should be aware of children's strengths and weaknesses, and how their characteristics have an impact on learning. Identification of these needs is crucial for designing adaptations in the inclusive science classroom that encourage presence, participation and learning (Childre et al., 2009).

As mentioned above, Norman et al. (1998) initially reported a lack of training of General Education teachers and Educational Therapists in either specific strategies to respond to diversity or in knowledge of science, respectively. So, which strategies can educators use to adjust teaching in science?

Adaptation of the teaching-learning process to students' needs can be approached from different perspectives. One strategy to follow is Universal Design for Learning (UDL), which does not modify the nature of the contents or learning but consists of the "modification of instruction and materials to ensure that all students can participate to the greatest extent possible" (Cabe, 2008, p. 82). These adaptations can be implemented in different parts of learning.

1.4.1. Strategies to organise the classroom: create an organised and supportive classroom climate

First of all, it is relevant to establish an inclusive classroom setting that fosters collaboration and respects and values all diversity, including students with special, physical and learning needs. The teacher plays a crucial role to organise a supportive classroom climate and to promote students' participation under safe conditions (Cawley et al., 2003; Pujol, 2003). Some of these actions involve designing an engaging classroom climate, organising time, spaces and materials, creating mixed-ability groups and promoting students' autonomy and reflection.

As regards the classroom climate, it is essential but challenging to *prepare a context that boosts students' interests*. One way of raising learners' motivation in inquiry-based activities is starting with scientific questions (Bell et al., 2005). Thus, the role of the teacher is crucial to select a good question and problem that motivates students and guides the teaching-learning process (NRC, 2000). A criterion for making an appropriate selection is that questions should a) have a defined context b) be linked with the objectives c) boost curiosity (Martin et al., 2005; Cañal de León et al., 2016).

Secondly, an *organised learning environment* can decrease students' undesired behaviour and raise critical thinking, active listening, and communication skills. One strategy to arrange time periods in the classroom is dividing the time into small activities (Wagner, 2015, as cited in Rivera & McKeightan, 2019). Regarding *physical spaces*, the classroom can be organised into different spaces to encourage participation of all students by designing an environment where all students can work comfortably and effectively; dividing the classroom into different spaces that allow mobility; making materials available and allowing their manipulation (Burgshtaler, 2009).

Along with time and physical spaces*, materials* can be adapted taking into account some measures that also consider students with difficulties in fine motricity (Burgstahler, 2009; Harlen & Qualter, 2018).

- Adapting difficulties with fine motor control in using accessible equipment such as adapted scissors and instruments that are easy to manipulate.
- Avoid copying notes and provide copies or notes when it is necessary for the children to have accurate and available information.
- Encouraging the use of a computer for written work.
- Including elements to make information attractive so kids can follow instructions during the class.

Additionally*, organising learning in cooperative, mixed-ability groups* can be beneficial in an inclusive science classroom and inquiry activities for increasing motivation and encouraging social interactions among students. What is more, when children work in heterogeneous groups, they are more likely to help each other while learning science (Scruggs & Mastropieri, 2007; Therrien et al., 2011).

Finally, activities can be designed to *increase students' autonomy and promote reflexion* on learning by (Wagner, 2015, as cited in Rivera & McKeightan, 2019):

- Providing planning and assessment strategies, such as anticipating timelines and graphic organisers.
- Being specific about the steps of the activities.
- Using thinking strategies to reinforce listening and thinking.

1.4.2. Adjustment of instruction in the teaching-learning process

In addition to organising an inclusive classroom environment, instruction, as part of the teaching-learning process can be adjusted to children's rhythms and capabilities. Some actions include graduating the level of assistance given according to the needs of the student; re-explaining again some concepts with more examples to some students when necessary; monitoring the rhythm of students at which they are expected to work, with extra time allowed for some and providing extension activities for those students who need it (Westwood, 2001).

1.4.3 Access adaptations to learning

Lastly, a final category has been established to group all these adaptations that can enhance access and acquisition of knowledge during the teaching-learning process.

Concerning a *careful selection of materials*, resources that involve multiple textures and senses and that are large and easy to manipulate for kids should be prioritised in order to ensure participation and access to learning (Scruggs & Mastropieri, 2007).

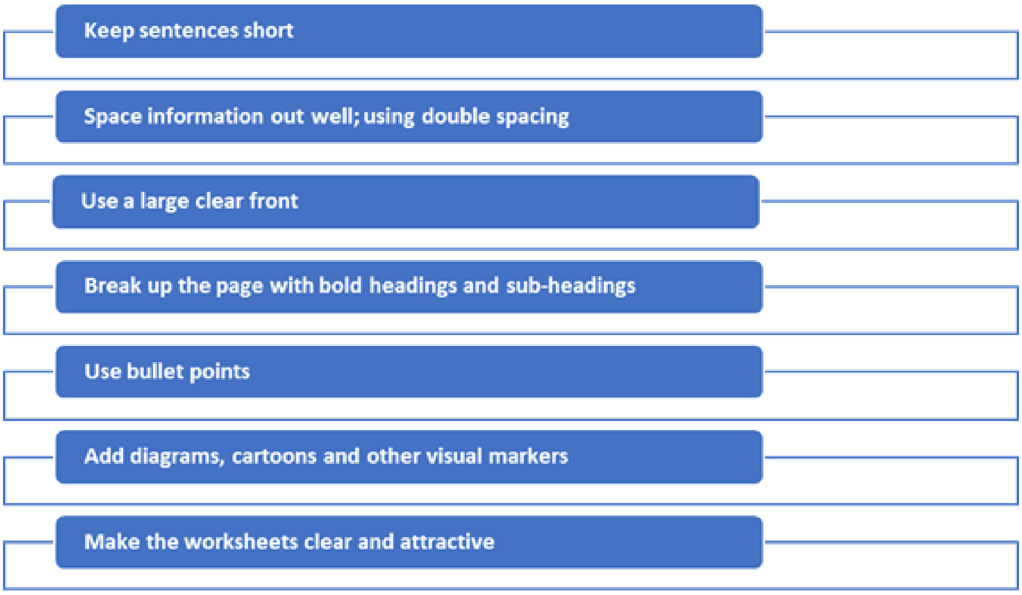
On top of that, the *inquiry process and activities can be segmented into different parts* using different supports, such as a whiteboard to show the facts, evolving hypothesis, learning issues and the action plan. Dividing the tasks also entails introducing the information in small steps or in other words, presenting one concept at a time with concrete examples (Stefanich, 2001; Harlen & Qualter, 2018).

Another strategy to foster access to learning in the science classroom is *using a multi-sensory approach in teaching* "so that children with communication difficulties can learn in the way they find best" (Harlen & Qualter, 2018, p. 332). Therefore, apart from written instructions, visual explanations play an important role and should be included to facilitate acquisition of information in different processes of learning.

- Graphic organisers are a tool that can help learners to organise data and analyse the results, specifically to establish relationships between the observations and previous knowledge. This resource can be used before, during or after the activity (NRC, 2012).
- Texts can be adapted in format and include graphic explanations. As mentioned in section 2, one of the most notorious difficulties of science was its language complexity. Thus, due to the high cognitive and language demands of texts in this area, some guidelines to accommodate texts to the different needs are given in Figure 6 (Harlen & Qualter, 2018).

Figure 6

Guidelines for Making Texts and Worksheets



Adapted from Hudson, 2016, as cited in Harlen & Qualter, 2018, p. 331

- Visual aids might be helpful to facilitate understanding and recalling new words (Scruggs et al., 2008).

Finally, apart from graphic means to support scientific words and the scaffolding examined in the previous section, *language adaptations* to smooth the access to contents include a thorough planning to select the essential vocabulary. New concepts and processes should be introduced as needed, using examples and linking scientific words to everyday terms that pupils may use. Moreover, peer tutoring is thought to be a strategy to help the comprehension of scientific concepts (Scruggs et al., 2008; Harlen & Qualter, 2018).

All in all, our interest in this Final Degree Project is to check and provide an example on how these guidelines can be applied in a real situation to enhance participation and learning in the science classroom.

2. OBJECTIVES AND ACTIONS

2.1. Objectives

The necessity of including all students goes beyond integrating them in the science classroom. Luckily, a response to the learners' needs can be approached with the help of the Supports Paradigm. Considering the specific difficulties of science and the obstacles that teachers experience to deal with diversity in this area (lack of preparation, insufficient training), the objective of this project is to design a didactical proposal to meet the demands of diversity in the science classroom that includes recommendations on different scales (classroom organisation, modifying instruction and access adaptations to learning) of different authors: Burgstahler; Westwood; Scruggs & Mastropieri; NRC; Harlen & Qualter.

The present project General Objective is

- To study the educational response that teachers are giving to meet the demands of the diversity in natural sciences.
- To analyse if an educational proposal based on IBSE and BPS serves to meet the demands of diversity, understood as access, participation and success, in Primary Education science classes.

The Specific Objectives are

- To analyse the visions and challenges that teachers present when responding to diversity in science.
- To design an inclusive science proposal including (1) BPS and (2) IBSE, incorporating the necessary adaptations stated previously.
- To examine the effect of an adapted BPS proposal in order to foster learning and respond to the diverse needs in science.
- To validate the strengths and weaknesses of an IBSE proposal to deal with diversity.

2.2. Actions

In order to meet the objectives of this investigation, a proposal based on Inquiry Based Science Education (IBSE) and Basic Process Skills (BPS) in relation to plants will be designed.

- On the one hand, the educational proposal will be implemented in a Primary Education classroom to examine the value of adaptations to foster learning in the science classroom.
- On the other hand, an educational proposal based on IBSE towards plant transpiration will be validated by teachers' knowledge and experience.

It is noticeable that in both situations the necessary adaptations to enhance students' learning will be implemented (in reference to section 1.4.).

3. MATERIAL AND METHODS

In order to meet the objectives, material and methods were designed with the focus on studying the teachers' vision and challenges when meeting the demands of the diversity in science and the impact of an adapted proposal based on inquiry and Basic Process Skills (BPS).

3.1. Teachers' perceptions on responding to diversity in Natural Sciences

3.1.1. Participants and sample

Regarding the sample, it was non-probabilistic because, as Otzen & Manterola (2017) state, subjects were selected depending on certain features: professionals of the educational field that were close students that learn natural sciences. It was incidental because it was based on recruiting cases that meet the established requisites until the number of desired cases is completed (Otzen & Manterola, 2017). Finally, the sample, apart from intentional, was also by convenience since in certain cases subjects were more accessible because there was a previous contact, as in the case of two schools of Primary Education (one public and other concerted) and a Secondary school teacher from a public centre.

The current sample was composed of 40 teachers from the Foral Community of Navarre, 39 of them of Primary Education and 1 of Secondary Education, as well as one invited guest: the Environmental Museum of Pamplona. *Centro de Recursos de Educación Especial de Navarra* (CREENA) was also contacted but they decided not to respond to the survey. Subjects were contacted by *email*.

Regarding teachers' profiles, their professional field varied among tutor, specialists, professionals of attention to diversity and a specialist in Biology. They also taught in different linguistic models: Spanish, English, Spanish and English and Basque (Table 4).

Table 4.

Teachers' specific professional fields and linguistic models

SAMPLE OF TEACHERS (n=40)			
Professional field		**Linguistic model**	
Tutor	22	Spanish	26
Specialist in an area	13	English	10
Professional of attention to diversity	3	Spanish and English	1
Specialist in Biology	1	Basque	3
Total	*40*	*Total*	*40*

3.1.2. Instruments and analysis

The means that were used to gather information from the participants were elaborated "*ad hoc*". Two questionnaires were created using *Google Forms*. One of the surveys was addressed to teachers and one to the external guest. Therefore, the instruments to gather information were adjusted to the characteristics of the participants and their contexts.

The first questionnaire, which is reachable through Annex 1, was intended to the Environmental Museum of Pamplona. It contained 11 questions divided into three sections that combine qualitative and quantitative answers to see which resources and strategies are used to respond to diversity of Primary Education students in science workshops and analyse the value of IBSE in an informal educational context. Finally, this entity decided to give their perspective on how they adapt their workshops to students' needs via email, providing a qualitative response.

The second questionnaire was designed for teachers and is available through Annex 2. It included 14 questions and was divided into four big sections. Section 1, included 4 initial questions, which determined the teacher's profile and degree of diversity in their classroom by multiple choice or short text answers. Section 2 contained 2 short-answer questions related to general notions towards diversity. Section 3 posed 6 questions connected to natural science teaching and diversity in the classroom and were either short-answer or multiple choice. The final part, Section 4, presented the IBSE proposal 'Inquiry sequence: Plant nutrition' and 2 open-ended questions to reflect thoughts on it. With these 14 questions we wanted to be aware of the educational response that teachers were providing in science to deal with diversity as well as the value of IBSE to accommodate learning to students' needs in science.

The questionnaires gathered quantitative and qualitative information in order to give the results. The open-ended questions, which provided qualitative results, were examined through a content analysis that consisted of categorising, codifying and classifying the data according to criteria that has been established to study and interpret adequately the evidence reported by the respondents (Martínez González, 2007).

Specifically, the creation of the categories to analyse teachers' statements on the value of IBSE to meet the demands of diversity followed an inductive process of classifying information. This inductive procedure was based on configuring data progressively once the studied reality had been researched (Martínez González, 2007).

What is more, teachers' testimonies were collected in Spanish and have been translated to English due to the linguistic requirements of this project.

3.2. Contextualization of the proposal based on IBSE and BPS

3.2.1. Centre

The didactic proposal was designed to be executed in an Infant and Primary School located in a neighbourhood of Pamplona. It offered a *PAI* program in all levels of Infant and Primary Education and thus Maths and Natural Sciences were taught in English. The centre was characterized by a low sociocultural level and multiculturalism. The institution chose cooperative and active methodologies, in which the student became the centre of the teaching-learning process. The school did not divide the schedule in subjects, but the teachers had the autonomy to design flexible programming and each session lasted 45 minutes.

Therefore, this proposal was organised for the area of natural sciences from an active viewpoint, with English as the vehicular language.

3.2.2. Participants

Regarding the characteristics of the classes, Class 1 was formed by 18 students (9 ♀ and 9♂) and Class 2 by 17 students (8 ♀ and 9 ♂). For privacy issues, all the names have been replaced with pseudonyms of flowers or plants, which are used to refer to children across all the work (see Table 5 and 6).

All the learners had different needs that enriched the teaching-learning process (see Tables 5 and 6). Both classes had obstacles when understanding explanations in English and tended to be unfocused in tasks. It was also noticeable the disparity of the work pace of both classes. Class 1's work pace was slow, but they were quite creative and imaginative. Class 2 was generally more hard working and the main students' difficulties were writing in English.

In total there were seven students with SEN (4 in Class 1; 3 in Class 2) and all of them received specialized support (see Table 5 and 6):

- One absentee boy in sociocultural disadvantaged position (*Corn*)
- Two in late incorporation (*Tomato* and *Artichoke*)
- One girl with Intellectual Disability (*Willow*)
- One with short attention spans and difficulties in fine motricity (*Peach*)
- One girl with learning difficulties (*Bean*)
- One boy with several learning needs and a disfavoured situation (*Carrot*).

Table 5.

Characteristics of students from Class 1. Names = pseudonyms. Grouped by work groups

Group	Name	Sex	NEAE/ Attention to diversity	Relevant characteristics
GROUP 1	Apple	♂		A talented kid in mathematics but with little interest in learning.
	Pear	♀		Sensitive and generous child. Strong personality.
	Orange	♂		Open-handed and a very nice classmate. Attentive and good behaviour.
	Lemon	♂		High academic achievement but several behaviour problems in class and with classmates. Difficulties in focusing attention and slow work rhythm.
	Peach	♀	-7 h SEN teacher - P -RE-ACA	Difficulties in fine motricity as well as in logic and mathematic reasoning. Very short attention span. Obsessive behaviours and difficulties in socialization with classmates.
GROUP 2	Lily	♂		Participative but impulsive. Difficulties in self-regulation and he has behaviour problems.
	Rose	♀		Low academic achievement. Low socioeconomic level. Little participation in class.
	Tulip	♀		Very shy, but helpful with her peers.
	Cactus	♀		Extrovert and participative.
GROUP 3	Lettuce	♂		Low self-esteem and low academic achievement, but constant.
	Tomato	♀	-3h PAEP -P	Late incorporation and disadvantaged sociocultural position. Generous but quite lazy. Frequent arguments with her group peers.
	Cucumber	♂		Medium academic achievement. Honest, but he has some behaviour problems and wants to call people's attention.
	Corn	♂	-3h PAEP -P	Absentee kid. Disadvantaged social position. Helpful and good partner but sometimes distracted.
	Aubergine	♀		Intelligent and good partner. Very good friend of Rose.
GROUP 4	Oak	♂		Participative, caring and a good partner. High academic achievement.
	Pine	♀		Participative, responsible, and high academic achievement.
	Maple	♂		Intelligent, but disruptive behaviour with classmates specially in the playground.
	Willow	♀	-3h ET -3h SL	Very shy girl, but really helpful with her classmates. She is a student with DI and has a curricular level of 1st year of Primary Education.

ID=Intellectual Disability; P= Permanence in the year; PAEP= *Profesional de Apoyo de Educación Primaria;* ET= Educational Therapist; RE-ACA= *Adaptación de Acceso*; SL= Speech Language Teacher

Table 6.

Characteristics of students from Class 2. Names = pseudonyms. Grouped by work groups

Group	Name	Sex	NEAE/ Attention to diversity	Relevant characteristics
GROUP 1	Mango	♂		A participative kid with medium-low academic achievement and difficulties in English language. Slow working rhythm.
	Cherry	♀		Good partner and helpful. Medium academic achievement.
	Apricot	♂		Responsible and hard-working.
	Melon	♀		Honest but a bit indolent. Medium-low academic achievement in English and Mathematics.
GROUP 2	Daffodil	♂		Participative but nervous. Sometimes he has difficulties to focus attention.
	Violet	♀		Constant and responsible. High academic achievement, especially in English literacy. Loves painting.
	Camellia	♀		Very creative and artistic. High mathematical reasoning.
	Orchid	♀		Caring but a bit shy. Special difficulties in reading.
	Lotus	♂		Late incorporation to the school. English difficulties since he comes from a non PAI school.
GROUP 3	Bean	♂	-LD	Absentee kid. Introvert and with learning difficulties, especially in understanding English language. Short span attention.
	Aubergine	♀	-3h PAEP -3 h SEN	Caring. Low sociocultural condition. He has curricular adaptations in English and Maths. Difficulties in focusing attention, especially in subjects taught in English. Tends to reject activities in English.
	Artichoke	♂	-3h PAEP	Late incorporation to the school. Perfectionist, but lazy in the tasks she does not like, as English. Started studying English this school year. She sometimes has arguments with Bean.
	Cabbage	♂		Curious, but frequently behaviour problems interrupting and disturbing in the classroom.
	Zucchini	♂		Friendly, but a little bit unfocused.
GROUP 4	Conifer	♂		Resilient, good partner and participative. Very high academic achievement
	Chestnut	♀		Participative, responsible, and high academic achievement. Organised.
	Walnut	♂		Creative and art lover. Often unfocused and extremely lazy.
	Hazelnut	♀		Organised and constant.

LD= Learning Difficulties; P= Permanence in the year; PAEP= *Profesional de Apoyo de Educación Primaria;* ET=Educational Therapist; SL= Speech Language Teacher

3.2.3. Methodologies in science classes

As it can be seen in the previous Tables 5 and 6, students were arranged in groups of four or five people, which allowed learning cooperatively. In that way, science classes' learning approaches went hand in hand with the active and cooperative methodologies of the school. Therefore, while learning science, students were used to interacting and learning from each other, enriching the teaching-learning process.

Following Lago et al. (2015), students were taught to learn cooperatively and were assigned a specific role, which could be material responsible, language assistant, coordinator, or secretary (Annex 3). Roles were also applied in the science classroom. They were distributed deliberately among group members and changed every term. For the present proposal, due to COVID-19 situation, the same group organisation was used. What is more, the educational activity was arranged trying to give priority to interaction among children. Hence, children became the centre of the teaching-learning process and the teacher was the guide of this process.

The institution approached natural sciences from *Project-Based Learning* methodology. One project was organised for each grade and considered students' interests. Consequently, the process started using the routine *Know-Want to learn- Learnt (*KWL) to activate students' prior knowledge as well as to make children's motivations explicit. The project that fourth grade students were developing in natural sciences was 'Plants'. Specially, two of the topics that kids aimed to cover in their project were Plant Reproduction and Nutrition. For that reason, the educational proposal seeks to observe and reflect on the different reproductive structures of the flower and their function in order to understand the reproductive process of plants. It also aims to make explicit the nutrition process of plants, making an emphasis on water.

One of the main resources to learn science used by the responsible teacher were worksheets. These written exercises were programmed connecting the topics to work on the project with the contents of the curriculum of fourth grade of Primary Education in natural sciences (D.F. 60/2014). Additionally, digital and interactive resources were introduced in the science classes, such as videos or online activities through the digital whiteboard to facilitate content acquisition and receiving information visually.

Thus, this educational proposal was set in the context of the Plants Project, prioritising interactions among students and extremely considering the group and individual needs of learners.

3.3. Description of the adapted didactic proposal

As stated, the educational proposal was part of the Plants Project studied in two classes of fourth grade of Primary Education. It aimed to grasp knowledge in the topics of Reproduction and Nutrition of Plants. Particularly, the teaching-learning process was designed examining students' needs to include strategies that enhance learning in natural sciences.

Before the implementation of the activity, within the Plants Project, students had acquired knowledge on the basic anatomy of the plant (stem, roots, leaves and flower), life cycle and plants' needs. Learners had also studied photosynthesis during two sessions. So far, all students had learnt science mainly through worksheets. Interactive videos had also been added to help them understand concepts. It is noticeable that all children had carried out the same tasks and had not been provided with adaptations or accommodations of learning.

However, these didactic activities were based on active approaches and methodologies, as it is Inquiry Based Science Education (IBSE), which encompasses not only contents, but also the processes of science (Science Process Skills). Moreover, activities also included guidelines of different authors to try to improve participation and learning of all students.

3.3.1. General description of the Proposal Plant Reproduction

The first proposal was centred on plant reproduction with the aim of working Observation and description as a Basic Process Skill (BPS). It was planned to last three sessions and maintained the regular structure of groups due to COVID-19. An overview is shown in Table 7 and more details are given in Annex 4.

Table 7.

Overview of the proposal based on plant reproduction: 'Knowing my Flower'

	"KNOWING MY FLOWER"	
WHAT?	Proposal for fourth grade of Primary Education towards plant reproduction based on acquiring BPS (observation). It has a duration of three sessions.	
OBJECTIVE	To observe and reflect, as part of developing processes in science, the reproductive structures of the flower and their functions in order to comprehend the reproductive cycle of the plant.	
HOW?	The activity is structured in five different parts:	
	activation of prior knowledge	assembly with interactive whiteboard
	drawing a flower (individual)	drawing an imaginary flower
	dissecting and observing a flower	routine I see, I think, I wonder
	drawing a flower (individual)	
	extending knowledge	Explaining the reproductive cycle of the flower

3.3.2. General description of the Inquiry Proposal: 'Plant Nutrition'

After having observed the flower's reproductive structures in the first activity, the second adapted activity was devoted to nutrition. Indeed, plant nutrition was a topic that children wanted to study within the Plants project. In the previous activity, that is, activity 1 ('Knowing my Flower'), students had the opportunity of watching the appearance of the stem from inside and reflecting on its function. The second activity followed an Inquiry model to gain understanding on the process the water of a plant takes. In other words, it aimed learners to acquire general knowledge on water *absorption* and *evapotranspiration*. An overview of the Inquiry proposal is shown in Table 8.

Table 8.

Overview of the Inquiry sequence: 'Plant Nutrition'

INQUIRY SECUENCE: "PLANT NUTRITION"		
WHAT?	Proposal for fourth grade of Primary Education based on IBSE to observe and learn about the process of absorption, evaporation of water and transpiration in plants.	
OBJECTIVE	To learn where and what happens with the water that plants absorb, that is, gain basic knowledge of absorption and transpiration, as well as to train Science Process Skills involved in IBSE (mainly observation and prediction).	
HOW?	The activity is structured in five different parts:	
	Motivation and activation of knowledge	-Initial questions: What happens with the water that plants take? Where does it go? Why do plants use it for? -Organisation of students in heterogeneous groups for the inquiry sequence
	Formulation of hypothesis	Use scaffolding to formulate hypothesis about 'where does the water that plants take goes'
	Action plan	Design a Plan to carry out an experiment that proves students' hypothesis
	Conclusions and extension activities	-Draw conclusions -Communicate results -Extension and activities to deepen knowledge for those who require it

3.3.3. Adaptations

The scope of this work is attempting to respond to students' needs in the science classroom. In both proposals, working cooperatively was prioritised as a link with the methodologies of the school. Thus, students were arranged in groups and each one is assigned a role with the aim of engaging students actively and encouraging them to share diverse perceptions and viewpoints in the science classroom. (Lago et al.,2015).

Moreover, common adaptations for both proposals were considered ('Knowing my Flower' and 'Plant Nutrition'). They included, apart from organising heterogeneous groups, introducing and structuring the activity, selecting suitable materials, providing visual explanations, and anticipating vocabulary. These general adaptations are specified in Table 9.

Table 9.

Common adaptations for the proposals 'Knowing my Flower' and 'Plant Nutrition'

	BPS: KNOWING MY FLOWER	IBSE: WATER PROCESS
Creation of a supportive classroom climate (Burgstahler, 2009; Harlen & Qualter, 2018).	Taking the guidelines of authors to design a safe and organised climate in the science classroom, the class is structured into four different groups and there is also a corner with all the material needed that the students in charge of the material will take.	
Selection of materials (Scruggs & Mastropieri, 2007)	For both proposals, lilies and big pots are selected to assure the possibility of manipulation by the students, taking into account the presence of a girl with fine motor difficulties.	
Anticipation and structuring the activities (Harlen & Qualter, 2018)	-All the activities are introduced to students at the beginning of the sequence. -The sequence is divided into 4 structured parts. -The dissection is divided and structured into small periods of time.	-The process of Inquiry-Based Learning is introduced and anticipated using visual tools.
Visual explanations (NRC, 2012)	Visual explanations are prioritised to help those with short attention spans and language difficulties.	
	Graphic organisers, PowerPoint presentations and flowers as visual element are implemented to support verbal explanations (Annex 5).	Graphic organisers to structure the inquiry process and the use of flowers as a visual element are implemented to support verbal explanations (Annex 6).
Anticipation of vocabulary (Harlen & Qualter, 2018)	New terms and challenging vocabulary are identified prioritising their introduction through a multi-sensory channel. In this proposal based on BPS, texts are adapted with images and highlighting key words, following guidelines of Hudson (2016) to bear in mind children with language difficulties (Annex 7).	New terms and challenging vocabulary are predicted to provide a clear explanation as well as deciding when they are going to be introduced (Annex 8).

Each of the educational activities also included individualised adjustments. On the one hand, implemented adaptations in the sequence 'Knowing my Flower' (Basic Process Skills) are detailed in Table 10.

Table 10.

Specific adaptations for the proposal 'Knowing my Flower'

Kid(s) and needs	Adaptation
Students with short attention spans	Provision of a support to help them be on task during the dissection of the flower (Annex 9).
Peach (difficulties with fine motricity)	Human resources
	An individualised access adaptation is provided for this student instead of drawing the second flower (Annex 10). It consists of placing each observed reproductive structure in a blank picture of a flower. However, the contents and nature of the activity are the same to the rest of the students (Harlen & Qualter, 2018).
Apple (talented kid) and high-ability students	Extension activities. Apart from the observed flower, daisies, which are compound flowers, poppies (asymmetric flowers) and clover flowers are brought to class to challenge some learners and deepen knowledge (Annex 11).

On the other hand, due to the complexity of the process of inquiry, guidance *or scaffolding* was provided in all the steps of the inquiry process. The purpose was ensuring everyone's participation and boosting learning including those with learning difficulties, short attention spans. Also, as natural sciences were taught in English, support was based on making students discuss and interact with more ease (see Table 11).

Table 11.

Guidance for the Inquiry sequence: 'Plant Nutrition'

Make hypotheses	Helping kids with the structure and formulation also taking into account students are learning natural sciences in English (Napal & Zudaire, 2019).	Annex 12
Action plan	- Guidance to design and collect the results. - Wrapping up the groups' inquiry process in the whiteboard (Hmelo-Silver, Duncan & Chinn, 2007).	Annex 13
Argumentation and reflection talks	Creation of discussion cards adapted from English language and showing and practising a simple structure to give arguments in English ('I think...because…') (Polias, 2016; Harlen & Qualter, 2018).	Annex 14

3.4. Instruments for the validation of the didactic proposals

For the purpose of validating the two didactic proposals connected with the Plants Project, data will be gathered at two levels: first of all, from students' evaluation and secondly, from teachers' opinions.

3.4.1. Validation of the proposal 'Knowing my Flower'

In order to prove the sequence based on plant reproduction, the proposal was implemented in two classes of fourth grade of Primary Education. The group and individual evolution of the students before and after the intervention, as well as the degree of involvement in the task were examined.

The drawings of the flower before and after the intervention were analysed using some categories defined *a priori.* Five levels were defined according to the complexity of the organs depicted (see Table 12 and 13). Moreover, the productions were labelled as *A* if they were overly academic (formal, stereotypic representations, as they can be found in the textbooks) or *O* if they were more realistic, based on Observation of the available specimens (see Table 14).

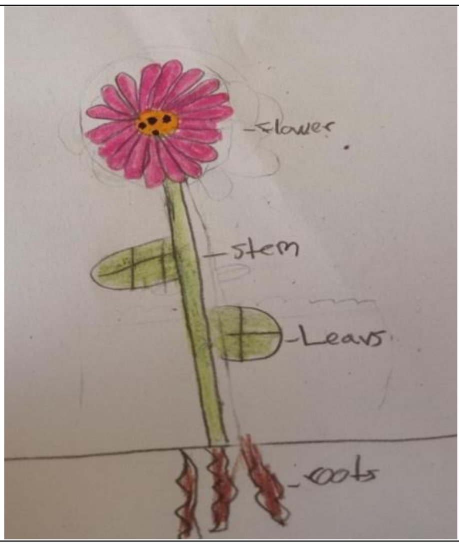
Table 12.

Levels defined according to the complexity of the depiction of the flower

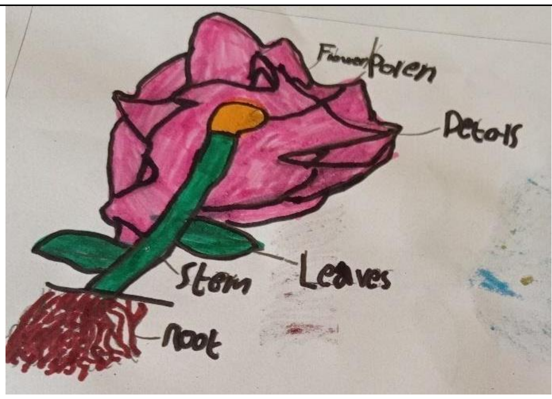
Level	Description
Level 1	Stereotyped flower (daisy). There appear the names of the complete plant (stem, leaves, roots) and petals at most.
Level 2	Some parts of the reproductive function of the flower are pointed out (pollen). But unsuitably placed.
Level 3	Considerable parts of the reproductive function of the flower are cited, but unsuitably placed.
Level 4	The reproductive parts of the flower are properly indicated but the drawing is incomplete (only the masculine or feminine part).
Level 5	In their correct place, all the relevant parts of the flower are mentioned, although some of the following: receptacle, petals or sepals may be lacking.
(A)cademic (O)bservation	To the previous level, an A/O are added if (A): is too academic, similar to the guidance worksheet or (O): it is not that formal but more similar to the real plant.

Table 13.

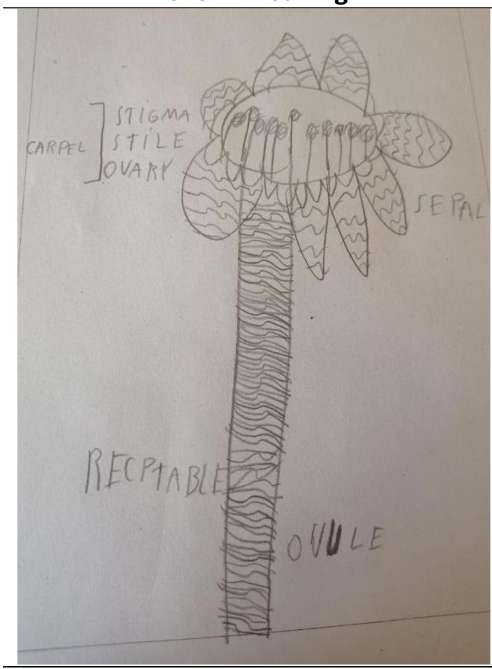
Meaning of the levels defined according to the complexity of the depiction of the flower



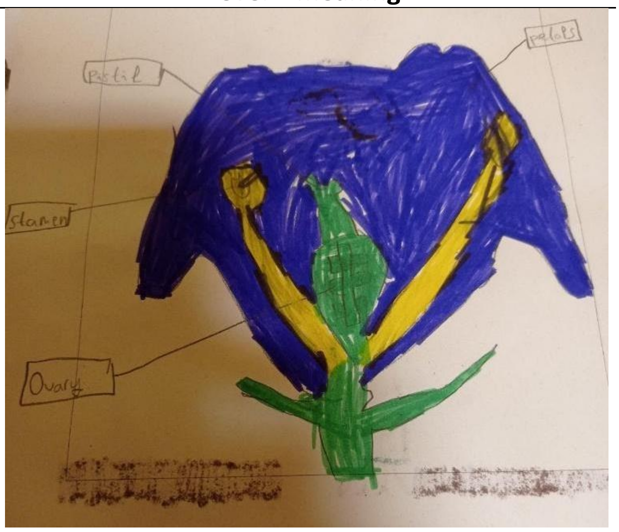
Level 1 meaning



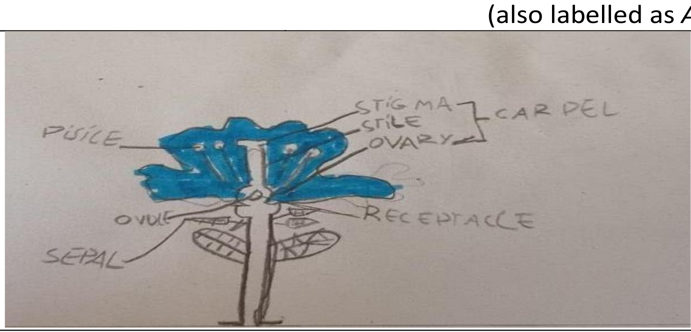
Level 2 meaning



Level 3 meaning



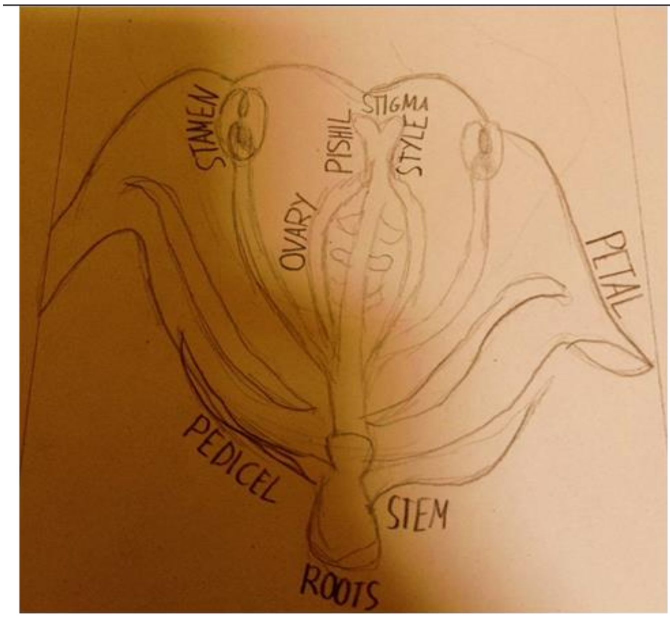
Level 4 meaning
(also labelled as *A*)



Level 5 meaning
(also labelled as *A*)

Table 14.

Illustrative examples of the *(A)*cademic *(O)*bservation according to the formality of the depiction



(***A***)**cademic**	(***O***)**bservation**

In addition to the quantitative techniques of observation, a qualitative observation analysis was selected to examine the impact of the proposal on students' behaviour and participation. Specifically, an observational register of narrative description was carried out, reflecting some attitudes and changes comparing before and after the activity in order to systematise the observation and guarantee the maximum objectivity (see Annex 15) (Martínez González, 2007).

3.4.1. Validation of the Inquiry sequence: 'Plants Nutrition'

Secondly, Section 4 of teachers' questionnaire (detailed in section 5.1.1.) included two questions on their perceptions of the inquiry-based activity. Professionals were asked if they found the proposal suitable to meet the demands of diversity and why; the difficulties that could emerge and possible suggestions.

4. RESULTS

4.1. Results of teachers' visions to respond to diversity

4.1.1. General notions of attention to diversity

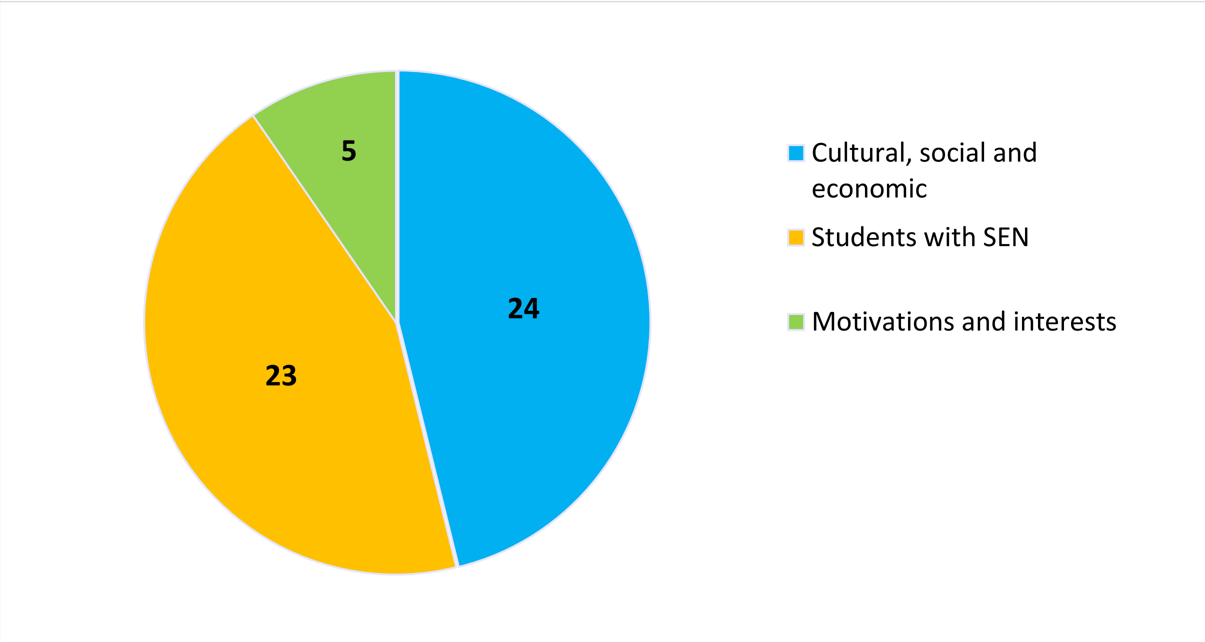
- *Students' diversity in the classrooms*

38 teachers out of 40 (95%) justified that there was a high grade of diversity in the classroom, while 2 teachers (5%) mentioned the opposite.

Diversity was understood by teachers in different ways. Educators justified diversity "because of the difference of development, capabilities and experiences of the different students" and stated that meeting students' needs in the classroom implies a big challenge. Also, some educators perceived diversity linked with students with Specific Educational Needs (SEN) (23 times). On 4 occasions the disparity among some kids was caused by the diversity of capacities and learnings, while 24 cultural and social: "diverse abilities and competences"; "different levels of knowledge in English and science" (see Figure 7).

Figure 7

Frequency of Appearance of the Different Categories of Diversity

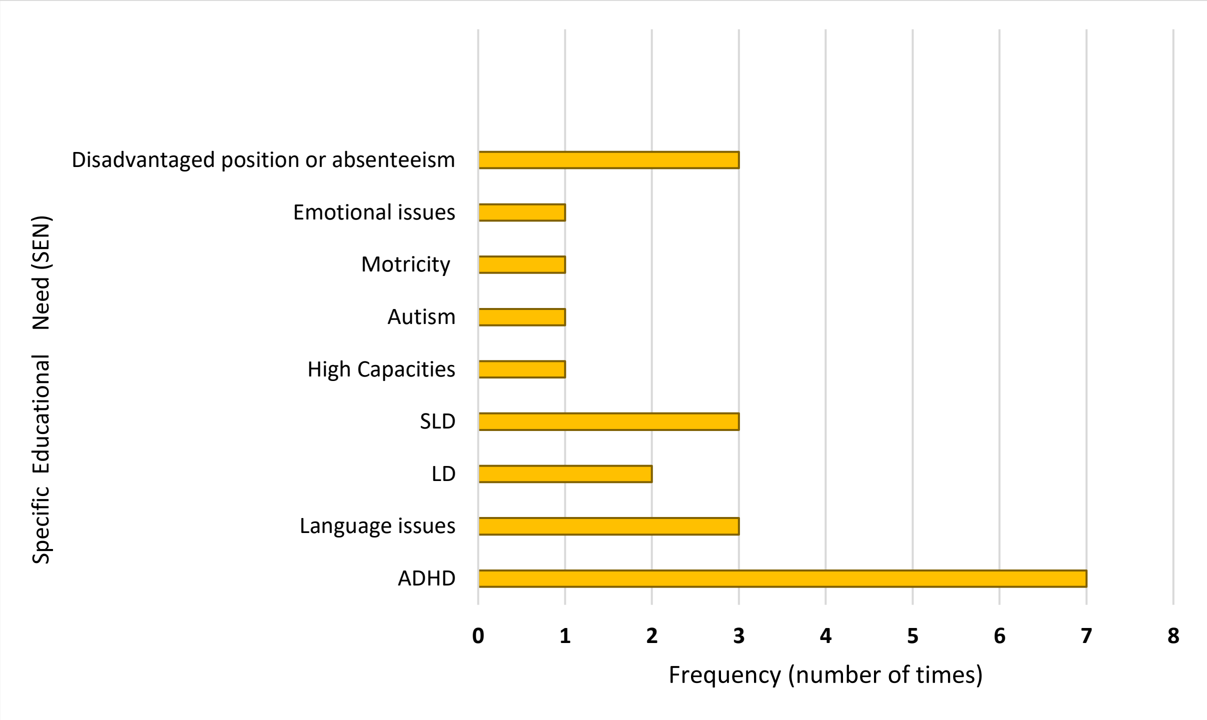


In 24 out of 50 cases, multiculturalism and family situations were reported to be a main reason for a high diversity in the classroom. Specifically, 18 educators out of 40 respondents justified a high diversity in their classes due to the different nationalities and cultures: "different nationalities with different mother tongue"; "wide variety of cultures and religions"; 80 % of immigrant students. Moreover, there are 6 testimonies over 50 arguments about family background and economic situations inside this group: "different economic status"; "characteristics of the families".

On 23 occasions, teachers justified a high rate of diversity referring to the existence of students with SEN. Among the 23 answers, ADHD was the most reported (7 times), followed by disadvantaged position or absenteeism, Language Difficulties (LD) and Specific Language Difficulties (SLD) (see Figure 8).

Figure 8

SEN Reported by Teachers



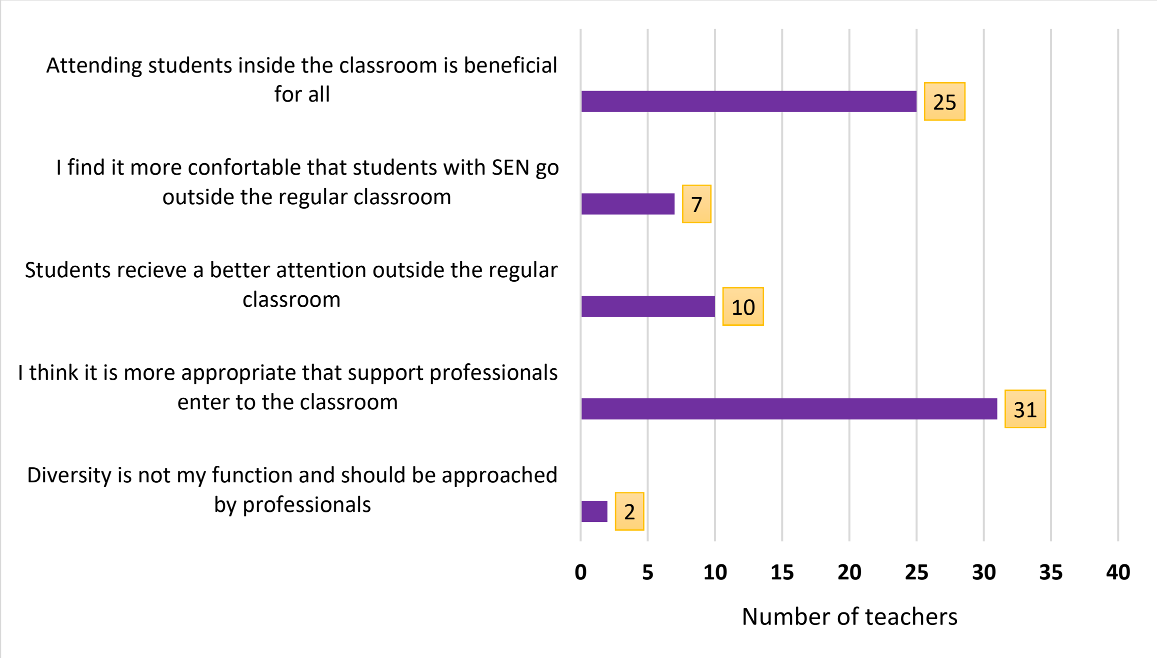
Teachers also communicated diverse interests and motivations. Although it was only mentioned 5 times, this aspect seems to be crucial in organising the activities in science.

- *Teachers' notions of inclusion*

Figure 9 captures a quantitative overview of teachers' beliefs towards inclusion, which affected the way they provided support in their classes. It highlights that 25 teachers out of 40 held that attention inside the classroom is positive for all (62.5%) and 31 (77.5% of the sample) stated that they find it more appropriate that support professionals provide attention to students inside the classroom. However, 17 educators, representing a 42.5%, selected answers related to the better attention of students with SEN outside the classroom or the feeling of comfort when these students are in the support classroom. Only 2 subjects indicated that responding to diverse needs was not their responsibility.

Figure 9

Teachers' Perception towards Inclusive Support



- *Abilities to respond to diversity in an inclusive setting*

19 educators out of 40 (47.5%) felt ill-prepared to respond to diversity (see Figure 10; categories *Nothing* or *Scarce*). This result corresponds mostly to tutors and subject specialists, but also to one Support Professional. Only 13 teachers (32.5%) had sufficient training and just 8 (20%) felt extremely prepared to respond to diversity in the classroom. It is noticeable that 28 out of 37 tutors and subject specialists needed the suggestions of the Educational Therapist (see Table 15).

Figure 10

Teachers' Abilities to Respond to Diversity

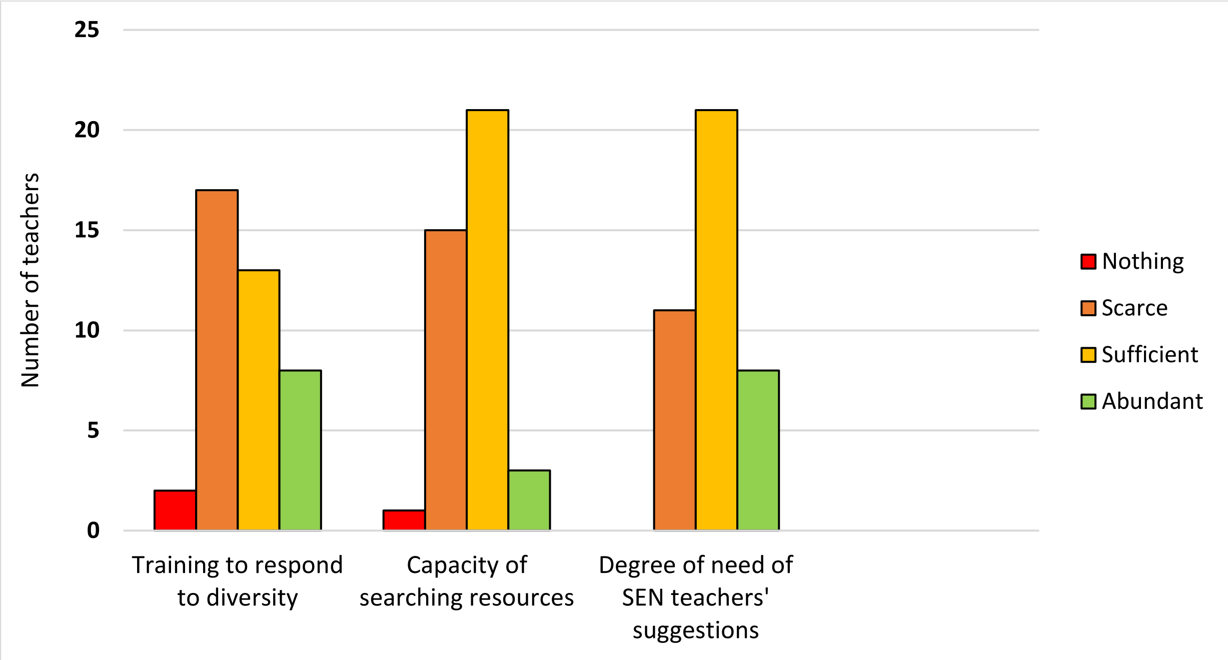


Table 15.

Relation between the profile and abilities to respond to diversity

	Nothing-Scarce	Sufficient-Abundant	Total
TRAINING			
Tutors and subject specialists	18	19	37
Support professionals	1	2	3
CAPACITY OF SEARCHING RESOURCES			
Tutor and subject specialists	16	21	37
Support professionals		3	3
DEGREE OF NEED OF SEN TEACHERS			
Tutor and subject specialists	9	28	37
Support professionals	1	2	3

- *Specific teaching skills*

Tutors and Support Professionals suggested acquiring various competences to meet the needs of diversity in the science classroom (see Annex 16). Among all the statements, it is discernible that only 3 teachers out of 40 mentioned specific strategies of natural sciences: "…use active methodologies"; "I would try to work on projects"; "The practice of retelling is vital for recalling, assessing and detecting misconceptions or gaps in learning". The rest of the subcategories can be seen in the upper part of the table and refer to *Flexibility*, *Open-mindedness*, *Emotional implication*, *Patience*, *Systematic observation*, *Lifelong training,* and *Communication*.

4.1.2. Attention to diversity in natural sciences

Experimental approaches

- *Strategies*

Concerning methodologies, 70% of teachers (28) used inquiry or experimental approaches. It is remarkable that 31 educators made use of outdoor trips to connect and include science learning. 67.5% of teachers (27) reported they use manipulative materials in relation to the topic and 67.5% (27) used instruments such as scales or thermometers in their science classes (see Table 16).

Table 16.

Relation of the number of teachers and the use of teaching strategies

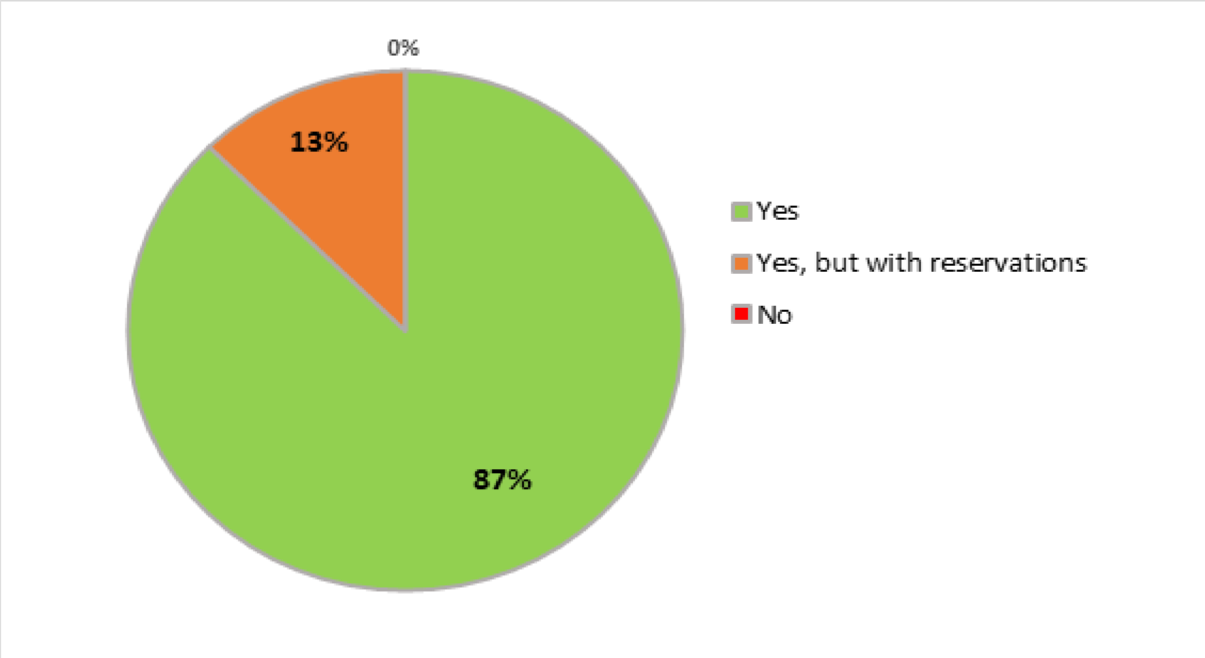
Teaching strategy	Number of teachers (N= 40 teachers)
Technological resources	39
Manipulative materials related to the topic	27
Instruments: thermometers, magnifying glasses…	27
Worksheet-like activities	29
Outdoor trips	31
Inquiry or experimental activities	28
PBL	1
Gamification and Flipped Classroom	1

- *Challenges of experimental activities*

87% of the sample perceived that experimental activities are a beneficial approach to teach sciences and 13% reported their advantages with doubts. It is remarkable that no-one pointed experiment-based methodologies to be negative in the natural science classroom (see Figure 11).

Figure 11

Grade of Benefit of Experimental Activities



Main obstacles to implementing experimental activities were related to diversity of students: difficulty to meet their interests and different capacities (see Table 17) and teacher demands (mostly material resources) (see Table 18). 4 subjects stated COVID-19 as an added challenge (see Figure 12 and Table 19).

Figure 12

Quantitative Analysis of Challenges of Experimental Activities

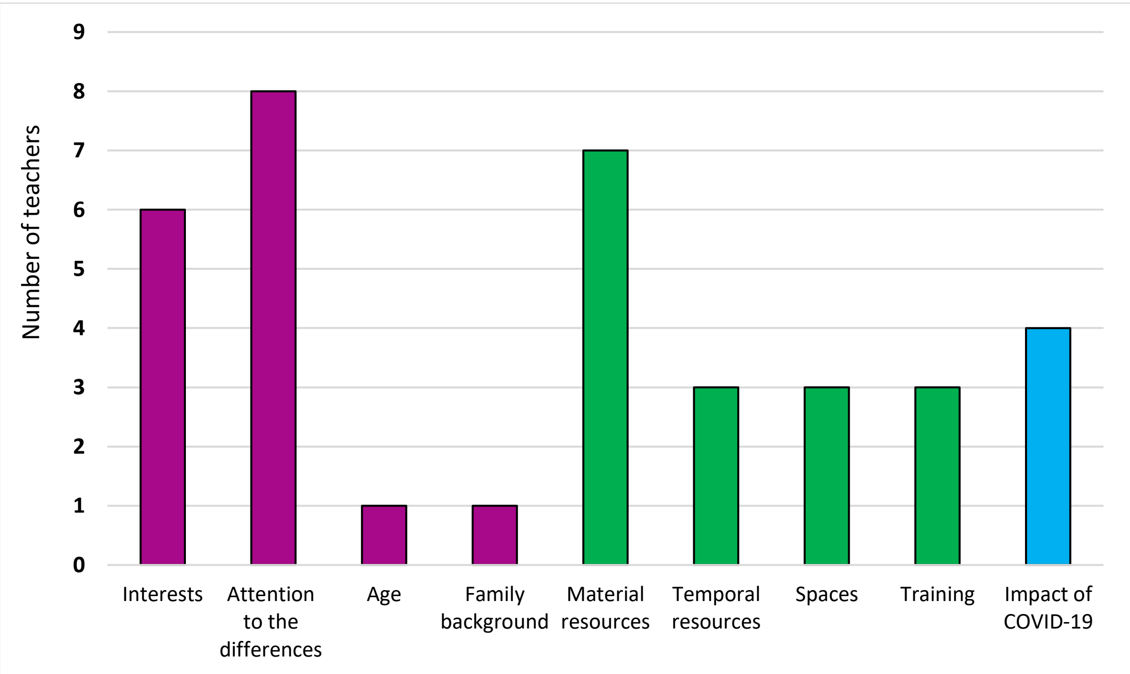


Table 17.

Students' diversity. Subcategories and evidence

DIVERSITY OF STUDENTS	
Definition**:** Attributes that make students unique, depending on their interests, personality, individual difficulties or due to family's involvement and background.	
Interests	- "Present the topics so they become interesting for all students" - "Carry out direct experiences that are engaging"
Attention to the differences and participation	- "That all students are able to follow the explanation without getting lost" - "Adaptation of materials underneath and on top" - "Active participation of all students, always considering their potentialities"
Family background	- "Little involvement of families and disinterest of families; lack of attention of children"

Note. Teachers' testimonies were translated from Spanish to English

Table 18.

Teachers' necessities. Subcategories and evidence

TEACHERS' NECESSITIES	
Definition**:** Demands of educators in order to introduce experimental activities in natural sciences.	
Material resources	- "Lack of school funding" - "In the majority of occasions lack of material in the educational centre" - "Many times, there are not materials for all students"
Human resources	- "In the class there are very diverse students and only one person cannot attend everyone" - "Lack of personnel to carry out the activity with tranquillity and security" - "Too many students to achieve that all can experiment"
Temporal resource	- "Lack of time in 40 minute-sessions" - "Time limitation, very short sessions to carry out experiments"
Demands	- "It requires to prepare all the material and it takes a lot of time" - "More work: investigation, documentation, planification, materials…"
Spaces	- "Limitation of spaces" - "…and of adequate spaces to develop some of the didactic proposals (labs or adequate external spaces")"
Training	- "To know more aspects to teach students in a more manipulative and practical way and make sciences more comprehensible in English to those that have low levels of the language" - "Access to materials" - "Lack of specific training in attention to diversity"

Note. Teachers' testimonies were translated from Spanish to English

Table 19.

Evidence about COVID-19

Impact of COVID-19	
Definition**:** Organisational consequences and restrictions to design experimental activities that have been caused by the pandemic	
	- "COVID-19 mostly" - "COVID-19" - "Not being able to work in groups" - "Limitations of the pandemic"

Note. Teachers' testimonies were translated from Spanish to English

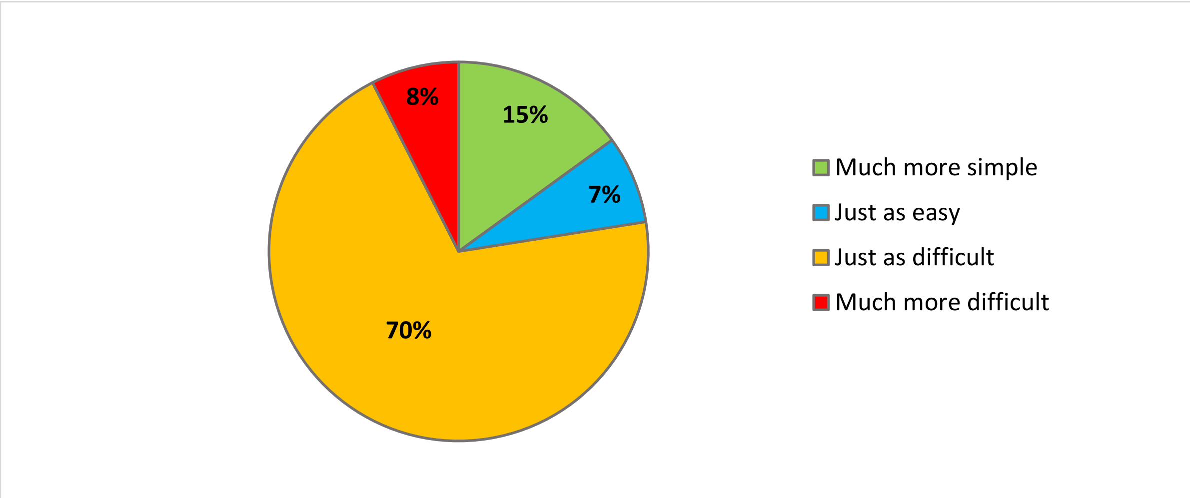
Response to Diversity in Natural Sciences

- *Connection with other areas*

28 teachers out of 40 (70% of the sample) found attention to diversity in natural sciences just as difficult as other areas. It is noteworthy that 6 educators (15%) perceived this discipline as an easy subject to deal with diversity (Figure 13).

Figure 13

Difficulty of Attention to Diversity in Comparison with other Areas



- *Obstacles when responding to diversity in natural sciences*

The challenges educators presented to provide an inclusive response in natural sciences shared common features with their challenges to design experimental activities, which referred to students' characteristics and professionals' demands (see Table 20 and 21). However, in contrast to the testimonies connected with experimentation, in this category teachers also remarked specific difficulties of science and specific conditions of students as a challenge to meet students 'needs.

Table 20.

Students' diversity. Challenges to respond to diversity and to design experimental activities

	DIVERSITY OF STUDENTS	
	EXPERIMENTAL ACTIVITIES	ATTENTION TO DIVERSITY
Attention to the differences	- "It is difficult to reach all students" - "Attending the differences"	- "Providing the adequate response to their needs" - "Too many levels in the classroom" - "The different levels of learning"
Interests	- "Present the topics so they become interesting for all students" - "Carry out direct experiences that are engaging"	- "The eagerness to learn" - "Motivation"
Specific difficulties of sciences		- "The understanding of basic concepts, which are necessary to carry out the activities. " -The language is very specific and difficult for students. Sometimes, the concepts are abstract and cannot be understood" - "The competence level, as the inappropriate development of other fields conditions the scientific competence"
Specific conditions of students		- "Adapting experimental activities that involve different senses (specially sight) to students with SEN that present high level of disability (partial or total blindness)

Note. Teachers' testimonies were translated from Spanish to English.

Table 21.

Teachers' necessities Challenges to respond to diversity and to design experimental activities

	TEACHERS' NECESSITIES	
	EXPERIMENTAL ACTIVITIES	ATTENTION TO DIVERSITY IN NATURAL SCIENCES
Material resources	- "In the majority of occasions lack of material in the educational centre"	- "Lack of adapted materials" - "Not having appropriate material to do so"
Human resources	- "In the class there are very diverse students and only one person cannot attend everyone" - "Lack of personnel to carry out the activity with tranquillity and security"	- "The difficulty to attend all students without the necessary support" - "Lack of support professionals"
Time demand	- "It requires to prepare all the material and it takes a lot of time"	- "Creating adapted materials takes a lot of time" - "Lack of time to attend all students"
Training	- "To know more aspects to teach students in a more manipulative and practical way and make sciences more comprehensible in English to those that have low levels of the language" - "Lack of specific training in attention to diversity"	- "Lack of knowledge"

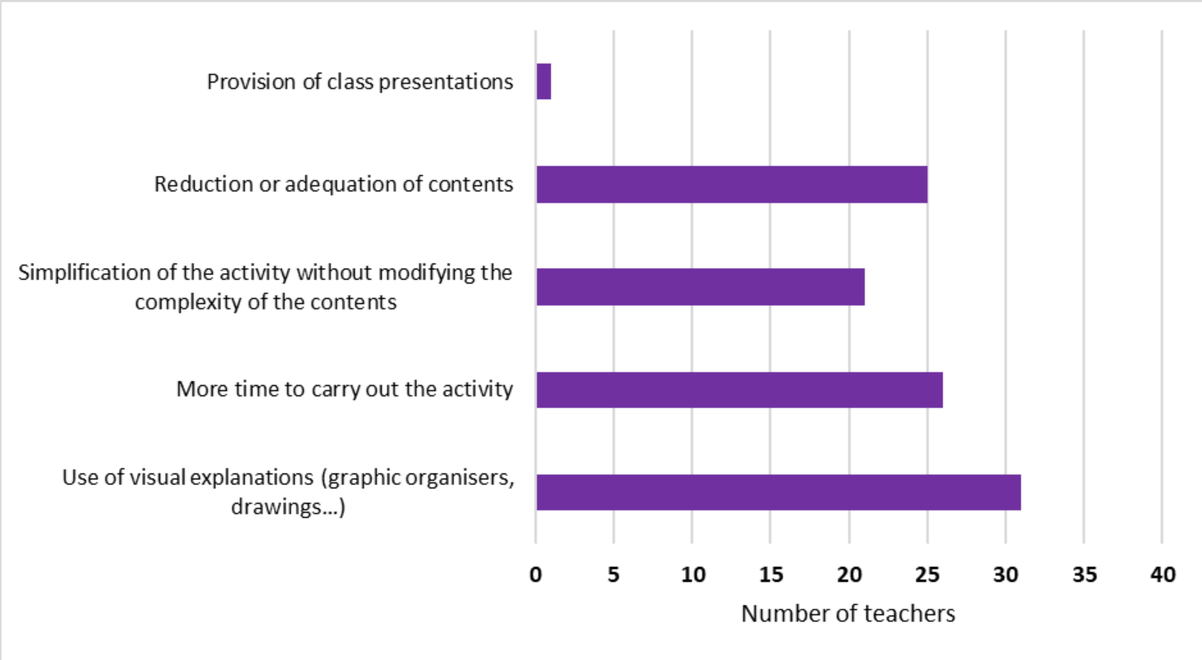
Note. teachers' testimonies were translated from Spanish to English.

- *Adaptations in natural sciences*

It is noteworthy that a high rate of respondents indicated to use most of the questioned strategies to make adaptations in natural sciences. As it is reflected in Figure 14, the most selected adaptation approach was the provision of visual explanations (77,5%), closely followed by time constraints, reduction of contents and simplification of the activities.

Figure 14

Quantitative Responses of Teachers' Adaptations in Natural Sciences



After having analysed teachers' predisposition to use experimental activities and the challenges to use this approach as well as to attend diversity (mainly resources and training), results of the didactic proposals will be examined in the following section.

4.2. Results of the Educational Proposals

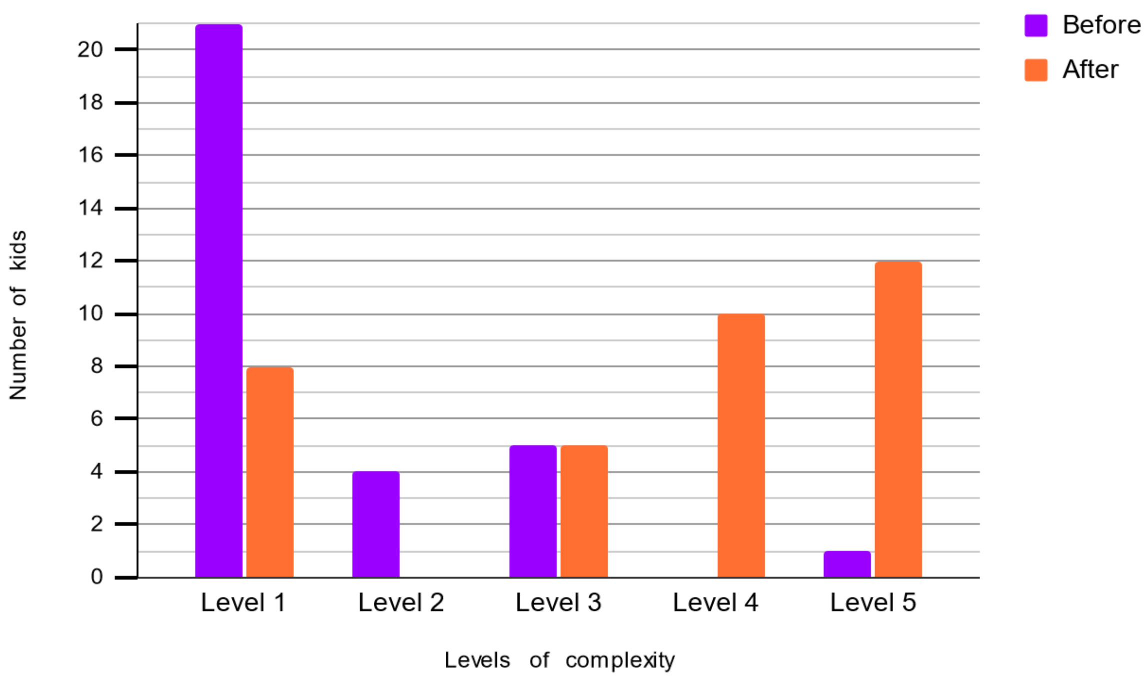
4.2.1. Results of the proposal 'Knowing my Flower' implemented in class

First of all, the proposal 'Knowing my Flower' was put into practice within the Plants project. It consisted of a dissection of the flower structures and trains observation as a Basic Process Skill (BPS) of science. The data obtained from the proposal based on BPS and adaptations in order to measure access, participation and learning was analysed global and individually from the two classes in which it was implemented.

Globally, there was a noticeable progress in the complexity of the drawings following the intervention. While in the previous drawing 21 out of 35 students drew stereotyped flowers, lacking details of the reproductive parts (level 1), after the dissection 22 children successfully represented part or all the reproductive organs and placed them correctly (levels 4-5) (see Figure 15).

Figure 15

Global Evolution of the Complexity of the Drawings



Moreover, the most cited structures following the dissection were the stamina (15, and the carpel/ pistil (21), and the least the gametes (pollen/ ovules). The number of structures cited was notably higher in the Class 2 (see Table 22).

Table 22.

Frequency of appearance of the structures in the final drawing

	FREQUENCY (number of times)		
	Structure	Class 1	Class 2
M A L E	Stamina	4	11
	Anther	1	4
	Filament	1	5
	Pollen	1	0
F E M A L E	Carpel	5	0
	Pistil	5	11
	Style	5	6
	Stigma	8	6
	Ovary	10	8
	Ovule	4	0
PROTECTI-VE	Receptacle	5	1
	Petals	3	12
	Sepals	6	0

Regarding the realism of drawings, a total of 8 students drew flowers that recreated standard flowers in textbooks after the dissection. This number corresponds to 4 learners from each class. In contrast, 7 students pictured a flower that was similar to the observed one (4 + 3) (see Table 23).

Table 23.

Number of Academic (formal) or Observational representations of flowers

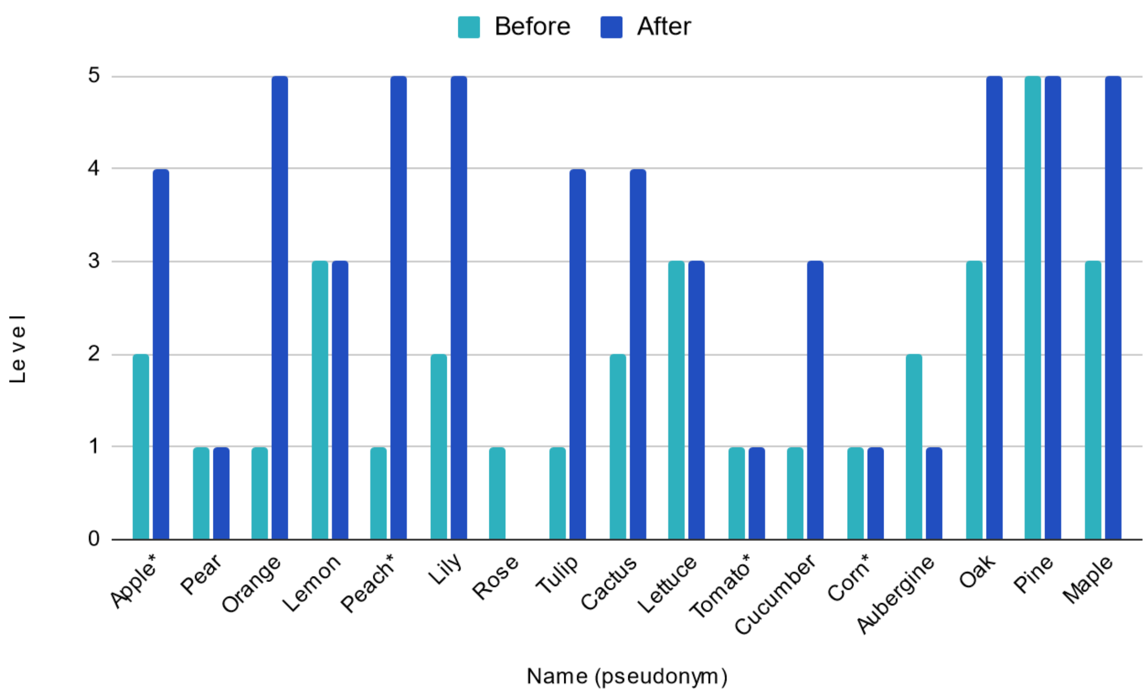
	Class 1	Class 2
A(cademic)	4	4
O(bservation)	4	3

After having observed a notable progress in the evolution of the representation of the flower and its structures after the dissection globally, Figures 16 and 17 illustrate individual advances of students. Results show that 24 students out of 33 made a progress after the flower dissection and 4 remained the same. There was just one case of recession in Class 1 and 2 students did not complete the second activity: *Rose* (Class 1) and *Carrot* (Class 2).

In relation to students with SEN, all of them remained the same or improved after the observation of the flower. From Class 1, *Apple* (gifted kid) and *Peach* (difficulties with fine motricity) performed better, and obtained the highest levels, 4 and 5, respectively. *Tomato* and *Corn* stayed in the same level, the lowest levels from their class. It is notorious that *Peach*, who had an access adaptation, is the student that raised her level the most from her class. Evidence could not be gathered on *Willow*, as she was missing the days of the implementation of the proposal. From Class 2, *Artichoke* and *Bean* evolved their representations. *Artichoke* reached level 3 and *Bean* 4, being on average with their peers (see Figure 16 and 17). However, *Carrot* could not complete the activity.

Figure 16

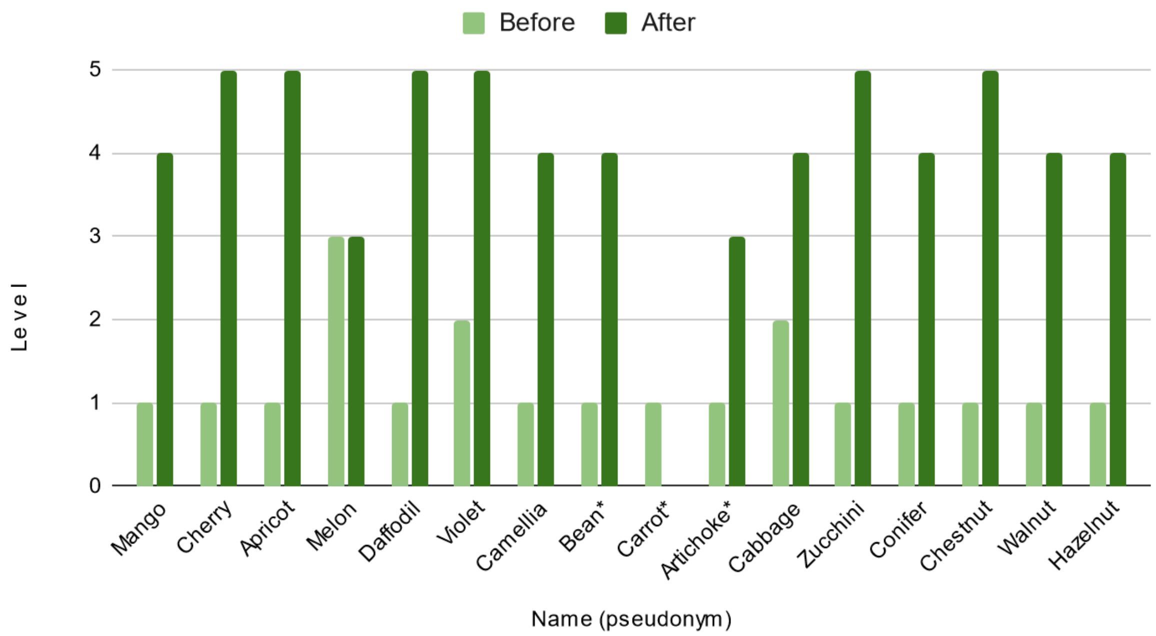
Class 1. Individual Evolution of the Complexity of the Drawings



Note. * = represents students with SEN

Figure 17

Class 2. Individual Evolution of the Complexity of the Drawings



Note. * = represents students with SEN

Apart from the learning progress of students with SEN, which are represented with an * in Figures 16 and 17, on the whole they were all benefited from the adapted proposal and participated in the activity.

From Class 1, *Apple* (talented kid) under regular conditions did not show interest and wanted to finish tasks soon. During the activity, he was strongly implicated in the observation but not much in the drawing of the flower. *Peach* (individualised access adaptation and behaviour issues) in a regular lesson took the calculator and the book and did not pay attention or participate. During the proposal, she first took the materials as usual but then participated and showed interest in the activity. *Tomato* (sociocultural disadvantaged situation) normally did not pay attention and barely worked. She often argued with peers. During the activity, she worked, but had two arguments with her peer group. *Corn* (disfavoured situation) did not often understand explanations in English. During the activity, he participated and understood all the given instructions.

All in all, results reveal that after the dissection of the flower there was a global and individual progression of their representations, based on the established criteria. Concerning students with diversity, they all made progress or remained in the same level, which was equal to the vast majority of their peers.

4.2.2. Results of the Inquiry sequence validated through teachers' perceptions

When teachers were asked whether the proposal would be useful for responding to the demands of diversity and the possible difficulties that it would entail, they agreed on the need of guidance (Table 24). The obstacles could be linked with the complexity of the topic (Table 25), which could be lessen with a correct development of BPS (Table 26). One notorious advantage of inquiry instruction was the organisation of learning in cooperative groups (Table 27). In addition, IBSE was also accentuated for being a very engaging teaching strategy (Table 28).

Teachers and the invited guest, the Environmental Museum of Pamplona, detected the necessity of adapting the teaching-learning process in science. However, few individualised adaptations were proposed (Table 29) or there were mentioned few from the ones designed initially (Table 9 and 11 from section 5.3.3.).

Table 24.

Teachers' testimonies on teaching guidance

Teaching guidance	
Definition: Degree of support that is provided so students can access, participate and enhance their learning through IBSE.	
Value	- "The process would need to be highly guided" (tutor)
Aspects	- "Take into account important steps for a good understanding of what is to be worked on" - "…the observation guidance" - "…will depend on how well the questions guide the process."

Note. All the testimonies from Tables 24-29 were translated from Spanish to English

Table 25.

Teachers' testimonies on intrinsic difficulties of the sequence

Specific difficulties of science
Definition: Embedded challenges that imply learning science due to the complexity of its nature.
- "the process of plant transpiration is somewhat complex, as it is not easy to demonstrate it visually…" - "can be complex for students with diversity because of the subject itself." - "a lot of anticipation to difficulties is required"

Table 26.

Teachers' evidence on BPS a part of IBSE

Observation
Definition: A Basic Process Skill that involves gathering information through the senses to build knowledge and explanations as well as to pose new problems
- "…systematic observation of a plant over time…" - "…observation as a basic process of knowledge acquisition"

Table 27.

Educators' evidence on cooperative learning for the inquiry proposal

Cooperative learning
Definition: approach that organises activities in a way that students learn from one another and contribute to learning in Natural Sciences.
- "…heterogeneous organisation facilitates learning" - "It will depend on whether the groups formed are heterogeneous and have clear how to act in order to be collaborative." - "Group work helps to keep the class motivated"

Table 28.

Testimonies on the emergent implications of IBSE

Implications of IBSE
Definition: impact that IBSE has on learning and on students' attitudes and motivation.
• Teachers - "In this way, we could also work on specific content of Spanish or English (in the case of the PAI model) such as the production of scientific texts, spelling, the use of certain grammatical structures, vocabulary, and specific register, etc." - "Discovery learning encourages students to be active and eager to learn" • Environmental Museum of Pamplona - "From our experience, we can tell you that both with groups of functional diversity and with diverse groups what works for us are experimental and manipulative activities." - "In general, this type of students enjoys the activity, as they go outside the school and we usually do dynamic activities."

Table 29.

Considerations on adaptations made for the inquiry proposal

Adaptations	
Definition: group or individual modifications of resources, materials, strategies, organisation that eliminate barriers on learning, participation, and access in natural science.	
Focus of attention	• Teachers - "We would have to look at the degree of need of the students". -The adaptation will depend on the level of the children in that group: if they have strategies to work, what level of attention they require, what degree of difficulty.... Each person is a different world and a priori…it doesn't depend on the course they are doing; it depends on their abilities and personal and social characteristics".
Types	• Teachers - "It is very good that there are visual resources to support the understanding of the concepts, which are very necessary and great for all students." -"There are introduced appropriate verbal explanations, visual aids, appropriate materials..." • Environmental Museum of Pamplona - "In the case of attention to diversity in ordinary classes, we have very little margin for adaptation, because the guided tours last between an hour, an hour and a half."

Note. All the testimonies from Tables 24-29 were translated from Spanish to English

4.3. Interpretation and Discussion

This study is set out to investigate the educational response that teachers are giving as well as the methodologies and adaptations that might enhance participation and learning in order to meet the demands of diversity in natural sciences. Thus, after having gathered results from the implementation of the proposal and collected evidence on teachers' testimonies, the following triangulation and interpretation of data will lead to the value of Inquiry Based Science Education (IBSE) and adaptations to respond to diversity in natural sciences.

First of all, 60% of teachers reported another meaning of diversity that involved not only students with SEN, but also different motivations and interests. This result indicates the basis of the *Salamanca Statement* (UNESCO, 1994) because, although an inclusive response in science should bear in mind learners' difficulties, teaching should take into account the features of all learners (Echeita, 2020). When teachers were asked for suggestions to respond to diversity in science, only 7.5% mentioned specific guidelines of science, while the rest of the professionals (92.5%) advised to improve skills related to flexibility, open-mindedness, emotional implication, patience, systematic observation, lifelong training and communication. Consequently, evidence reflects the importance of personal abilities to provide instruction and respond to diversity in natural sciences.

Regarding strategies, inquiry and experimentation are meant to be an appreciated methodology to respond to diversity in science. Indeed, 87% of the professionals mentioned to use experimental activities in science classes, emphasizing cooperative learning and motivation. These benefits fit with the theory reviewed by NRC (2000), Pujol (2003) and Martin et al. (2005). In the implementation of inquiry in the classroom, the proposal contributed to learning and participation of all students because it was based on developing basic process skills of science (BPS) and inquiry skills, namely description and observation. Thus, findings suggest that inquiry supports a scientific literacy concentrated not only on concepts, but also on the processes of science (Furman, 2008).

Moreover, the satisfactory results might have been triggered by the value of the teacher as a guide to create an adequate context and scaffold the process of the observation of the flower, taking into account guidelines from Osman (2012), Harlen & Qualter (2018) and Napal & Zudaire (2019).

In addition, the proposal favoured students with specific difficulties and also most of the students from both classes, as occurred with *Anfomam* Project conducted by *Public University of Navarre* (UPNA) and *Erasmus +*, which designed mathematical manipulative activities for students with *Down Syndrome* that in the end aimed to benefit teaching of mathematics in Primary Education. Particularly, in this proposal there was a global advance of participation and learning, since 78% of students reached high levels (levels 3-5). This result might have been boosted by a thorough planning based on the *Index for Inclusion* to attempt to diminish barriers in learning, which in this case also considered the teaching of natural sciences in English (Ainscow et al., 2002).

Comparing data from another angle, the proposal was implemented in two groups of Primary Education and there was a noticeable difference of the performance from both classes (Class 1 and Class 2). In fact, Class 2 drew more academic flowers and cited more times the male and female reproductive structures of the flower than Class 1 (11 versus 4 and 5 times, respectively). This evidence could be explained by the different characteristics and groups and correlates with one of the levels of designing an inclusive school: the creation of a classroom culture that gives students the opportunity of experiencing learning in different ways and developing multiple intelligences (López Melero, 2012).

Regarding the aim of analysing the advantages of inquiry-based learning, the results and benefits from the implemented proposal contribute to a clearer understanding of the flexibility of inquiry to adapt and accommodate learning to students' diverse needs, which was also studied by Mastropieri et al. (1997). In this proposal, teachers' guidance and adaptations benefited learners who presented any challenge or specific difficulty, as students with difficulties in understanding explanations could comprehend and carry out the activity. Also, students who struggled with paying attention showed interest and implication in the activity. What is more, while some children could not usually finish the worksheets and were not used to participating, during the adapted lessons they were motivated and focused on completing the tasks.

Therefore, results indicate that, although this activity is limited in time, it was satisfactory because general adaptations were applied, as the creation of a supportive climate (Burgstahler, 2009), selection of appropriate materials (Scruggs & Mastropieri, 2007), division of activities in shorter periods of time (Harlen & Qualter, 2018), adaptations of worksheets based on Hudson (2016)'s guidelines, and visual explanations and anticipation of activities to facilitate attention and comprehension of English language (NRC, 2012; Harlen & Qualter, 2018).

Moreover, agreeing with the *Supports Paradigm* and *Universal Design for Learning* (UDL) to adjust learning to individual needs, personalised access and extension adaptations were applied for students with fine motricity difficulties and talented children. Thus, this study can be added to previous investigations on the implications of inquiry for students with sensory impairments and high-ability learners in science (Mastropieri et al.,2001; Erwin et al., 2001).

Then, from another scope of the analysis, an adapted Inquiry sequence was designed, which was validated by teachers. It was not implemented in the classroom, but based on the gathered testimonies, teachers believed that it could be engaging and that heterogeneous groups should be designed carefully to foster interaction and the exchange of knowledge and experiences. Actually, cooperative learning represents one of the specific challenges of science to include all students in the groups (Dawes, 2004). This obstacle could be solved by an equitable division of tasks and by assigning students roles to encourage them to participate within their groups (Lago et al., 2015). Moreover, evidence on cooperative learning does not only agree with one of the implications of inquiry but corresponds to one of the levels to design a more inclusive school: classroom practices that enhance peer group cooperation (Echeita & Ainscow, 2011).

Concerning the possible difficulties that could emerge during the Inquiry proposal, few educators mentioned specific challenges of science (3.5%), referring to abstract concepts and language difficulties (Melber, 2004; Villanueva & Hand, 2011; Parker et al., 2016). However, generally, teachers' necessities to implement experimental activities were linked with the scarcity of materials and time, agreeing with previous studies (Cawley et al., 2003; Arnaiz et al., 2013).

On top of that, meeting the demands of diversity in natural sciences seemed to be as challenging as other areas by 70% of the teachers. Evidence was based on the lack of resources and training either in science or in strategies to deal with diversity, complying with the investigations of Villanueva et al. (2012) and Gómez-Zepeda et al. (2017). This confirmation responds to the initial problem of this project and has an impact on the grade of inclusive response that is being given in some science classrooms.

It is also discernible that few educators (10%) remarked COVID-19 as a noticeable obstacle to meet the demands of diversity in the science classroom. This statement might be justified by the general demands to carry out a more inclusive education, which are common to all disciplines and hinder the goal of participation and learning of all students in the classroom (Azorín et al., 2017).

Thereby, despite all the analysed challenges, this proposal, although small, responds to the possibility of experimenting and adapting in the science classroom with few and accessible materials (NRC, 2000; PISA, 2003; Harlen & Qualter, 2018; NGSS, 2019):

- Plants and flowers have been used as a main resource
- The activity has been developed inside the classroom without the need of going to the laboratory
- The same heterogeneous groups have been maintained due to COVID-19, as well as the measures to use resources (magnifying glasses) in two different classes.
- All students were provided with the same material and activities, giving them the possibility of acquiring knowledge and improving depending on their characteristics.

CONCLUSIONES Y CUESTIONES ABIERTAS

Como consecuencia de la investigación, en relación con nuestro primer objetivo general, realizar propuestas adaptadas de indagación que desarrollen los procesos básicos de la ciencia pueden facilitar el aprendizaje y participación del alumnado en el aula de ciencias naturales. De este modo, las actividades experimentales son posibles en el aula, sin necesidad de un tiempo y recursos excesivos y ajustándose a la realidad del COVID-19.

Así, respondiendo al tercer objetivo específico, cuando se implementan adaptaciones en ciencias naturales siguiendo las recomendaciones de Harlen y Qualter (2018), como son las explicaciones visuales, adaptación de vocabulario en las explicaciones y fichas, y segmentación de las actividades, se demuestra que el alumnado con dificultades específicas puede alcanzar un progreso que en ocasiones llega a niveles similares al de sus compañeros y compañeras. Además, se concluye que introducir actividades experimentales adaptadas no solo aumenta la participación y aprendizaje de niños y niñas con retos específicos, sino que el grupo en su conjunto se ve beneficiado de estas ayudas. De esta manera, surge la necesidad de proporcionar una guía y andamiaje según las necesidades del alumnado, de acuerdo con el paradigma de apoyos.

Asimismo, para que estas adaptaciones respondan a las demandas de los estudiantes en el desarrollo de destrezas científicas básicas, se destaca el valor de la flexibilidad como docentes para proporcionar ese apoyo, conforme a los principios de la Educación Inclusiva y del Diseño Universal de Aprendizaje, y las recomendaciones de la *National Association for Research in Science Teaching* (NARST).

En cuanto al cuarto objetivo específico, se confirma que las metodologías constructivistas que hacen al alumnado partícipe del aprendizaje, como son la indagación y la experimentación, ayudan a vincular los conocimientos científicos con sus propias experiencias; es decir, a aprender de una manera más práctica. En consecuencia, la metodología de indagación posibilita el aprendizaje de forma motivadora y partiendo del conocimiento del alumnado, que responde a uno de los retos que percibe el profesorado encuestado en relación con la diversidad presente en sus aulas. Sin embargo, una gran ventaja de este enfoque didáctico, que implica a su vez un reto en la enseñanza, es el aprendizaje cooperativo para tratar de involucrar y hacer partícipe a los estudiantes según sus necesidades.

No obstante, y en concordancia con el segundo objetivo general del estudio, el desarrollo de un aula de ciencias más inclusiva que introduzca metodologías experimentales se puede ver afectado por la falta de recursos y materiales, así como por un problema de formación, que se relaciona con la situación de partida de este proyecto.

De este modo, una vez analizadas las necesidades en una muestra de profesorado en activo mayormente de Educación Primaria, la investigación abre la posibilidad de:

- Crear recursos, materiales adaptados o cursos de formación que ayudaran al Equipo Docente a diseñar respuestas educativas más inclusivas en el área de ciencias naturales.
- Implementar las propuestas didácticas por los profesionales encuestados para medir el impacto de la actividad en unas circunstancias específicas.

Sin embargo, este proyecto se ha visto limitado por dos factores principales:

- Restricciones en el tiempo de intervención de la propuesta en el centro educativo e implementación con un alumnado y características específicas.
- En relación con la muestra de profesorado, solo participaron tres docentes de Pedagogía Terapéutica. En un futuro también se podrían recoger más evidencias sobre profesionales de atención a la diversidad, añadiendo a la muestra Orientadores/as y especialistas de Audición y Lenguaje.

Como futura docente de Educación Primaria, esta investigación ha resaltado la relevancia y beneficios de proporcionar apoyos para desarrollar procesos científicos básicos y fomentar la participación y el aprendizaje en ciencias naturales: el diseño de un clima de aula favorecedor y organización del alumnado en grupos heterogéneos y además introducir andamiajes para desarrollar procesos de indagación y destrezas científicas básicas. Finalmente, concluimos que aún queda un largo camino por recorrer hasta llegar al horizonte que nos lleve a alcanzar el sueño de este viaje: una educación inclusiva.

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ANNEXES

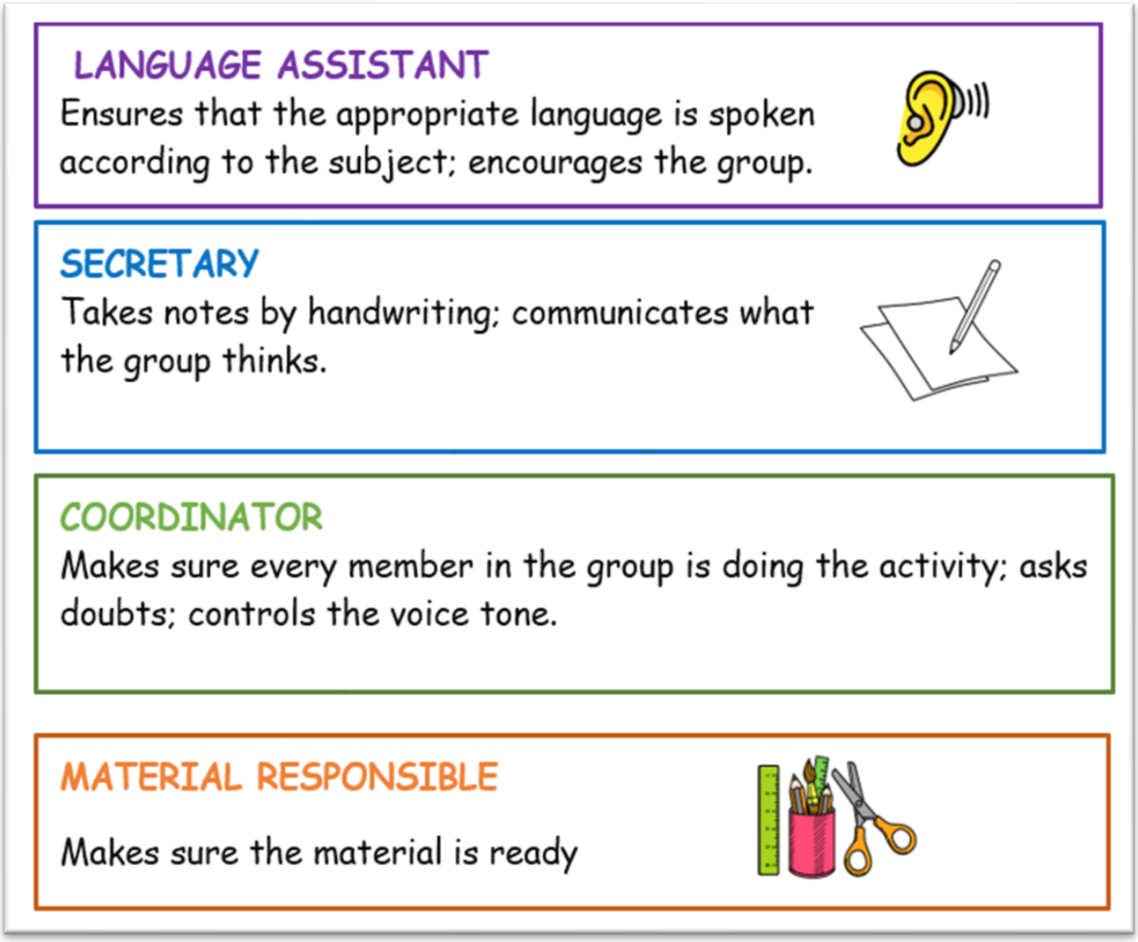
Annex 1. Questionnaire for the Environmental Museum of Pamplona

https://forms.gle/98aAB6Z9PaCf1Exa9

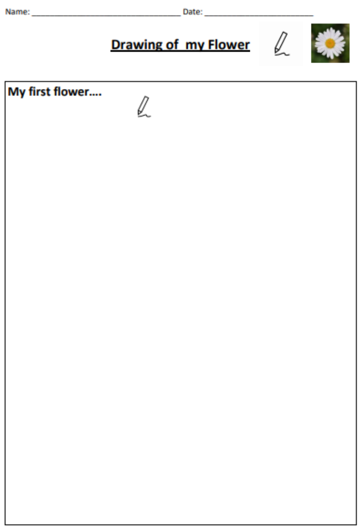
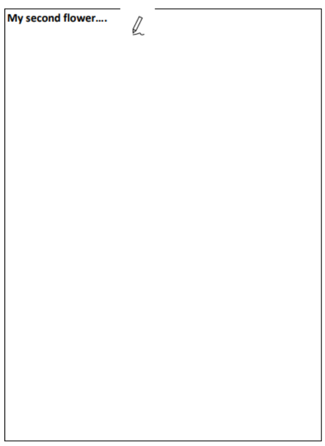
Annex 2. Questionnaire for teachers

https://forms.gle/ne3Yodpz1Yi5e9hz7

Annex 3. Roles of the students

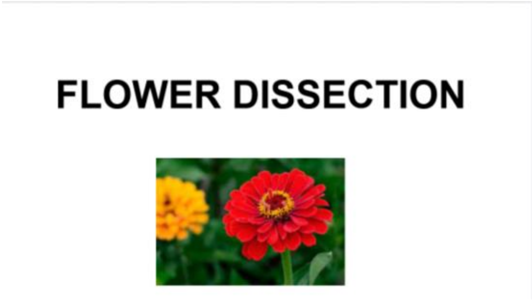


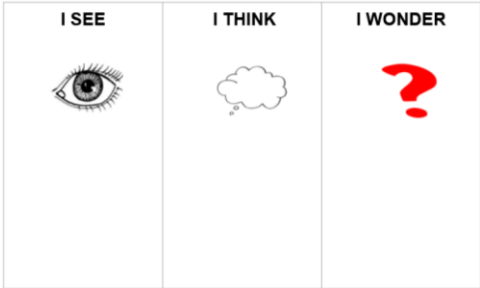
Annex 4. Details of the proposal based on BPS: 'Knowing my Flower'

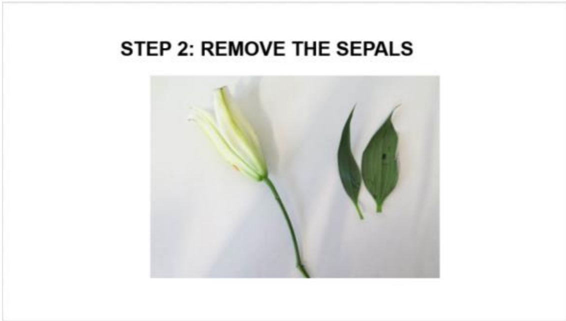
Description	"KNOWING MY FLOWER"
1.Activation of previous knowledge	Previous knowledge is introduced in assembly discussing the flower reproduction in the digital whiteboard and posing questions: Why do plants have flowers? Why are flowers important? How does a flower look like? Why are flowers from different colours and smells?
2.Drawing a flower	Students are asked to draw an imaginary flower individually. Human resources are considered for a girl with fine motricity (*Peach*) 
3.Dissecting and observing a flower	Students are divided in pairs or trios within their regular work groups. They are handed an adapted worksheet (Annex 7) and explained the thinking routine *I think, I see, I wonder*. Then, the flower is dissected following a process and segmenting the activity going part by part: stem, sepals, petals, stamina, pollen, pistil and ovule (Annex 5). 
4.Extending knowledge	Knowledge is extended by explaining the reproductive cycle of the flower in assembly and sharing all the reflections regarding the observed structures. For that, some videos are planned: https://cutt.ly/YbAeju7 https://www.youtube.com/watch?v=MQiszdkOwuU

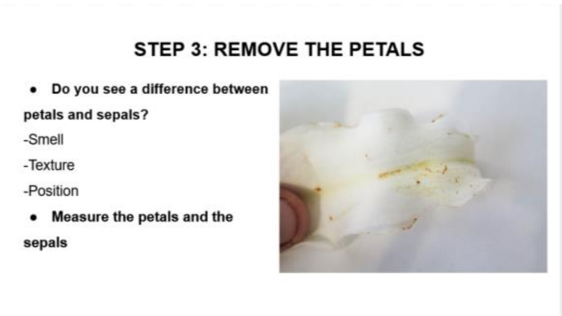
Additional resources	-Digital whiteboard -Magnifying glasses -Lilies (one for each pair) -Poppies, Daisies and clover flowers for extension activities

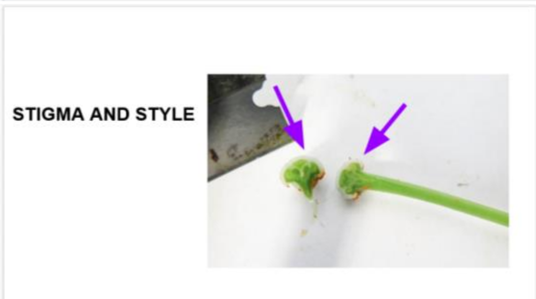
Annex 5. Visual explanations of BPS sequence

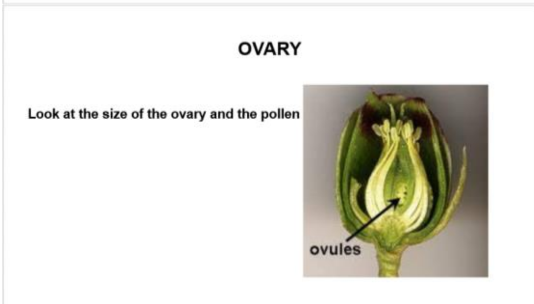




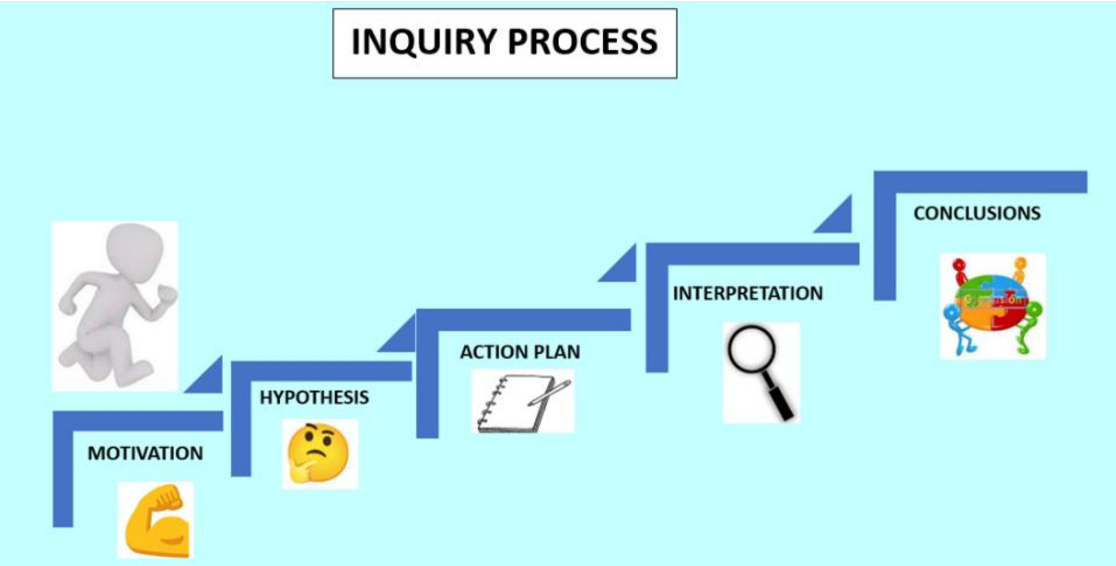








Annex 6. Inquiry sequence. Graphic organisers about the inquiry process



Annex 7. BPS proposal. Adapted worksheet for the observation of the flower

Flower structure Guide

Pistil: Central FEMALE organ of the flower. It has the shape of a bowl and it is in the centre of the flower.

-Stigma: Receives pollen, typically flattened and sticky

-Style: Connective tissues between stigma and ovary

-Ovary: Contains ovules

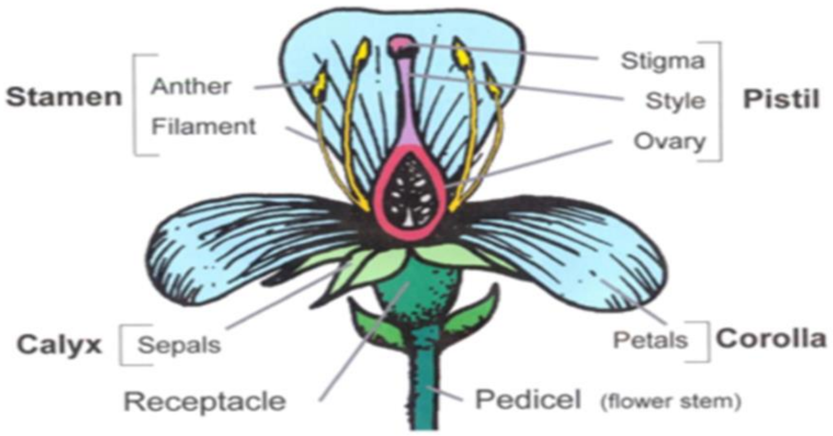
Stamen: MALE flower organ

-Anthers: Pollen-producing organs

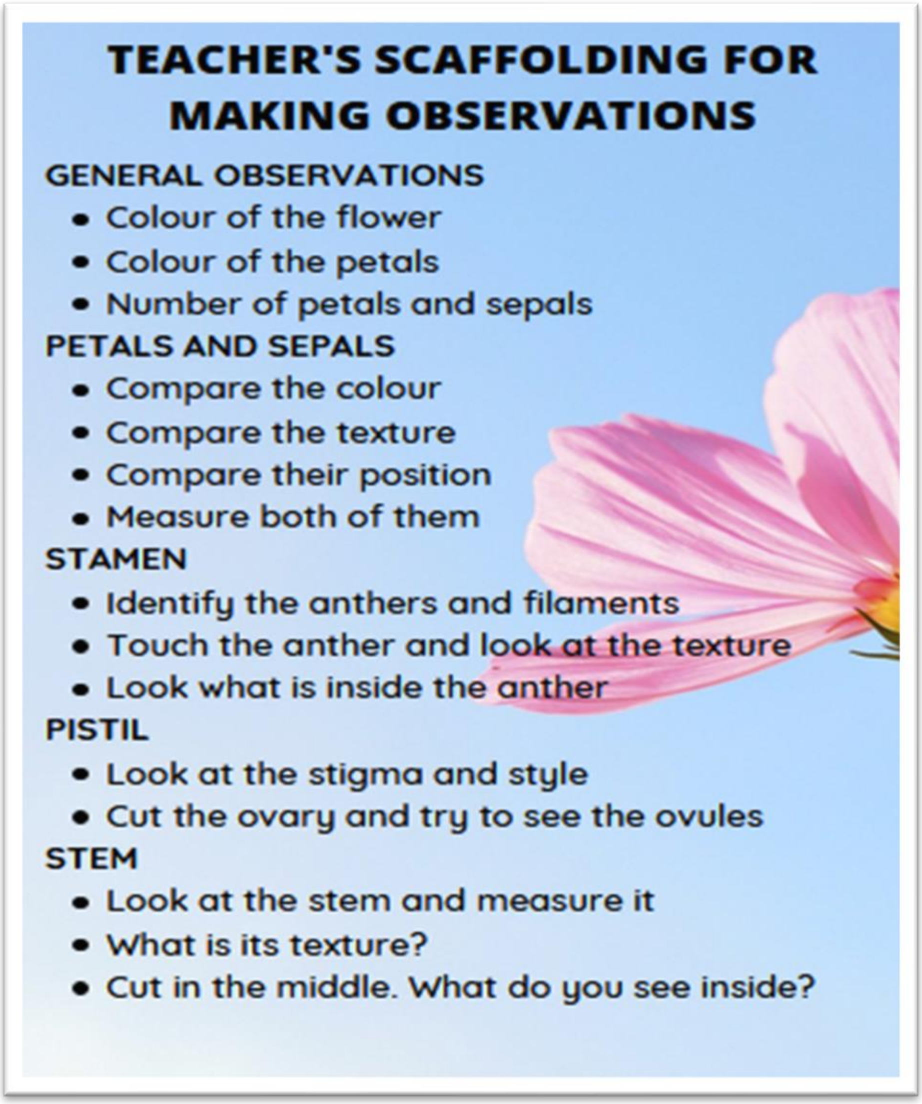
-Filament: They support the anthers

-Petals: Usually colourful structures making up the "flower", collectively called the corolla. They may contain perfume and nectar glands.

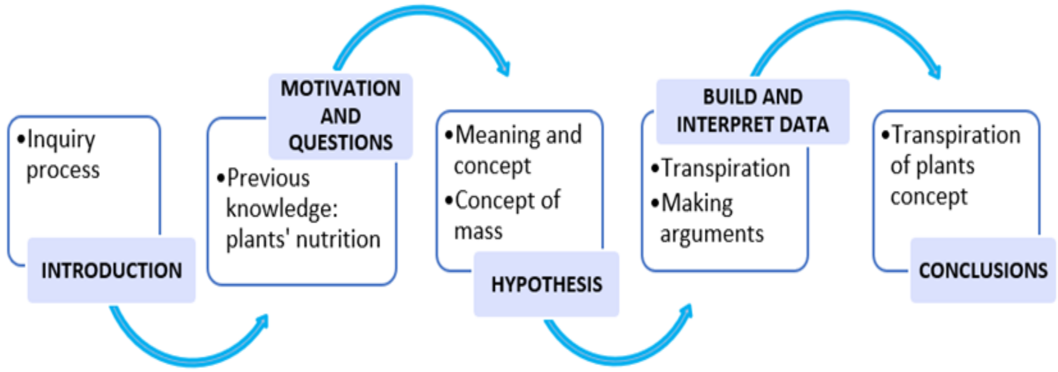
-Sepals: Protective structure. It looks like a leave. It is usually green, collectively called calyx. Sometimes highly coloured like the petal as in iris.



Adapted from https://fyi.extension.wisc.edu/ncrvd/files/2015/04/Flower-Dissection-Handout.pdf


TEACHER'S SCAFFOLDING FOR MAKING OBSERVATIONS
GENERAL OBSERVATIONS
• Colour of the flower
• Colour of the petals
• Number of petals and sepals
PETALS AND SEPALS
• Compare the colour
• Compare the texture
• Compare their position
• Measure both of them
STAMEN
• Identify the anthers and filaments
• Touch the anther and look at the texture
• Look what is inside the anther
PISTIL
• Look at the stigma and style
• Cut the ovary and try to see the ovules
STEM
• Look at the stem and measure it
• What is its texture?
• Cut in the middle. What do you see inside?

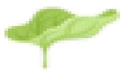
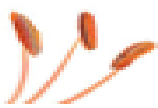
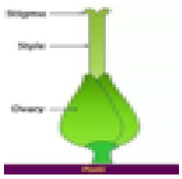
Annex 8. Inquiry sequence. Guidance for the detection of new terms



Annex 9. BPS proposal. Adaptation for short attention spans

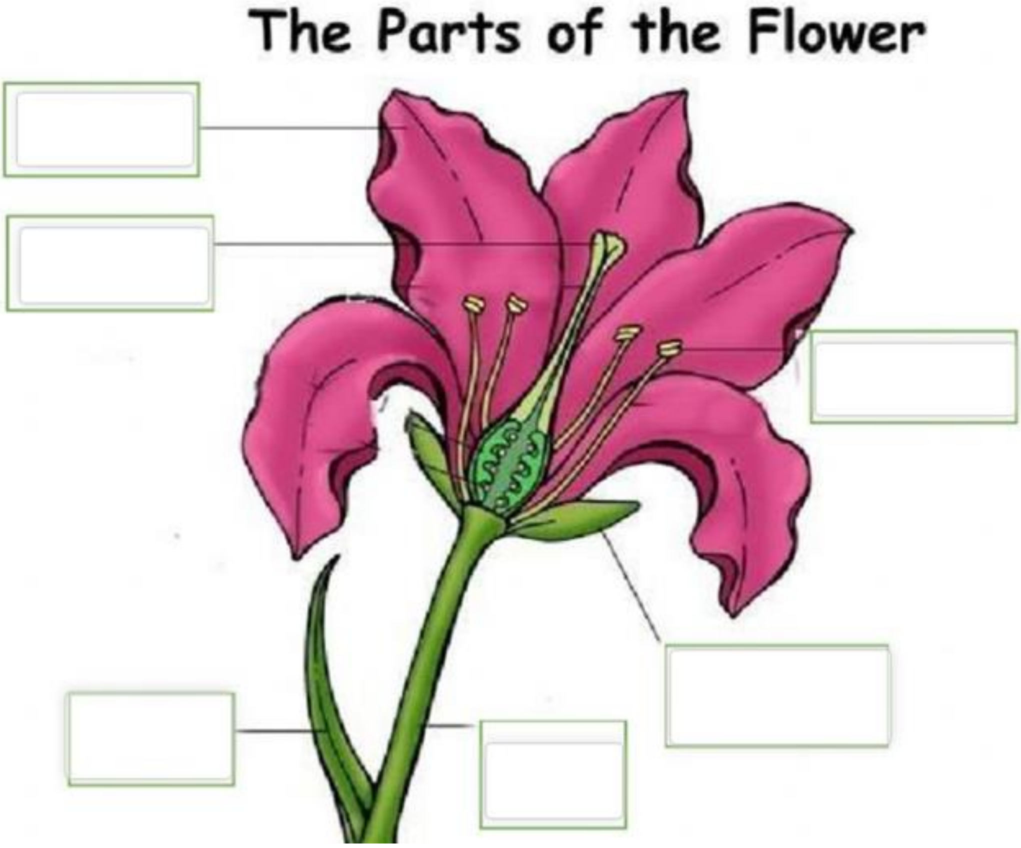
It consists of sticking the reproductive structure of the flower in each space while completing the flower dissection to help students to be on-task, based on Harlen & Qualter (2018)'s guidelines.

<u>Parts of a Flower – Dissection lab</u>

Petal	Sepal	Pollen
		
Stamen	**Pistil**	**Ovule**
		

Annex 10. Individualised access adaptation

Annex 10 shows the Individualised adaptation for *Peach*, a girl with fine motricity difficulties (see Table 5). While her peers are drawing the second flower, she will be asked to place the reproductive structures in its place.



Adapted from https://cutt.ly/RbVVdey

Annex 11. BPS proposal. Extension activity

This is an extension activity because the flowers that differ from the observed flower, that is, a *Lilium*, are presented to students with high academic abilities. The aim is to compare and challenge them in issues of symmetry of the flower (to prove that not all are symmetric) and contrast flowers with different structures (as the daisy, whose stamina and pistils are not visible). Some of the examples presented to students are:

Flowers to extend knowledge	Specific features
	The observed flower (*Lilium*) is considered a complete flower because it has all the reproductive structures (calyx, corolla, stamens and carpels). Moreover, it is also *symmetric*, as both side of the flower coincide.
	The Daisy (Bellis perennis) is categorised as a compound flower. It is different from the observed flower since it is formed by many small flowers with stamens and pistils (inflorescence) that seem to be the "petals" of a simple flower.
	Flowers like the Poppy (*Papavereales*) are asymmetric because, as opposed to the *Lilium*, they only have one plane of symmetry. In this case, all the parts merge together. In other cases, flowers are asymmetric as different parts grow in various directions.

Annex 12. Inquiry sequence. Scaffolding the hypothesis

Our **DRIVING QUESTION** is:

Select three **FACTORS** that affect your plant:

Select the **FACTORS** that you think that affect your plant:

Humidity

Season

Wind

Sunlight

Temperature

Oxygen

What will it **CHANGE**?

What will you **MEASURE**?

When I change______________, what will it happen to___________?

Our hypothesis is: if I change__________, then the plant's _______________ and __________ will _________________________.

Annex 13. Inquiry sequence. Scaffolding the action plan

ACTION PLAN

HYPOTHESIS

HYPOTHESIS

-What will it CHANGE?

-What will it stay EQUAL?

Select the MATERIALS you need

- Plastic bag
-
-
-

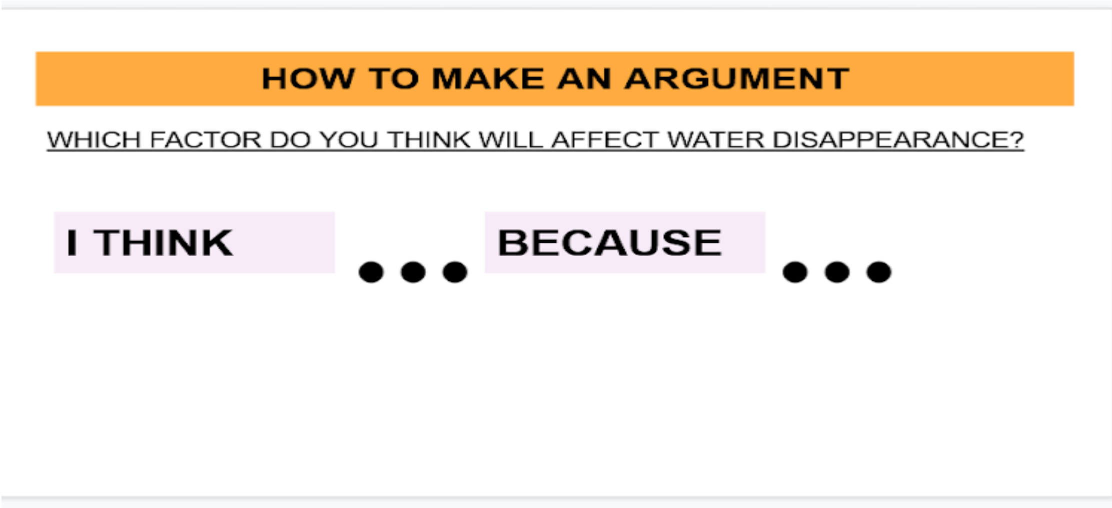
Complete the PROCEDURE to make the experiment

1. Take the plant and remove____________
2. Use the ___________ and cover it
3.
4.

How will you RECORD data? - circle

Every hour/ day / week

Annex 14. Inquiry sequence. Scaffolding the argumentation



Annex 15. BPS proposal qualitative information gathering tool

Date:	**ANECDOTE**	
STUDENT'S NAME	**BEFORE**	**AFTER**

Annex 16. Testimonies on personal abilities

Specific teaching skills **Definition**: Those teaching competences that allow the attention to diversity in natural sciences	
Flexibility	• *Tutors* - "The same as for any other subject. Try to adapt to the pace and abilities of the students." - "Trial and error. Adaptation is the key word in biology".
Open-mindedness	• *Tutors* - "Be prepared and open to any unforeseen events/difficulties." - "Reality and day-to-day life sometimes is rewarding and sometimes not so much." • *Support professionals* - "…diversity does not only involve students diagnosed with something and that they should focus on the preparation of diverse materials."
Emotional implication	• *Tutors* - "As important as the methodology is the emotional involvement with the students." - "They should be willing to attend to everyone and appreciate that all children are part of the group and contribute." • *Support professionals* - "Look at it positively: every little step is an achievement, and all students enjoy learning something they like. "
Patience	• *Tutors* - "A lot of patience" - "Work with patience and understanding "
Systematic observation	• *Tutors* - "Getting to know the pupils in depth, through daily observation, initial assessments, as each pupil is different and has a different learning style, whether they have a diagnosed SEN or not."
Lifelong training	• *Tutors* - "It is important to be trained, because unfortunately, at university, students who do not choose the mention of *PT* are not trained at all in this aspect..." - "*PT* support and courses to have resources for support and attention to diversity." • *Support professionals* - "… to investigate what is ADHD, dyslexia, Asperger....some teachers do not know it yet."
Communication	• *Tutors* - "Coordination and communication with specialists." - "Constant communication with family and professionals."
Diverse strategies	• *Tutors* - "I consider continuous experimentation to be fundamental, the translation of what has been observed and experienced into the code of verbal language (oral and written), the practice of retelling what has been learnt (exhibitions) is vital for recalling learning, assessing what has been acquired and detecting

	misconceptions or gaps." - "Use active methodologies in which each pupil can contribute according to his/her abilities, interests... to the class-group. " - "I would try to make science fun and manipulative, and learn through observation, manipulation, teamwork; the book can become boring, discouraging, and difficult. I would try to work on projects."

Note: Evidence was translated from Spanish to English. PT (*Pedagogía Terapéutica*) = Educational Therapist