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Inquiry methodology for teaching Science in L1 and CLIL Primary text books

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0. Abstract

This research focuses its attention on the inquiry methodology for teaching Science in Primary Education text books. This methodology has had a huge reception between scholars and it has been included in curricula such as the Currículo Aragonés. So, first of all, the inquiry methodology is explained, as well as the compatibility between the inquiry methodology and CLIL principles that is discussed to reach the conclusion that the inquiry methodology has a positive influence in promoting CLIL principles.

This study sought to analyze L1 and L2 text books, designed for teaching Science, for evaluating the extent to which the inquiry methodology is carried out in Primary Education. The method used for the books' analysis and evaluation was a quantitative method with some qualitative comments in order to identify the inquiry processes, classify the simple inquiry tasks and evaluate the extent to which the inquiry methodology is implemented in L1 and L2 books for teaching Science. It was showed that the second language or the mother tongue may affect, positively and negatively, Science education with regards to inquiry principles. These principles establish that inquiry tasks must promote cognitive processes, a cooperative environment, production of knowledge and learners' autonomy. Also, there are other factors that have an influence in the depth to which the inquiry methodology is implemented in Science text books such as the publishing house, author, publication year and other principles and objectives.

Key words: Primary Education, inquiry methodology, Science text books, CLIL approach, teaching Science, analysis and evaluation.

1. Introduction

In the last few years, there has been an agreement among most of scholars that inquiry is the best methodology for teaching Science. This method has been adopted by Educational Curricula in Primary Education as the Currículo Aragonés. Simultaneously, there has been a huge increase in the number of Bilingual Primary Schools, in Aragon, most of which are teaching Science through a second language. Generally, bilingual schools use the Content and Language Integrated Learning (CLIL) approach "for

learning and teaching of both content and language" (Coyle, Hood and Marsh, 2010 :1). So, we find here that the CLIL approach should be deal with the inquiry methodology.

But, Integrating language and content can have positive or negative effects. I think that teaching Science through a foreign language can affect the methodology that is used, originally, in the subject which is given through the mother tongue for some reasons. The use of a second language can be a barrier for teaching content because the language learning takes time that could be dedicated to content. Also, the lack of communicative skills in a foreign language may affect students and teachers negatively because the inquiry methodology requires a complex interaction through a scientific discourse. Consequently, L2 text books may focus on simple tasks which don't promote the inquiry methodology as deeply as L1 books. When a teacher looks for a book they focus their attention on the relation quality-prize, and quality for CLIL books of Science means to follow CLIL and inquiry principles, so our study may help teachers to choose Science books that follow both CLIL and inquiry principles. Books have a relevant role in Education because they guide teachers to carry out the lessons, so they are going to be our study object.

The main purpose of this research is to analyze and evaluate the extent to which L1 and L2 books designed for teaching Science promote an inquiry methodology.

1. To which extent are the principles of CLIL compatible with the principles of inquiry?
2. Is inquiry good for CLIL classrooms in which language and content are integrated?
3. What inquiry and CLIL principles can be used to analyze and evaluate Primary text books?
4. Do L2 books of Science follow the CLIL principles?
5. Do L1 books follow inquiry principles more closely than L2 books?
6. If so, which possible factors may explain why inquiry is developed to a different extent depending on the language in which Science is taught?

Our study consisted of a comparison of L1 and L2 Primary text books of Natural Science in order to see in which books inquiry methodology is followed more closely. Our study is divided into some parts which seek to answer the research questions. Firstly, it is going to be showed that CLIL principles are compatible with inquiry principles by reasoning logically, as well as that the inquiry methodology may be adequate for the CLIL principles. Then, the suitability between CLIL and inquiry principles for analyzing and evaluating Science books is going to be discussed. Then, we will make sure that L2 books chosen our study follow the CLIL principles. After that, the books will be compared according to the inquiry principles for which we have chosen L2 and L1 text books of the 5th course of Primary Education created by the Santillana and Edelvives publishing houses, in order to compare them just changing the language variable to do a reliable research. Finally, possible factors, that may affect the depth with which the inquiry methodology is implemented on L1 and L2 text books, will be suggested.

2. Theoretical framework

2.1 Inquiry methodology

First of all, if we need to extract the inquiry principles that are going to be analyze, we must know what inquiry means in an education context and its evolution to get over misconceptions. Some Science practitioners tend to believe that all the experiments and hands-on activities are based on an inquiry methodology but the scientific method, known as the hypothetico-deductive method and the inquiry methodology differ in some aspects. Scientific Inquiry, as it is known nowadays, differs from the conception that academics had in the early 20th centuries when scientific inquiry referred to the hypothetico-deductive method.

The former view of scientific inquiry was that new knowledge was discovered through experiments which justified it but no attention was paid to the way in which knowledge was discovered (Grandy and Duschl, 2007). This perspective is known as the "received view" and it is similar to the traditional scientific method (Grandy and Duschl, 2007 :150). It is important to know the differences between the scientific

method and scientific inquiry because we may find experiments suggested in the books that follow the scientific method but we couldn't consider it as authentic inquiry tasks.

There are some differences between the scientific method and scientific inquiry. The scientific method is simpler than scientific inquiry because it involves fewer processes which are just cognitive. However scientific inquiry includes social and epistemic processes. Differences are explained in depth in next paragraphs.

The scientific method is less complex than scientific inquiry. The scientific method involves 5 steps that are sequenced in order: to make observations, to formulate hypothesis, to make predictions, to carry out observations to prove the hypothesis and reject or accept the hypothesis, while the scientific inquiry methodology includes those processes and many more like: posing questions, representing, discussing and recording data and learning theories.

The scientific method includes cognitive processes and just the process of generalizing implies an epistemic construction. However, scientific inquiry goes further and involves epistemic and social tasks in most of their processes (Grandy and Duschl, 2007 :144) as you can see in table 1.

The social processes are forgotten in the Scientific Method and they have an important role in developing science because nowadays it is needed a group of scholars to do research as progresses/models/theories must be agreed among the scientific community to be valid. Just a few processes incorporate explicitly the social dimension and those are *discussing* and *explaining* which need to take into account the audience, because they are social processes and therefore the language must be adapted to listeners or readers for reaching an agreement or persuading the audience. Many processes may have the social element if it is worked in teams and they involve more than one person.

Scientific inquiry involves as well epistemic processes because their aim is to build up knowledge. Processes like discussing and writing about data or theories produce knowledge and are not included in the scientific method, also known as the hypothetico-deductive method.

Once we have set the two main differences between the scientific method and scientific inquiry, we can start establishing the inquiry principles that we need to study for determining if they are compatible with CLIL principles or not.

The first principle is that all learning activities should focus on using **cognitive processes**. According to Chin and Malhotra (2002) and Grandy and Duschl (2007) a number of different processes promote the inquiry methodology as you can see in table 1, in which the cognitive, social and epistemic dimensions are related to the processes. An inquiry task has not got to include all those cognitive processes for learners to carry out them. We may find in books some simple tasks which involve a few processes, so they promote specific research skills that can be useful for authentic inquiry. For students it is difficult to do projects which involve many processes. Consequently, we must simplify the way scientists discover knowledge in order to implement it in Primary Education.

The second principle is that the inquiry methodology should be carried out in a **cooperative environment**. It is essential that inquiry tasks are put into practice by groups of students for not to forget the social aspect of scientific inquiry. Knowledge can be produced, discussed and accepted in a group for being valid, so we can see the social dimension of inquiry processes.

The third principle is that inquiry makes students to be **active and autonomous**. Inquiry tasks must give responsibilities to the students and the teacher must act as a facilitator. Inquiry activities make students to be active and autonomous, for instance, because they have to take decisions about the variables that have to be taken into account in the investigation and they must explain and reach their own conclusions.

The fourth principle is that inquiry produces **knowledge** through evidences obtained from researches. The aim of an inquiry task must be to answer a question linked to a natural phenomenon for what is needed to learn, discuss, write and report which are epistemic processes.

	Cognitive	Epistemic	Social
Grandy and Duschl (2007)			
Designing experiments	X		
Making observations	X		
Collecting and representing data	X		X
Relating data to hypothesis/model and theories	X	X	
Formulating hypothesis	X		
Learning and refining theories	X	X	
Giving arguments for/against models and theories	X	X	X
Making predictions	X		
Recording data	X		
Discussing data	X	X	X
Writing about data/theories/models	X	X	
Chin and Malhotra (2002)			
Posing questions	X		
Selecting variables	X		
Planning procedures	X		
Controlling variables	X		
Planning measures	X		
Explaining results	X		X
Generalizations	X	X	

Table 1. Key processes involved on Authentic Inquiry and dimensions that include. (Processes adapted from Chin and Malhotra, 2002; Grandy and Duschl , 2007)

2.2 CLIL methodology. Compatibility with inquiry methodology

The CLIL approach focus on both content and language, consequently CLIL is not learning content through language (Immersion) nor learning a language through content (Content Based Learning and Teaching). As Marsh et al. (1999) contended the concept of CLIL is based on principles different to those which refer to teaching a subject matter in a second language in an identical manner as in the mother tongue.

Now, our study continues with a discussion about if CLIL is compatible with Inquiry and if Inquiry is favorable for implementing a CLIL methodology. For discussing the compatibility we needed to analyze CLIL principles one by one. These principles are as follows: previous knowledge must be activated, communication understanding must be guided, learning focuses on languages as mean for learning and communicating, different ways of assessment must be provided as well as social and cultural awareness and cognitive skills must be developed progressively as linguistic abilities.

The first principle is that students' **previous knowledge** must **be activated** for each new topic (Coyle, Hood and Marsh, 2010). It is important to know the children misconceptions about natural phenomena as it can be the origin of an inquiry task. When a research question is asked in a classroom the previous knowledge is activated for which it is needed and positive to share evidences that are part of that previous knowledge.

The second principle is that learners' **understanding must be guided**. Inquiry activities must be guided because children are not authentic scientists and consequently they are not autonomous at all. Teachers must know where is the Zone of Proximal Development (ZPD) which is the line that separates what a learner is able to do on their own and what they are able to do with the help of someone who is more competent (Vigotsky, 1978). In this case, children must be guided to understand the nature of science and put into practice the inquiry methodology and the skills that it entails.

For that it is useful to provide multimodal input because it facilitates understanding and scaffolds learners with input which is comprehensible so as learners can have a background to build up their own knowledge autonomously. Scientific inquiry can provide multimodal input because students are asked to read, to observe, to listen, to touch and to experiment. Hands-on activities are a good way for guiding understanding because students can be guided trough some steps.

The inquiry methodology goes through the Bloom's new taxonomy (Raths and Wittrock, 2001) whose skills are *remembering, understanding, applying, analysing, evaluating* and *creating*. In inquiry tasks, children create their own knowledge, discuss, explain and write but, before that, it is necessary to read, observe and try to understand for reaching some conclusions. There are basic skills like reading and there are others that are more complex, for instance, discussing. Moreover, guiding understanding means to do activities from those that involve lower-order thinking skills to those that include higher order thinking skills.

Working in groups is another aid for guiding understanding because children can learn and work easily with the help of their mates but students little by little must learn to be autonomous and sometimes work individually. Moreover, the inquiry methodology is based on cooperative learning because knowledge is build up thanks to

a group of scientists that reach conclusions, discuss them and agree. Therefore, the CLIL approach and the inquiry methodology support the cooperative learning.

The third CLIL principle is that **learning focuses on language as a mean for learning and communicating**, that is, language is not only the mean for learning content, as it is in an immersion environment, but for communicating for which is required to learn the language as an end in itself. Can we learn a language and do inquiry activities simultaneously? Personally, I think that there is a positive interdependence between the terms language and inquiry.

The inquiry methodology promotes language of learning, language for learning and language through learning which is a classification made by Coyle, Hood and Marsh (2010). The language of learning refers to the concepts and skills related to the topic. As Aragón (2007 :155) explains, language cannot be taught without content, and **for learning content it is needed to activate linguistic abilities.** That is one reason why the inquiry methodology is a good way for learning a language.

The inquiry methodology provide processes for which is needed to use the four main linguistic skills. For instance, asking questions promote speaking and writing and recording data promote reading and oral comprehension. For seeing the relationship between the inquiry processes and the linguistic skills we have made a table (see table 2) in which we can see that productive skills are required as the receptive skills although most of skills are productive. So, we reach the conclusion that the active role of the learners, required for the inquiry methodology, is promoted throughout writing and speaking, which are linguistic skills. Once again, we see the compatibility, even the positive relationship between inquiry and CLIL principles.

Another reason why the inquiry methodology is a good way for learning a language is that **Inquiry provides a lot of opportunities to learn vocabulary**, which corresponds to **"language of learning"** (Coyle, Hood and Marsh, 2010). Science is a subject that involves many topics of the daily life such as living things, energy, nutrition or rivers through which inquiry activities may be implemented. Moreover, the vocabulary may be learnt easily thanks to the context, the visual aids in CLIL classrooms and the meaningful activities that make students be motivated and use vocabulary for a purpose. Consequently vocabulary is acquired in a fast way.

	Productive skills		Reading skills	
	Speaking	**Writing**	**Reading**	**Oral comprehension**
Grandy and Duschl (2007)				
Posing questions	X	X		
Designing experiments	X	X		
Making observations	X	X		
Collecting data and representing		X	X	X
Representing data		X		
Relating data to hypothesis/model and theories	X	X		
Formulating hypothesis	X	X		
Learning theories			X	X
Refining theories	X	X		
Giving arguments for/against models and theories	X	X		
Making predictions	X	X		
Recording data			X	X
Discussing data	X	X		X
Writing about data, theories and models		X		
Chin and Malhotra (2002)				
Selecting variables			X	
Planning procedures	X	X		
Controlling variables				
Planning measures	X	X		
Explaining results	X	X		X
Generalizations	X	X		

Table 2. Key processes involved on Authentic Inquiry and required linguistic skills. (Processes adapted from Chin and Malhotra, 2002; Grandy and Duschl , 2007)

Another reason why the inquiry methodology has a positive influence on learning a language is that it **provides different kind of texts** that involve several language functions such as asking, explaining, predicting or suggesting. These texts refer to the **"language through learning"** (Coyle, Hood and Marsh, 2010) because they involve language and thinking at the same time. For instance, through inquiry students can ask questions, explain results, predict effects and causes, suggest variables for the research and many more processes. Those language functions lead learners to learn grammar because they need to know the questions structure for asking questions; students need to know how to make a coherent explanation with linking words such as *firstly, as a result* and *to sum up* and learners are required to know how to predict by using modal verbs such as *can, may* and *might.* The grammar is part of "the language needed for learning" (Coyle, Hood and Marsh, 2010) because although it is not necessary to learn grammar explicitly, the use of it is required to operate in a second language environment.

The fourth CLIL principle is that assessment must include **self-assessment, peer assessment and teachers' assessment**. These three kinds of assessment are promoted with the inquiry activities. For instance, when one predicts that something is going to happen then one has to test their hypothesis, as a result children are using the self-assessment. When one discusses their conclusions with a partner we can see that they are assessing to each other, peer assessment. Finally, when the teacher assesses the students' writing, report or participation we are referring to teachers' assessment.

The fifth CLIL principle is that **cultural and social awareness** must be provided. That is to say, learning involves acquiring knowledge of content, values as citizens, social skills… The inquiry methodology can provide cultural and social awareness, for instance, because a group of students need to behave according to good citizen values by respecting opinions, helping to each other, solving problems and also the aim of inquiry is to acquire knowledge and skills for learning Science as part of the culture.

The sixth principle is that learners' **cognition must be taken into account for developing linguistic skills progressively**. Cognitive and linguistic demands go together and this progression can be carried out through an inquiry methodology. Learners can start understanding a simple theory which requires few cognitive demands and just reading and they can also explain conclusions after an inquiry task which requires more cognitive demands and speaking to an audience which is a productive linguistic skill.

In conclusion, we see that inquiry principles are compatible with the CLIL principles. Furthermore, the inquiry methodology promotes CLIL principles and it would be an adequate methodology for CLIL lessons. So, we answered to the second and the third research questions of our study.

3. Materials for the analysis

Since now, our research started focusing its attention on the materials, which are one of the main supporting aids for learning and teaching in Primary Schools. Our Education System in Spain and Aragon, specifically, has been based on books because they were and are a source of information which has the content that is compulsory to be learned

in the Elementary School. Teachers still base their teaching on **text books** although nowadays there are more resources such as digital books, CD's, teacher's guides with complementary suggestions, internet webs with interactive activities and many more. There are publishing houses like Santillana and Edelvives which have had a successful implementation in schools. Our analysis will be focus on both publishing houses because they create L2 and L1 books (table 3) for Science but before analyzing and evaluating books we need to concrete how books can promote CLIL and inquiry principles.

	Title	**Language**	**Publishing house**	**Units**	**Pages**	**Year**
Book 1	Essential Science 5	L2	Santillana	1-7	26	2006
Book 2	Conocimiento del Medio 5	L1	Santillana	1-7	93	2009
Book 3	Ciencias de la Naturaleza 5	L1	Santillana	1-15	137	2014
Book 4	Conocimiento del Medio 5	L1	Edelvives	1-7	114	2009
Book 5	Natural Science 5	L2	Edelvives	3	13	2014
Book 6	Ciencias de la Naturaleza en SPX 5	L1	Edelvives	3	15	2014

Table 3. Analyzed Books' Key. Natural Science for fifth graders.

4. Methods for the analysis

4.1 Method for the CLIL analysis

For analyzing L2 books we used a **check list** in which we have set out the criteria that a book must follow to accomplish CLIL principles. It has a great importance in education although teachers have on their hands the responsibility for making methodological decisions. However, books have influenced the way lessons are given as books follow

different approaches and learning theories which give us a pedagogic point of view that affects the lesson implementation. Books may contribute to the CLIL methodology with suggestions for activating previous knowledge, guiding understanding, developing content and language, assessing and providing social and cultural awareness. So, all the CLIL principles can be supported by books apart from teachers and children.

4.2 Method for the inquiry analysis

Science books may contribute to inquiry principles as well as L2 books to CLIL principles. Books can promote all the processes needed to carry out an inquiry task and may suggest students to cooperate and construct their own knowledge. For instance, a book which only contains information and some questions that can be answered by reading the written texts is likely to promote a PPP model which would consist in presenting a new topic, practicing by reading or listening and producing by answering the questions. However, books may suggest inquiry activities, experiments and hands-on activities for a meaningful learning, apart from providing information.

For evaluating to which extent the inquiry methodology is implemented on L1 and L2 books a **quantitative analysis** was implemented**,** in Excel (Appendix 6-11), which consisted of **indentifying the inquiry processes** which are involved in each inquiry task of L1 and L2 text books. Also, a **qualitative analysis** was carried out simultaneously to the quantitative analysis by noting the most important inquiry features of the text books.

The research it has been focused on some of the main inquiry processes, that Chinn and Maolhtra (2002) and Grandy and Duschl (2007) claimed, for seeing the extent to which text books follow the inquiry methodology. The selection was carried out by taking into account that children cannot do authentic inquiry as scientists.

Authentic inquiry differs from simple inquiry activities in three aspects. Epistemologically, in authentic inquiry a relevant aim is to refine theoretical models through evidences (Darden, 1991; Giere, 1988). However, the aim of simple inquiry tasks is usually to find out easily observable regularities (e.g., a plant changes its green colour when vinegar is poured over the plant) or structures of objects. (e.g., Plants consist of stems, leaves and roots). Cognitively, in authentic inquiry the scientists pose

their own questions, establish and control multiple variables, plan measures, explain results by transforming observations and generalize their research to different situations. In contrast, in simple inquiry tasks, children are given the questions, are given one or two variables to measure, are told the way of observing, explain cause-effect facts and if they generalize they do it to similar situations. Socially, authentic inquiry is implemented by groups of scholars and institutions. Otherwise, simple inquiry activities may be carried out by one or several students in collaboration. When children discuss, explain and report they have to take into account the audience, so we see that the social element is present at simple inquiry tasks.

Anyway, **there is not a precisely defined criterion** for determining if an activity is inquiry or not. Some activities are clearly inquiry, in contrast others involve some inquiry processes but cannot be clearly categorized as inquiry tasks. Zadeh (1965) stated that some objects we find in the physical world cannot be precisely classified in classes. For instance, Zadeh (1965) noted that some living things, like a horse or a dog, could be included precisely within the class of animals, while some objects as bacteria or starfish couldn't be placed in a determined class. We agree that there are some inquiry grades and some activities present more inquiry features than others although there can be activities that are not inquiry which involve cognitive processes that are not included in tasks that we consider as close to authentic inquiry.

The tasks analyzed were classified using a **classification of inquiry simple tasks** made by Chin and Malhotra (2002): Simple observations, simple illustrations and simple experiments. This order goes from the tasks which are further from authentic inquiry to the tasks which are closer to authentic inquiry to. **Simple observations** (SO) consist in observing and describing objects. For instance, in one of our analyzed book it is presented an activity which asks students to observe a leave and describe and explain its main features.

Simple illustrations (SI) consist of determined procedures in which students don't take decisions and just have to observe the outcome that is explained by a theory or experiment. For example, the same book suggests learners to blow a balloon and take it in a container filled of water, then students are asked for what they observed and causes that have induced the change.

Simple experiments (SE) differ a bit from simple illustrations. In simple experiments, students control variables and are free to explore and reach conclusions themselves. For instance, in one of our Science books learners are suggested to do an experiment with lentils. Students would control the variable of the amount of water to see what happens to the lentils depending of that variable. Also, learners are asked to predict and reach conclusions.

Our research includes another category for simple inquiry tasks called **simple searches** (SS) as learners are asked to gather information from webs, books, journals, people… for answering a question but there is neither a specific procedure nor variables to control because the question cannot be answered empirically. For instance, in a book it is asked students to search information about the carnivorous plants and answer the question *why can carnivorous plants live in dry environments?* This question cannot be answered empirically but students can find the information by gathering from different sources as it was said before.

5. Results of the analysis

5.1 Results of the CLIL analysis

In the check list 1, we analyzed the CLIL characteristics of the L2 books 1 (Appendix 4) and 5 (Appendix 5) for testing if they followed the CLIL principles. We used some CLIL features for each principle suggested by Coyle, Hood and Marsh (2010) that we considered relevant for analysing books.

After analyzing the books 1 and 5 we could test that they are **CLIL** books. They follow all the CLIL principles and most of the criteria chosen for analyzing CLIL books. Both books **activate learners' previous knowledge**. When a unit starts, the first page is dedicated to find out the prior knowledge of students with questions and pictures or diagrams that facilitate understanding. For example, book 1 suggests questions such as: *What natural features can you see in the landscape around your town? ¿Which things are man-made?* (p.32). Furthermore, these questions are next to a picture of a landscape that facilitates understanding. More over the book 1 propose hands-on

activities, personal experiences (p.5) or a brainstorming (p.12) for activating the previous knowledge.

	Book 1	Book 5
ACTIVATING LEARNERS PREVIOUS KNOWLEDGE		
It proposes a discussion on the new topic when the lesson starts	X	
It suggests questions for finding out the previous knowledge	X	X
It uses visuals like photographs like photographs or diagrams	X	X
It suggests a brainstorming about vocabulary related to the unit	X	
It provides hands-on activities to introduce new topics	X	
GUIDING UNDERSTANDING OF THE CONTENT		
It uses multimodal input		
- Texts with visuals	X	X
- Written stories	X	X
- Spoken stories	X	X
It scaffolds understanding and activities		
- Content learning	X	X
- Language learning	X	X
- It provides:		
- Graphic organisers		X
- Expert groups		
- Target practice	X	X
- Venn diagram		
- It provides activities for pair and group work	X	X
COGNITION IS TAKEN INTO ACCOUNT FOR THE LINGUISTIC ABILITIES' DEVELOPMENT		
- It uses questions from lower-order thinking to higher order thinking skills	X	
- Remembering	X	X
- Understanding	X	X
- Applying	X	X
- Analysing	X	X
- Evaluating		X
- Creating	X	X
FOCUSING ON LANGUAGE AS A MEAN FOR LEARNING AND COMMUNICATING		
It provides activities for language learning and use		
- Language of learning (concepts and skills related to the topic)	X	X
- Language for learning (language for operating in the target language)	X	X
- Language trough learning (learning through a foreign language)	X	X
It provides practice of the 4 linguistic skills		
- It encourages writing	X	X
- It encourages speaking	X	X
It encourage reading	X	X
- It encourage listening	X	X
It provides different kind of texts, genres.		
- Reports	X	X
- Instructs	X	X
- Explains	X	X
- Persuades		X
- Discusses	X	X
- Describes	X	X
- Predicts	X	X
It helps to understand vocabulary		
- It provides activities for learning specific vocabulary	X	X
- It provides a glossary	X	
- With the translation	X	X
- With English definitions and examples		
ASSESSING		
- It provides rubrics for assessing		
- Self-assessment	X	X
- Peer assessment		X
- Teacher assessment	X	X
-		
CULTURAL AND SOCIAL AWARNESS		
- It provides information about different cultures	X	X
- It promote discussion for giving opinions	X	X
- It engage students to acquire values as citizens	X	X

Check list 1. CLIL principles analysis in L2 books of Science.

Also, both books accomplish the principle of **guiding understanding**. Books 1 and 5 use multimodal input. For instance, in the book 1 each page has listenings recordings, readings, photographs and pictures. The book 5 provides written texts accompanied by images (p.34) and listenings (p.37) as well. Also, the book 1 promotes pair and group work. For example, in page 24 it is proposed a role-play. Moreover, the book 5 demands **progressive thinking skills** clearly trough questions. For instance, in page 18 the first question is *what is the main cause of acid rain?* and the next question is *what do you think will happen if we don't reduce the emissions of harmful gases?* The first question can be answered by reading the text but the second one requires predicting and applying the content by reasoning. The book 1 scaffolds learners as well; for example, the book proposes a true/false activity at first (p.523), then a filled-gap activity (p.24) and the final question is open for a more complex answer (p.24).

Another principle that books follow is that **language is considered as a mean for learning and communicating.** Both books develop the three dimensions of language claimed by Coyle, Hood and Marsh (2010). *Language of learning* is promoted with activities for acquiring specific vocabulary and the four linguistic skills needed for learning Science. *Language for learning* is provided in different types of texts. For instance, in the book 1 students are required to know how to describe the reproduction of plants, how to explain events scientifically as the decantation, as well as how to predict what will happen if we mix oil and water. The book 5 asks learners for predictions (p.44), descriptions (p.36), discussions (p.45) and reports (p.44), so students develop their abilities to create different genres of texts. Moreover, both books provide a bilingual glossary with specific vocabulary related to units.

With regards to **assessing,** book 5 promotes self-assessment through the scientific method because children have to test their hypothesis (p.44), peer assessment when it asks students to compare the leaves they have done and teacher assessment as a current book (p.41). However, the book 5 doesn't promote peer assessment but it encourage learners to self-asses at the end of each unit.

Finally, we founded that books provide **social and cultural awareness** about living things, nutrition, atmosphere, population and more topics. Furthermore, the book 1 promotes values for being a good citizen like saving water and eating healthy and the book 5 makes students reflect about environmental problems and its implications for the

society. In conclusion, these books strongly follow CLIL principles and are useful for our research.

5.2 Results of the inquiry analysis

For evaluating to which extent books follow the inquiry principles and comparing L2 books with L1 books we had got to pay attention to different factors that could help us: the number of simple inquiry tasks per page, the number of the different kind of simple inquiry tasks, the number of inquiry processes per task which are meaningful in inquiry tasks, the number of the inquiry tasks which have the more important inquiry processes and the cognitive, social and epistemic dimensions.

It is complicated to establish that some activities follow an inquiry methodology more than others but we agree that the more processes a task involves the closer to an inquiry methodology the task is. We founded that the 100% of simple experiments of our books have 6 or more inquiry processes, the 78, 3% of simple illustrations have between 4 and 6 inquiry processes, the 91% of simple observations have 4 or less inquiry processes and the 84% of simple searches have 3 or less inquiry processes. As a result, we consider that the more inquiry processes the simple tasks have the closer to the inquiry methodology the simple tasks are.

5.2.1 Number of inquiry simple tasks

If we fix our attention to the number of inquiry simple tasks, the book 1 (L2) includes 18 simple inquiry tasks in 26 pages, the book 2 (L1) 13 tasks in 96 pages, the book 3 (L1) 21 tasks in 137 pages and the book 4 (L1) 36 in 104 pages. With these data we would say that the books 4 (L1) and 3 (L1) are closer to the inquiry methodology than the book 1 (L2) because they provide more simple inquiry tasks than the L2 book.

However, as you can see in table 4, book 1 (L2) has more **tasks per page** (0.69) than L1 books that have 0.14, 0.15 and 0.31 tasks per page. So, there is a huge difference in the relation between tasks and pages, consequently, the book 1 (L2) would follow the inquiry methodology more closely than the L1 books. Moreover, a short book as the book 1 (L2) allows the teacher to be more free for adding more inquiry

tasks or carry out the proposed inquiry tasks with the time needed for students to conduct the inquiry processes.

	Number of pages	Number of simple inquiry tasks	Simple inquiry tasks per page
Book 1 (L2)	26	18	0.69
Book 2 (L1)	96	13	0.14
Book 3 (L1)	137	21	0.15
Book 4 (L1)	104	36	0.31

Table 4. Simple inquiry tasks per page

5.2.2 Frequency of each kind of simple inquiry tasks

As we claimed, simple experiments are inquiry tasks which follow the inquiry methodology more closely than the rest of tasks. The book 1 (L2) has 4 **simple experiments**, while the book 2 (L1) has 1 and the book 4 (L2) has 2. If we see the **simple illustrations** that books have there is a 10-10 tie among the book 1 (L2) and 4 (L1), otherwise the others are far away from these results. **Simple observations** and **simple searches** are implemented deeper on L1 books but this fact doesn't mean so much because a few inquiry processes are involved in those tasks. In the book 4 (L1) simple searches are strongly promoted but most of activities consist in searching information for answering a question or writing a report at a theoretical level. For instance, in the page 94 students are told to search information about the bread elaboration procedure for making a mural and they are asked for the stage in which the fermentation occurs as well. In short, the L2 book provides more simple tasks that are closer to authentic inquiry.

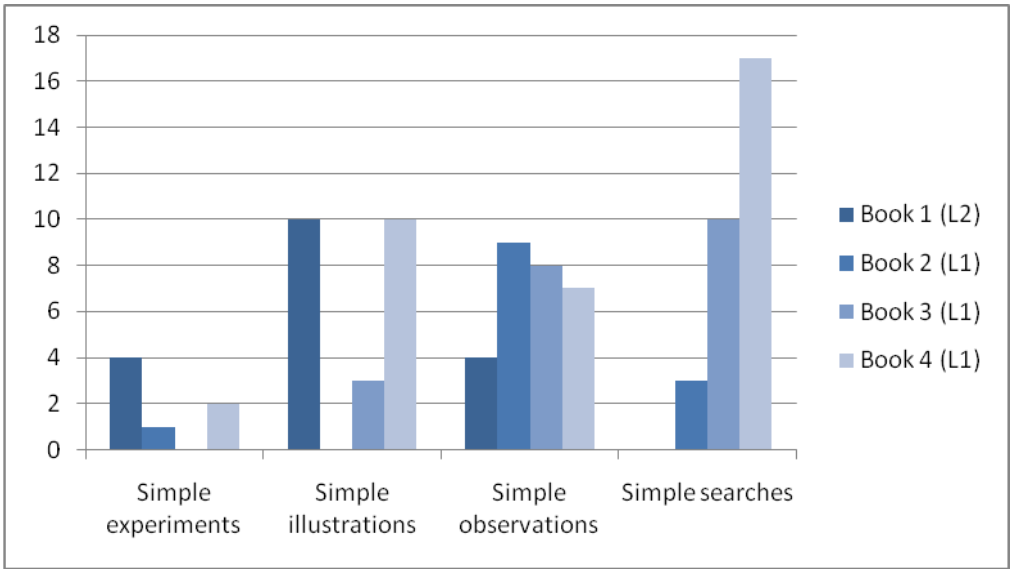

Chart 1. Quantity of simple inquiry tasks.

5.2.3 Number of inquiry processes per task

For a more accurate analysis we are going to focus on the **number of inquiry processes** which are involved in the simple inquiry tasks. We must highlight that book 1 (L2) includes 8 activities with more than 5 inquiry processes. However, the L1 books have 1 activity with more than 5 processes. So, the quality of the L2 book tasks is better as inquiry tasks are more complete and the net connections created by processes are more complex.

However, the simple task which is closer to the authentic inquiry is a task suggested by the book 4 in the page 78 (appendix 3 in page 32) which involve 11 inquiry processes from the 14 we analyzed. This task is a well-organized inquiry project in which students have to build up a terrarium equipped with soil, living things as plants, snails and worms and finally, water. After making the terrarium the book propose to organize the inquiry task in groups so that each group can investigate a different aspect of the ecosystem like the environment, the living things, the relation between them and the natural changes. Thus, children control variables that they can observe. The book also suggests the student to collect useful information from books, journals and webs for writing a report with highlighted data. Furthermore, the report of each group must be showed to the rest of the teams for discussing about what can be added or corrected. Then, the book proposes learners to make a short final report for displaying it to the class by explaining the conclusions to which they reached. It is

relevant to notice that the task which involves more processes in the L2 book has 7 processes, while there is a task which has 11 processes in a L1 book. This fact can be due to the language as the complexity of the inquiry task and the cooperative learning require mastering a language. Also, the use of the mother tongue facilitates the control of more variables, the access to more information taken from books, journals and webs and the discussions. In conclusion, we see the potential of the native language with this task that involves 11 inquiry processes although tasks with more than 5 processes predominate in the L2 book.

There was a relevant data to highlight for showing a general view of the quality of the inquiry simple tasks. As you can see in chart 2 and table 5, we analyzed the average processes per task. Book 1 (L2) is the book with the highest average with 4.58 processes per task. While the second book in this ranking is the book 4 (L1) with 3.64 processes per tasks. There is a difference of almost 1 process per task between the book 1 and 4 and a difference of more than 1 process per task between the book 1 and books 3 and 4. So, we agree that the book 1 (L2) follows more closely an inquiry methodology because their tasks involve more inquiry processes on average.

	Number of processes	Number of tasks
Book 1 (L2)	87	19
Book 2 (L1)	38	14
Book 3 (L1)	71	21
Book 4 (L1)	135	37

Table 5. Number of inquiry processes and simple inquiry tasks

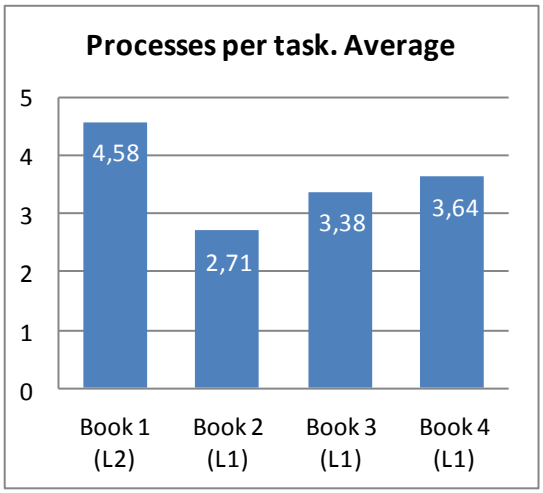

Chart 2. Processes per task. Average

5.2.4 Number of authentic inquiry tasks with essential processes

If we try to determine the quality of inquiry tasks we cannot focus only on the number of processes carried out in a task. It is also important to know **what processes are fundamental** for a task to be considered an inquiry task. There are three steps that all the inquiry tasks in Primary Education should follow: posing questions, looking for evidences and regularities and explaining results and conclusions.

In Authentic inquiry scientists pose questions by themselves but it can be accepted that in inquiry tasks carried out by children the teacher ask the research question. Thus, text books cannot contribute Authentic Inquiry with regards to the questions because if they propose a question children don't do it anymore. But, they can propose questions that can be investigated empirically. Children have to do inquiry tasks by knowing what question they have to answer because the most fundamental goal for scientists and the reason why scientific knowledge develops is to answer questions we cannot yet. Another process that is essential is to look for evidences and regularities because is the way for building up knowledge. In Science, if there are not evidences we cannot trust on a scientific research. The same happens with Justice because there have to be evidences for sending a person to prison. The last process that we consider fundamental for inquiry tasks is to explain results and conclusions as scientific knowledge is built up by a scientific community and there has to be an agreement.

We counted the **number of simple inquiry tasks which involve these three processes** (see chart 3) and we founded out that the book 1 (L2) is the book with more inquiry tasks which have the processes of posing questions, looking for evidences and regularities and explaining results and conclusions. There is a huge difference between L1 books and the L2 book. Even, the second book in number of tasks with these three processes has half of inquiry tasks that L2 book has.

In Education it may be possible that an inquiry task doesn't start from a question because it wouldn't affect the inquiry methodology. There can be well-conducted inquiry tasks which consist in looking for regularities and explaining the conclusions without an explicit question, for instance, there is a task in the page 44 of the book 4 (L1) which consist in identifying the characteristics that make some animals different from others. So, we counted the number of tasks with the two processes (see chart 3) of looking for evidences and regularities and explaining conclusions and the results were

similar to the results obtained from counting the inquiry tasks by adding the process of posing questions.

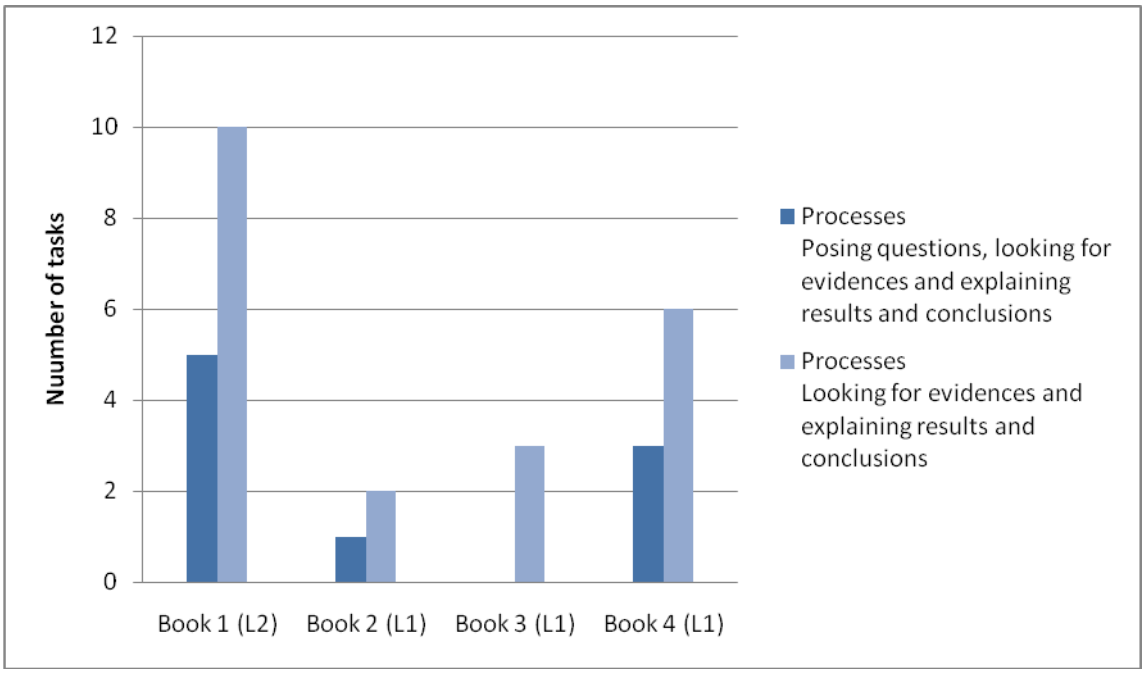

Chart 3. Number of tasks which have the processes of posing questions, looking for evidences and explaining results and conclusions. Number of tasks which have the processes of looking for evidences and explaining results and conclusions.

5.2.5 Cognitive, social and epistemic dimension

As we said in the theoretical framework, an inquiry task cannot just be based on cognitive processes as the scientific method is. An inquiry task must include the social and epistemic dimension as well because scientific knowledge is discovered in groups. Therefore, we analyzed the three dimensions that inquiry tasks must cover. In the page 6 of our study we made a table with the inquiry processes and the dimensions that they include. We used that table for obtaining the number of processes that involve each dimension per task. We did it by summarizing the processes that include each dimension and then, we divided them into the number of tasks for obtaining the average (see chart 4).

A result we notice is that the book 1 (L2) develop more cognitive processes but that is the consequence of having more inquiry processes as all they are cognitive. However, books 3 and 4 (L2) have more processes per task which cover the epistemic

and social dimension. It seems like there is not a huge difference between the L2 book and the L1 book. For instance, the biggest difference between book is in the social dimension as there is a difference of 0.46 social processes per task between the book 1 (L2) and 3 (L1). Nevertheless, we must take into account that the difference in the number of processes per tasks between these books is of 1.2 processes. So, we founded out that the epistemic and social dimension are developed deeper in books 3 and 4 (L1) than in the L2 book. But, we have to take into account that the book 2 (L1) was published by the same publishing house in a closer year to the L2 book's and it develops all the dimensions in a lesser extent. Otherwise, the book 3 was published by the Edelvives publishing house and the book 4 was published by the Santillana publishing house, but 8 years later.

Cooperative learning is not promoted in book 1 (L2) but it is in books 3 (L1) and 4 (L1) in which it is asked students explicitly to make groups, above all in the book 4 (L1) in which 11 from 37 simple inquiry tasks are asked to be done in groups.

These results show us that, in L1 books, interaction between children and the teacher is promoted in a greater extent by suggesting tasks that make students to discuss, explain and report. But is not the case of the book 2 because it is the book which has the inquiry tasks that are less closely to the inquiry methodology.

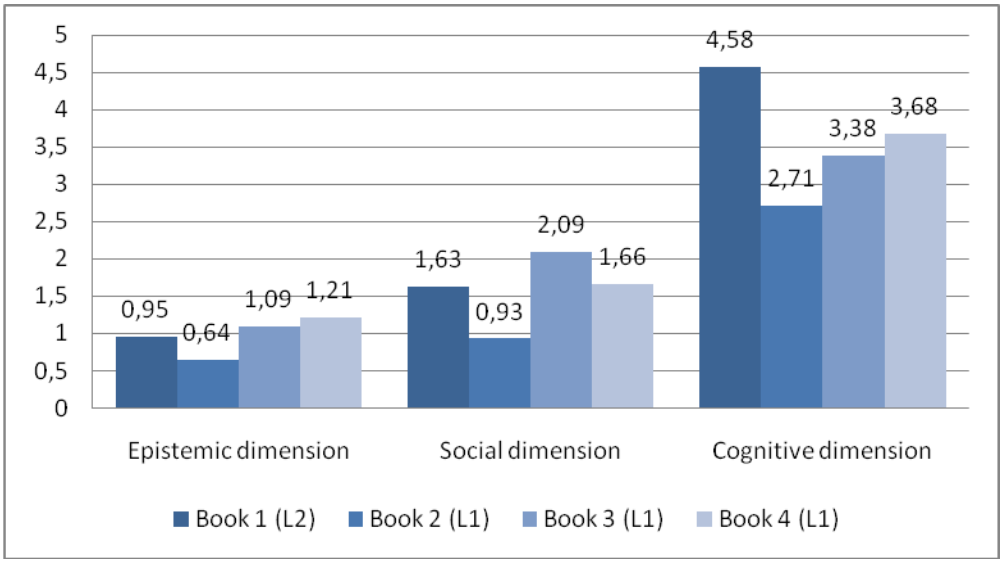

Chart 4. Number of processes per task in each dimension.

5.2.5 Contrastive analysis of two units

For our study to be more reliable we analyzed two Science books of the Edelvives publishing house published in 2014, one written in the mother tongue and the other in a foreign language. In order to analyze them we compared the units of plants for seeing if they followed the tendency of the books 1-4 in which the data collected showed us that the L2 book is more consistent with the inquiry methodology although the potential of L1 books is bigger as it can be seen in some tasks (see appendix 3 in page 32).

What we found in both books is that the first unit is dedicated to introduce the scientific method to students. So, there is an innovative view if we compare them with the books that were published before the year 2013 because there wasn't a specific unit dedicated to teach the way scientific knowledge is developed. This unit related to the scientific activity doesn't exist in the book 3 (L1) of Santillana published in 2014 and this fact make us think that Edelvives is nowadays an publishing house which is more conscious about the importance of engaging students to develop scientific skills.

Then, we analyzed the unit of plants in books 5 (L2) and 6 (L1). It is not needed to do a statistic analysis as deeply as we did with the books 1-4 because book 5 (L2) has just 2 simple inquiry tasks and book 6 (L1) has 3 simple inquiry tasks. Although, book 6 (L1) has more inquiry tasks it hasn't got any simple experiment or illustration task which are the tasks which involve more inquiry processes. However, book 5 (L2) include a simple experiment with 10 inquiry processes, while book 6 (L1) doesn't have any task with more than 4 inquiry processes.

Moreover, the inquiry task (p.44) with 10 processes of book 5 (L2) involve the processes of posing questions, looking for evidences and explaining results and conclusions which are relevant for implementing inquiry tasks . The question is *what is the effect of acid rain in plants?* For answering the question is carried out an experiment with initial hypothesis that will be tested. Students will have to observe the differences of the effects originated by watering a plant with tap water or acid water. So, students will be able to control the variable of the kind of water. Finally, learners will see evidences related to the colour and shape that plants get in order to explain the results and conclusions, as well as test their hypothesis.

However, the inquiry task (appendix 5 in page 41) with more processes in book 6 (L1) is not well-conducted because it suggests to make an experiment for proving that plants grow up towards the light but doesn't propose a question, nor asks students to explain, report or share their conclusions. This task consists of verifying a theory through an experiment in which students just have to observe the outcome, if the plant goes to the light or to the darkness.

6. Conclusions

Conclusions of this study

A number of conclusions may be derived from the results presented above. Firstly, the results showed that the inquiry methodology is compatible with CLIL principles, and that it has a positive influence on them. Language, cognition and culture can be developed by both CLIL and inquiry methodologies. Also, it is needed to activate children's previous knowledge, guide them and provide different kinds of assessment, CLIL principles that can be promoted by the inquiry methodology.

Secondly, text books can promote a CLIL methodology, as well as an inquiry methodology. CLIL methodology can be encouraged by providing activities which develop language vocabulary and linguistic skills, knowledge of content, social and cultural awareness and progressive cognitive skills. In contrast, inquiry methodology may be encouraged by providing inquiry tasks with cognitive, epistemic and social processes; cooperative learning activities, experiments… We could see how each book supports to a different extent the inquiry methodology.

Thirdly, inquiry methodology carried out by Science text books analyzed of fifth graders is far from promoting authentic inquiry as scientists do. Tasks provided by books consist of simple inquiry tasks which develop part of the processes required in order to implement an inquiry methodology. Otherwise, we have seen the potential of scientific inquiry in L1 and L2 books with two inquiry tasks which include 11 and 10 processes severally. That is, these tasks are good examples of the wide opportunities that a text book can provide for students to develop inquiry skills which are necessary for the future children's life. But, the inquiry task we found in the L1 book is more closely to the inquiry methodology because simulate the way scientists investigate and

it is a innovative perspective in Education, while the inquiry task founded in the L2 book is closer to the scientific method which is a narrow view of inquiry.

Fourthly, we observed that the L2 books and L1 books promote in a different way the inquiry methodology but it is complicated to establish differences in the extent to which they promote inquiry principles. L2 books analyzed provide more practical inquiry tasks such as hands on activities and experiments than L1 books analyzed, whereas L1 books propose more searches for information at a theoretical level which just consist in collecting data and explaining results of the search, fundamentally. Also, L2 books include more complex inquiry tasks with more cognitive processes on average. Moreover, L2 books include more tasks with the essential processes of inquiry that are: posing questions, looking for evidences and regularities and explaining results and conclusions. In favour to L1 books, they promote social and epistemic processes to a bigger extent such as discussing and writing. Also, they encourage learners to work in groups and let them more freedom and autonomy.

7. Discussions of the study

Possible factors which explain the results

There are some possible factors that may explain the differences in the extent to which books follow the inquiry methodology. The factor of the L1 or L2, the author and publishing house, the year in which books were published and other principles or objectives which books follow.

The mother tongue offers more opportunities for interacting between children and the teacher, therefore in L2 books it is engaged that learners make groups in order to collaborate for a social construction of knowledge which is relevant in the inquiry methodology. The native language also allows learners to collect and record data from more sources, above all from written texts that couldn't be comprehensible in a second language. However, the possibilities and ease of producing a theoretical reasoning in the mother tongue make L1 books not to provide enough experimental tasks in which students are in contact with natural phenomena. These experiments are a good way for

learning Science through a second language because they are a good context for understanding a foreign language.

The author and the publishing house can affect the extent to which inquiry principles are followed in books because there is a huge difference between the book 2 and 3 which allow to a different publishing house and author although both books were published in 2009. The publication year is another factor that influents the inquiry methodology in books. We could see in our research that books published in 2014 give more importance to the scientific method, although it is a narrow view of inquiry methodology, than more former books.

Moreover, books can be based in other principles or may have other objectives which they consider more important for the curricula. Content covers more pages in L1 books than in L2 books as there are not language objectives and reading is easier in L1 books. Also, L1 books focus on developing competences like the digital competence and more general competences such as learn to do and learn to learn that doesn't encourage the inquiry methodology.

Constrains and strengths of this study

Our research has had some constrains and strengths. A constrain has been that the study has been limited to text books when there are a lot of materials like webs, projects or workshop books which could promote tasks closer to the inquiry methodology. Another constrain has been that just 6 books were analyzed; consequently the conclusions cannot be generalized to all the Primary text books. Moreover, the role of books in teaching Science in the classroom is limited as there are other factors that may facilitate scientific inquiry such as the teacher because they can take decisions that include modifying the tasks in order to do a more authentic inquiry task.

There are some strengths as well that make our study reliable. One strength is that the quantitative analysis of the inquiry tasks was accurate and exhaustive. There were many processes involve in the inquiry methodology that were analyzed one by one. Furthermore, the classification in 4 kinds of simply tasks leads the reader to understand easily the results, as well as charts. Finally, the theoretical framework is

supported by authors with a recognized status and an article written from a conference of important scientific educators, cognitive scientists and philosophers.

In closing, there are research avenues that can be explored linked to this study. A factor that we didn't take into account for our study was the implementation of the inquiry tasks in schools. We analyzed the extent to which current books in Primary Education follow the inquiry principles. Future research could study the implementation of inquiry tasks for seeing if they are feasible for fifth graders.

Relevance of this study

The study provides an evaluation of L1 and L2 text books of Science in Primary Education. This evaluation about the extent to which books follow an inquiry methodology may give teachers advice about which book they must choose for teaching Science. Moreover, this research gives us a critical view of the inquiry methodology implemented in Science text books for Primary Education because they don't promote authentic inquiry tasks but simple inquiry tasks although the inquiry methodology is included in the *Currículo Aragonés* within the *competencia en el conocimiento y la interacción con el mundo físico.* It also shows that scientific inquiry can be carried out in both the mother tongue and a foreign language, so the first or the second languages are not decisive for implementing an inquiry methodology although the mother tongue facilitates to follow more closely the inquiry principles.

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9. Appendix

APPENDIX 1

Check list for analysing and evaluating books according to CLIL principles.

	YES	NO
ACTIVATING LEARNERS PREVIOUS KNOWLEDGE		
It proposes a discussion on the new topic when the lesson starts		
It suggests questions for finding out the previous knowledge		
It uses visuals like photographs like photographs or diagrams		
It suggests a brainstorming about vocabulary related to the unit		
It provides hands-on activities to introduce new topics		
GUIDING UNDERSTANDING OF THE CONTENT		
It uses multimodal input		
- Texts with visuals		
- Written stories		
- Spoken stories		
It scaffolds understanding and activities		
- Content learning		
- Language learning		
- It provides:		
- Graphic organisers - Expert groups - Target practice - Venn diagram		
- It provides activities for pair and group work		
COGNITION IS TAKEN INTO ACCOUNT FOR THE LINGUISTIC ABILITIES' DEVELOPMENT		
- It uses questions from lower-order thinking to higher order thinking skills		
- Remembering		
- Understanding		
- Applying		
- Analysing		
- Evaluating		
- Creating		
FOCUSING ON LANGUAGE AS A MEAN FOR LEARNING AND COMMUNICATING		
It provides activities for language learning and use		
- Language of learning (concepts and skills related to the topic)		
- Language for learning (language for operating in the target language)		
- Language trough learning (learning through a foreign language)		
It provides practice of the 4 linguistic skills		
- It encourages writing		
- It encourages speaking		
It encourage reading		
- It encourage listening		
It provides different kind of texts, genres.		
- Recounts		

- Reports		
- Instructs		
- Explains		
- Persuades		
- Discusses		
- Describes		
- Predicts		
- hypothesises		
It helps to understand vocabulary		
- It provides activities for learning specific vocabulary		
- It provides a glossary		
- With the translation		
- With English definitions and examples		
ASSESSING		
- It provides rubrics for assessing		
- Self-assessment		
- Peer assessment		
- Teacher assessment		
CULTURAL AND SOCIAL AWARNESS		
- It provides information about different cultures		
- It promote discussion for giving opinions		
- It engage students to acquire values as citizens		

APPENDIX 2

Check list for analysing and evaluating books according to the inquiry principles.

All learning activities should focus on using cognitive, epistemic and social processes.
- It poses questions that can be investigated empirically.
- It suggests experiments
- It promotes observations
- It suggests students to collect and representing data
- It encourages learners to formulate hypothesis and make predictions
- It promotes looking for evidences
- It suggests or asks for variables to be taken into account
- It promotes learning data/theories/models
- It asks for arguments to the students
- It asks for explaining results to learners
- It suggests to record data and measure
- It suggests to discuss about data
- It promotes writing about data
- It asks for generalizations
Inquiry is carried out in a cooperative environment (social aspect)
- It promotes pair and groups share
Inquiry involves information-processing skills (cognitive aspect)
- It requires skills for an information treatment.
Learners discover and construct new knowledge through Inquiry (epistemic aspect)
- It provides opportunities for students to create their own knowledge
Inquiry make the students to be active and autonomous
- It gives opportunities for working individually

APPENDIX 3

Inquiry task provided by an L1 book. Edelvives publishing house. 5th Year of Primary Education. 2009.

Organizamos la investigación

Investigad cada una de las facetas de los ecosistemas de modo que cada grupo se encargue de:

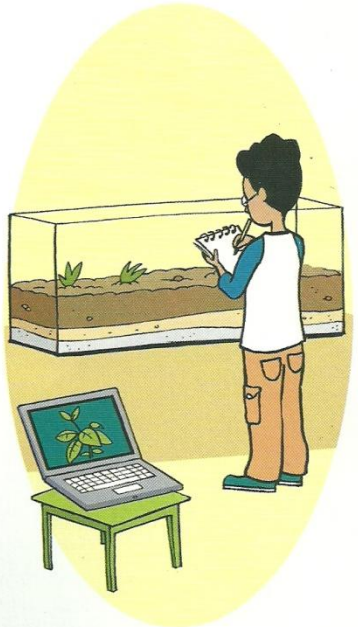
- El entorno o medio físico.
- Los eslabones de la cadena alimentaria.
- Las relaciones entre las distintas especies que viven en los ecosistemas.
- Alteraciones en los ecosistemas.

Investigamos los ecosistemas

Para realizar la investigación, elegid a un coordinador entre los miembros del equipo y repartid las tareas según los puntos del siguiente esquema:

El entorno o medio físico	Los eslabones	Relaciones entre las especies	Las alteraciones
La temperatura. El agua. La luz. El clima.	Productores. Consumidores primarios. Consumidores secundarios. Descomponedores.	Relaciones entre individuos de la misma especie. Depredación. Mutualismo. Comensalismo.	Desaparición de un eslabón de la cadena alimentaria. Introducción de especies. Deforestación. Contaminación.

Para realizar la tarea que te ha correspondido, debes observar el terrario y buscar información en libros, revistas e internet. Luego, redacta un informe que contenga los datos más destacados.



Redactamos el informe final

A continuación, reuníos todos los miembros del equipo y poned en común el resultado de cada investigación particular. Comentad de qué manera se puede completar o corregir cada parte del trabajo. Después, resumid en un informe, que expondréis ante la clase, vuestras conclusiones.

Comunicamos los resultados

Para terminar, como en toda investigación, hay que realizar una última e importante tarea: comunicar los resultados. Para ello, el coordinador del equipo leerá los resultados y las conclusiones de la investigación delante de toda la clase.

¡Enhorabuena! Habéis sido capaces de realizar un trabajo científico.

Con todo lo que habéis aprendido sobre los ecosistemas, cuidad y anotad semanalmente lo que ha ocurrido en vuestro terrario. Recordad que, a fin de curso, deberéis presentar un informe con fotos y dibujos que recojan la evolución de vuestro pequeño ecosistema.

79

APPENDIX 4

L2 book. Santillana publishing house. 5th Year of Primary Education. 2006

1 Living things

LOOK

Look at this photo.

- What living things can you see?
- What non-living things can you see?

READ

1. Living and non-living things

In nature, there are living things and non-living things.

People, animals and plants are **living things**.

Rocks, air and wind are **non-living things**.

Living things have the following characteristics:

- They **are born** from other living things.
- They **eat**.
- They **react** to their environment.
- They **grow**.
- They **reproduce**.
- Finally, they **die**.

2. Life processes

There are three basic life processes:

- **Nutrition**
  Living things eat food, which contains **nutrients**.
  Nutrients are substances which provide energy.
- **Sensitivity**
  Living things react to their environment.
- **Reproduction**
  Living things have offspring.
  Many living things need a mate to reproduce.
  New living things replace the ones which die.

- Make more sentences. *Living things are born. Living things …*
- What living things are there in your home?

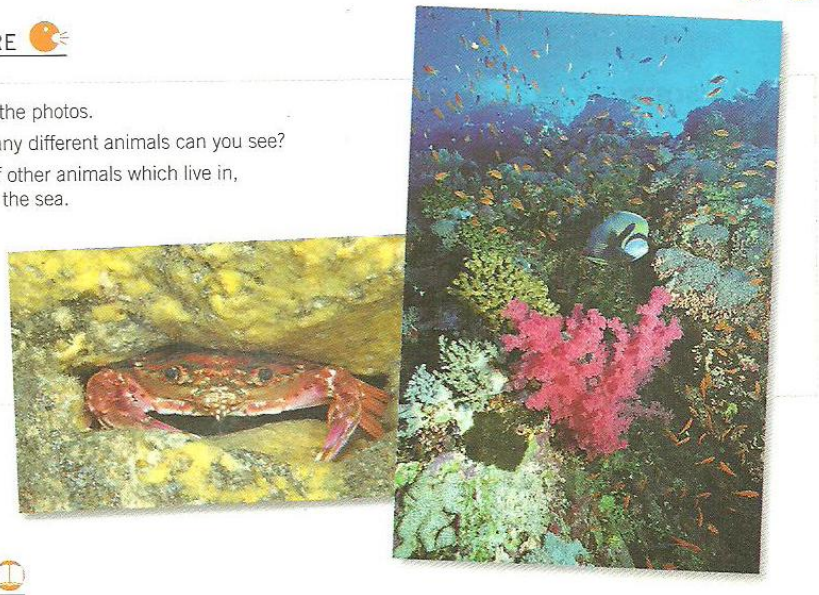
…react to their environment…grow…die…/ Open

3 Invertebrates

COMPARE

Compare the photos.

- How many different animals can you see?
- Think of other animals which live in, or near, the sea.



READ

1. What are invertebrates? 12

Invertebrates are animals which do not have a skeleton or a backbone.

- **Size:**
  Most invertebrates are very small, but some, such as giant squids, are enormous.
- **Body shape:**
  Most invertebrates are symmetrical, but some have irregular bodies.
- **Body covering:**
  Many invertebrate bodies are protected by **shells** or **exoskeletons**, but others have no covering.

2. How do invertebrates live?

Many invertebrates live in the sea, but some live in fresh water. Others live on land.

Most invertebrates can move, but some attach themselves to rocks or the sea floor.

Others, called **parasites**, live inside other animals.

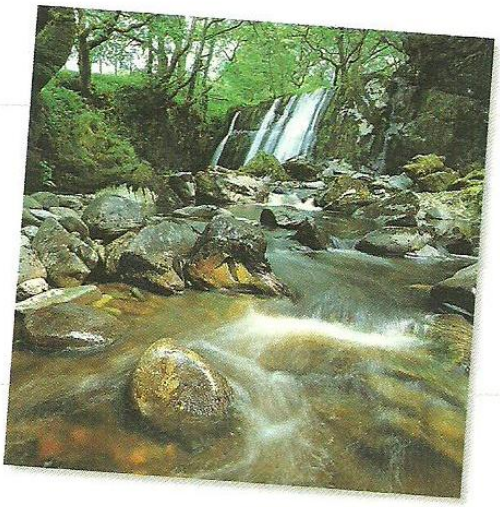
Invertebrates are **oviparous**. A larva hatches from an egg. At first, it does not look like an adult. Then its physical appearance changes.

- Describe invertebrates. *Most invertebrates are very small, ...*
- Why is it important to protect animals' habitats?

M.A. *...are symmetrical, are protected by shells or exoskeletons*
M.A. *If an animal's habitat is destroyed, it can die...*

6 Matter

LOOK



Look at the photo.

- Which things are solid? Liquid? Gaseous?
- Is there more water in the river at some times of the year?

READ

1. Matter 33

Everything in the universe is made of **matter**. The Sun, rocks, plants, human beings and manufactured objects are all made of matter.

Matter is made up of tiny particles called **atoms**. Atoms are extremely small. They are invisible to the human eye.

There are approximately one hundred different types of atoms. When they are combined in different ways, they make up all the substances in the world.

- An **element** is matter which consists of only one type of atom.
- A **compound** is matter which consists of more than one kind of atom.

2. Types of matter

Matter can be classified into two groups:

- **Pure substances** are made up of a single type of element or compound. For example, gold, iron and salt are pure substances.
- **Mixtures** are made up of several pure substances. For example, sea water is a mixture which is formed by water and salt.

3. Properties of matter

We can classify properties into two types:

- **General properties:** All matter has general properties like **mass** and **volume**. Everything which is made of matter has mass and takes up space.
- **Characteristic properties:** Properties like odour, colour, shininess and density are characteristic. They are different for each substance.

■ True or false?
Make more sentences about matter.
Human beings are not made of matter.
Sea water is a pure substance.

Both sentences are false. M.A. *The human body has mass and volume. Mayonnaise is a mixture of eggs, oil, salt and lemon juice.*

The properties of matter

■ READ

1. Mass 34

Mass is the amount of matter in an object. Some objects have more mass than others.

For example, a football has more matter than a pencil. The football's mass is greater.

The unit of measure for mass is the kilogram (kg), or kilo. One kilo is equal to 1,000 (one thousand) grams (g). 1,000 (one thousand) kilos are equal to one ton (t).

Scales are used to measure **mass**.

2. Volume 35

Volume is the amount of space which an object occupies.

For example, a football has more volume than a pencil. It takes up more space.

The unit of measure for volume is the litre (l). One litre is equal to 1,000 (one thousand) cubic centimetres (cm^3). 1,000 (one thousand) litres are equal to one cubic metre (m^3).

Measuring cups are used to measure the **volume** of a liquid.

3. Density 36

Density is mass per volume.

To calculate density, divide the mass of a substance by its volume:

$$\frac{\text{Mass}}{\text{Volume}}$$

Each object or substance has its own density:

- Water has a density of one kilo per litre of water: 1 kg/l. This means that one litre of water has a mass of 1 kilo.
- Iron has a density of 7.9 kilos per litre of iron: 7.9 kg/l. This means that one litre of iron has a mass of 7.9 kilos.

These two marbles have the same volume. However, the iron marble weighs more. Iron has more **density** than glass.

■ Complete the sentences.

Mass:

One kilo = … grams.

One thousand kilos = … ton.

Volume:

One litre = … cubic centimetres.

One thousand litres = … cubic metre.

■ How many litres of liquid do you drink in a day? Make a chart with the different kinds of liquid, and when you drink them.

…one thousand - one - one thousand - one

8 The landscape

LOOK

Look at the photo.

- What can you see in the landscape?
- Is everything natural, or are some things man-made?

READ

1. The landscape

All the different features of the Earth's surface make up the **landscape**. There are high mountains in some areas. There is low flat land in other areas.

There are mountain landscapes, flat landscapes and coastal landscapes.

2. Mountains 48

Mountain landscapes are made up of mountains and valleys.

- **Mountains** are raised parts of the Earth's surface. **Hills** have a lower **altitude** than mountains. (Altitude is the height of something above sea level, or the Earth's surface.)
- Several mountains grouped together are called a **mountain range**. A long line of mountain ranges is called a **mountain chain**.
- **Valleys** are low areas between mountains. Rivers are often found in valleys.

3. Plains 49

Plains are large areas of flat land with no hills or slopes.

A plateau is a plain at a high altitude.

Depressions are plains which are lower than the surrounding land.

Coastal plains are flat land near the coast.

- True or false? Make more sentences about landscape features.

  Mountains are low areas.

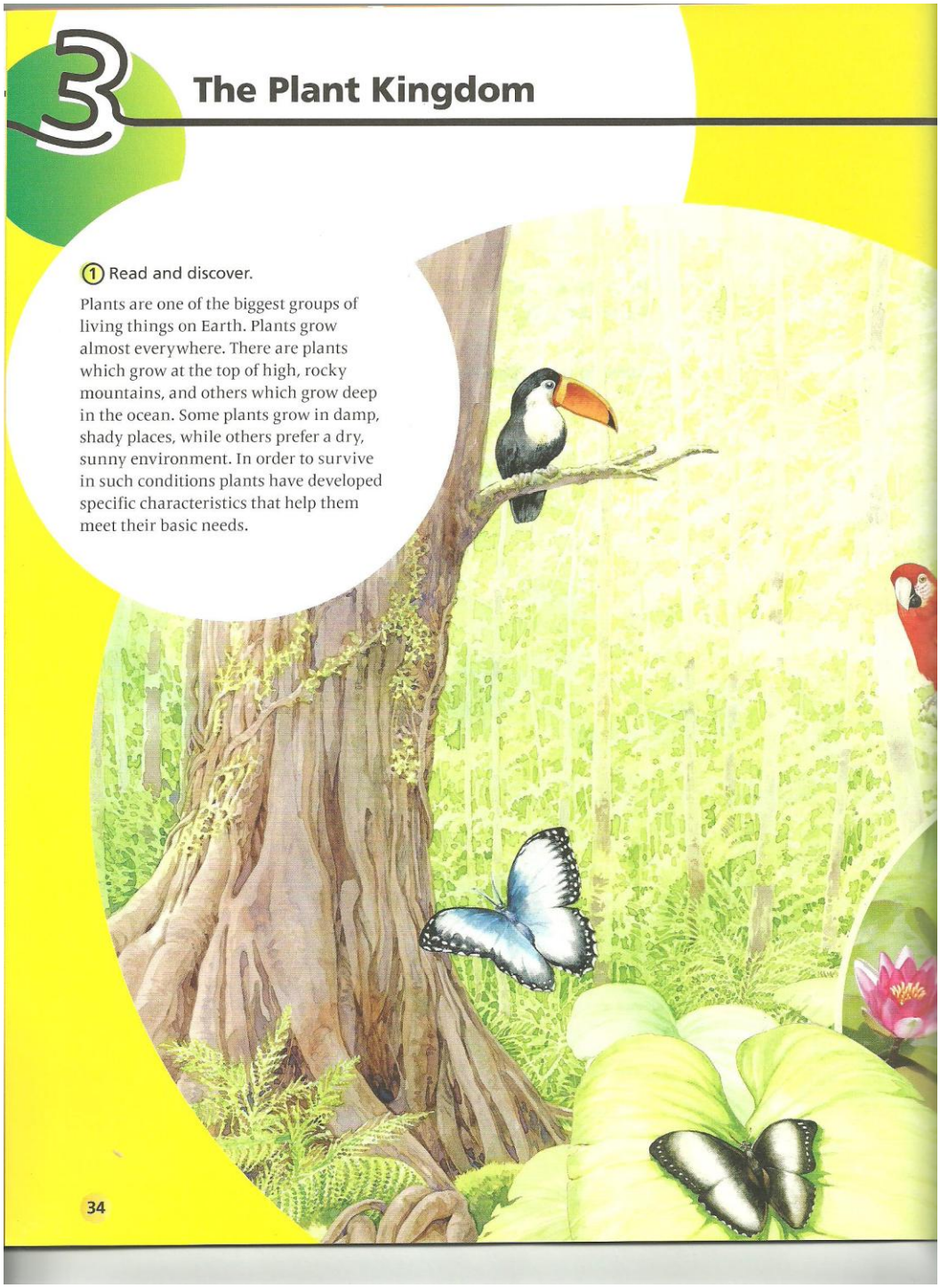
  Mountains are raised parts of the Earth's surface.

- Which mountains are closest to your home? What is their altitude?

M. A. ...*Valleys are low areas between mountains. A plateau is a plain at a high altitude. Coastal plains are flat land near the coast.*

APPENDIX 5

L1 book. Edelvives publishing house. 5th Year of Primary Education. 2014



3 The Plant Kingdom

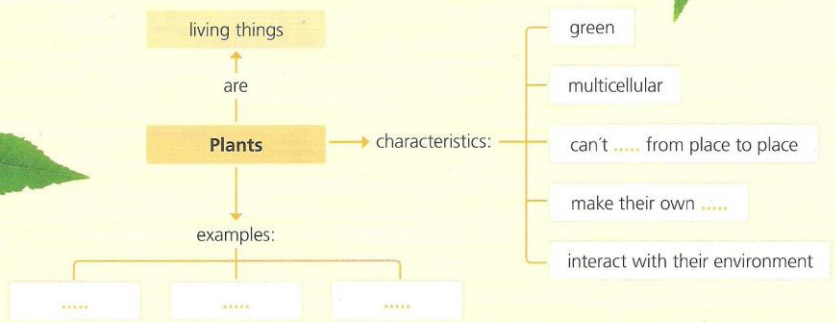
1 Read and discover.

Plants are one of the biggest groups of living things on Earth. Plants grow almost everywhere. There are plants which grow at the top of high, rocky mountains, and others which grow deep in the ocean. Some plants grow in damp, shady places, while others prefer a dry, sunny environment. In order to survive in such conditions plants have developed specific characteristics that help them meet their basic needs.

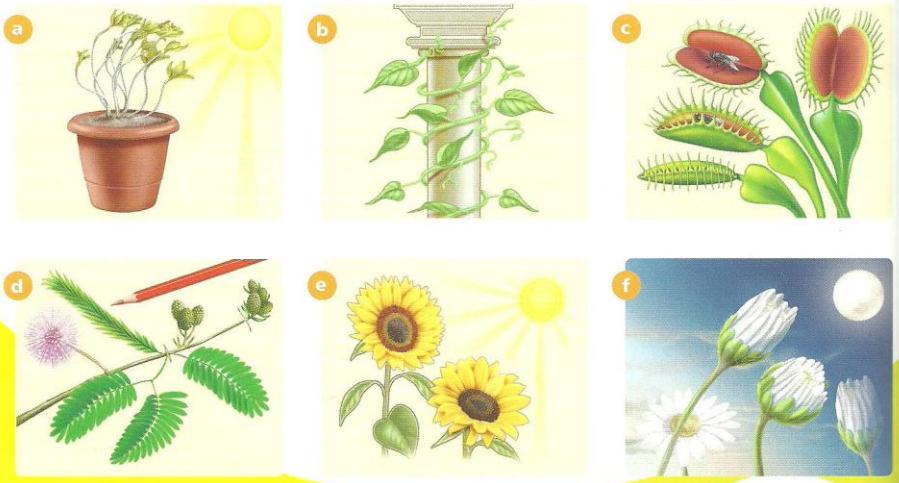
34

Analyse and organise

① Look at the diagram about plants. Think of the missing words. Then, in your notebook, write complete sentences using the information available.



② Plants interact with their environment in many different ways. Look at the pictures below. How do these plants react to the environment?

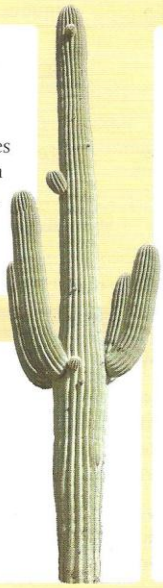


③ Read the texts and match the headings to the paragraphs.
There is one extra heading.

Pollination	Use of water	Sensitivity to touch	Nutrition

1

The **Venus flytrap** is famous for being a carnivorous plant, but it can also make its own food like any other plant. This plant catches insects because it does not obtain sufficient nutrients from the soil. It has to supplement its diet by absorbing the nutrients in insects.



2

Like all cacti, the **Saguaro cactus** grows in a hot, dry environment. It has adapted in order to survive. The Saguaro cactus has a large, thick stem which can expand to store water. The stem has sharp thorns to prevent animals from eating the plant. Saguaro cacti can live up to 200 years. An adult plant measures 12 to 18 metres.

3

Most **flowers** have brightly coloured petals that attract insects. When an insect feeds on a flower, pollen grains stick to its body. When the insect flies to another flower, it leaves some pollen grains there.

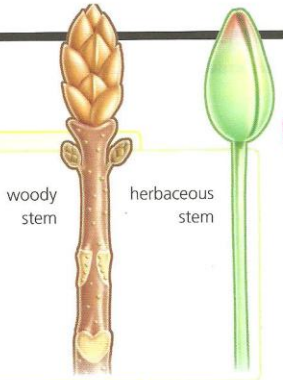
④ Listen to the recording about the giant water lily.
In your notebook, complete the missing information.

- **Scientific name:** *Victoria* .....
- **Habitat:** the ..... River
- **Leaves:** large (up to ..... metres) and strong (can hold up to ..... kilogrammes)
- **Flower:** ..... or purple; lives only for ..... days

Stem

The **stem** holds up the other parts of the plant. It also transports materials to and from the leaves. Water and minerals travel through the stem to the leaves for photosynthesis. The food produced through photosynthesis then travels to the other parts of the plant.

What do we call the stem of trees?

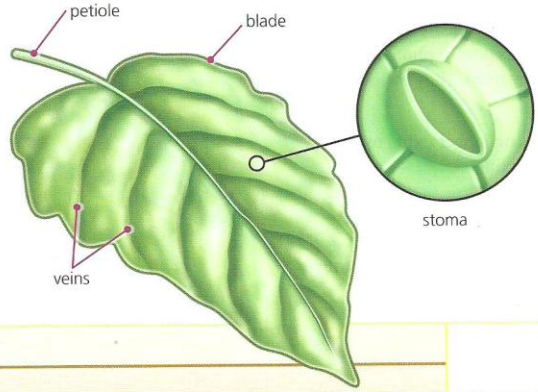


Did you know?

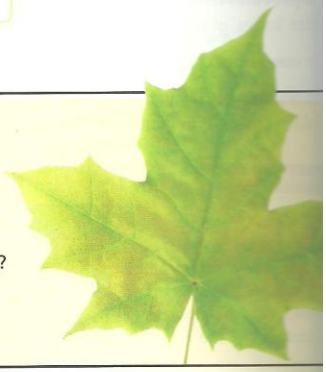
There is one species of sea slug that produces its energy through photosynthesis. These slugs eat algae but don't fully digest them. The remaining algae continue conducting photosynthesis inside the sea slugs and provide them with food.

Leaves

Leaves contain **chlorophyll**, a green substance which is necessary for photosynthesis. Most leaves have two parts: the **petiole** and the **blade**. **Veins** in the blade support the leaf and carry water and minerals. On the underside of the blade, there are tiny holes, called **stomata**. The gas exchange in leaves takes place through stomata.



1. Name the main parts of plants and their functions.
2. Look for a green leaf and identify its main parts. Can you name the plant your leaf comes from? Draw the leaf in your notebook and compare it with your friends' leaves.
3. What would happen if plants had no roots, stem or leaves?
4. Choose a plant. Then, in your notebook, draw it and label its parts.



Science Project provided by an L2 book. Edelvives publishing house. 5th Year of Primary Education. 2014

SCIENCE PROJECT: Acid rain and plants

Aim

Observe and understand the negative effects of acid rain on plants.

Hypothesis

I think that the plants watered with acid water ...

- will be seriously damaged, or
- will not be harmed.

- 2 small potted plants of the same kind
- tap water
- white vinegar
- 2 empty spray bottles
- a measuring cup
- a teaspoon

Method

1. Label one pot 'tap water' and the other 'acid water'.
2. Put the plants under a direct source of light.
3. Pour tap water into one of the empty spray bottles. Label it 'tap water'.
4. Mix 2 cups of tap water with 4½ teaspoons of vinegar. Stir well and pour the solution into the other spray bottle labelled 'acid water'.
5. Water and spray the plant labelled 'tap water' with tap water daily.
6. Water and spray the plant labelled 'acid water' with the vinegar solution daily.

Test

- Examine both plants after one week. What do you observe?
- Do you notice any difference in leaves' colour and appearance between the two plants?

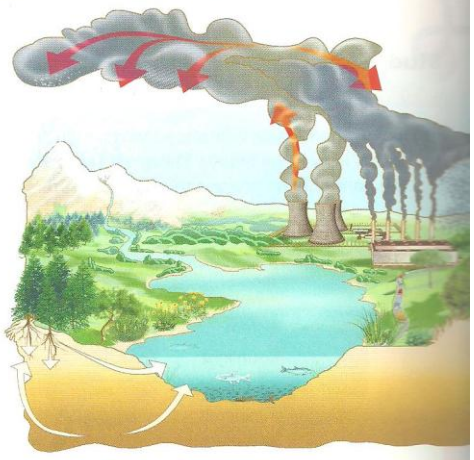
Conclusions

1. Why do you think it was necessary to add vinegar to the second spray bottle?
2. What is the effect of acid rain on plants?
3. What do you think will happen in the end if you carry on watering the plant with acid water?
4. Think what would happen if you grew a plant from seeds watering it just with acid water.
5. Was your hypothesis correct?

44

FRAGILE WORLD: Acid rain

What is acid rain?



Acid rain is any type of precipitation that has a high level of acid. It can be in the form of rain, snow, sleet or even fog. Most acid rain is the result of human activity. When we burn fossil fuels in power plants, cars or factories, large amounts of sulphur dioxide and nitrogen oxides are released into the atmosphere where they react with water and create sulfuric and nitric acid. These acids fall to the ground in precipitation and are introduced into water systems, such as rivers, lakes and oceans. Increased water acidity is deadly to plants and animals, takes away nutrients from the soil and releases large quantities of toxic aluminium. Acid rain is also harmful to humans because it can cause respiratory diseases.

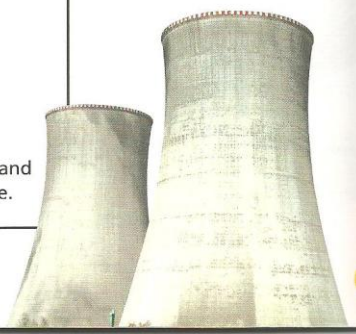
Reducing acid rain

The most effective way to avoid acid rain and its harmful effects is to reduce emissions of sulphur dioxide and nitrogen oxides. We can help achieve this by following a few simple steps:

- Use alternative energy sources.
- Turn off lights and electrical appliances when we are not using them.
- Use energy efficient appliances.
- Use public transport.
- Plant trees.

Acid rain effects on a forest

1. What is the main cause of acid rain?
2. What are alternative energy sources?
3. What do you think will happen if we don't reduce the emissions of harmful gases?
4. Acid rain also damages buildings, monuments, statues and cars. Think of the possible consequences of this damage.



APPENDIX 6 Quantitative analysis. Book 1. (L2)

	Unit 1		Unit 2			Unit 3		Unit 4			Unit 5			Unit 6			Unit 7			
Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Pages of the teacher's book	19	21	26	27	28	34	35	42	44	45	50	51	52	58	59	60	68	69	71	
Posing questions that can be investigated empirically	1	1		1		1		1					1	1	1	1	1			10
Doing experiments	1	1		1	1	1		1		1		1	1		1	1	1	1	1	14
Observating and measuring			1	1	1				1				1		1		1		1	8
Collecting and recording data			1		1		1		1		1			1						6
Representing data							1													1
Formulating hypothesis and making predictions	1				1	1		1							1					5
Looking for evidences and regularities		1			1	1		1	1	1		1	1			1	1	1	1	12
Controlling variables					1			1	1											3
Learning data/theory/model				1			1							1						3
Explaining results and conclusions		1				1		1	1	1		1	1		1	1	1	1		11
Discussing about data	1	1																		2
Writing about data							1													1
Generalizing																				0
Reporting		1				1		1	1	1		1	1		1	1	1	1		11
Total	4	6	2	4	6	6	4	7	6	4	1	4	6	3	6	5	6	4	3	
Simple experiments					1			1	1						1					4
Simple illustrations	1	1		1		1				1		1	1				1	1	1	10
Simple observations			1				1				1			1						4
Simple searches																				0
Total																				18

APPENDIX 7

Quantitative analysis. Book 2 (L1)

	Unit 1			Unit 2		Unit 3		Unit 4		Unit 5		Unit 6		Unit 7	
Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Pages of the book	14	15	17	28	29	43	45	56	57	69	71	85	87	97	
Posing questions that can be investigated empirically														1	1
Doing experiments or hands-on activities									1					1	2
Observating and measuring	1	1		1	1	1						1		1	7
Collecting and recording data			1					1					1	1	4
Representing data	1	1			1				1	1					5
Formulating hypothesis and making predictions															0
Looking for evidences and regularities						1								1	2
Controlling variables						1								1	2
Learning data/theory/model			1			1		1							3
Explaining results and conclusions				1		1					1		1	1	5
Discussing about data			1				1				1				3
Writing about data		1													1
Generalizing															0
Reporting							1	1			1				0
Total	2	3	3	2	2	5	2	3	2	1	3	1	2	7	
Simple experiment														1	1
Simple illustration															0
Simple observation	1	1	1	1	1	1					1	1	1		9
Simple searches							1	1		1					3
Total															13

APPENDIX 8 Quantitative analysis. Book 3 (L1)

	Unit 4	Unit 5			Unit 6			Unit 7	Unit 9	Unit 10			Unit 11	Unit 12	Unit 13			Unit 14			Unit 15	
Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
Pages of the book	36	41	47	48	53	56	57	64	80	88	89	93	102	110	118	119	119	123	126	127	140	
Posing questions that can be investigated empirically			1	1							1	1							1		1	6
Doing experiments or hands-on activities						1	1						1	1								4
Observating and measuring	1					1		1					1	1								5
Collecting and recording data	1			1	1		1			1	1	1			1	1	1	1	1	1	1	14
Representing data									1						1							2
Formulating hypothesis and making predictions			1											1								2
Looking for evidences and regularities	1					1				1				1								4
Controlling variables																						
Learning data/theory/model						1		1	1				1									4
Explaining results and conclusions	1				1	1	1				1		1	1		1	1			1		10
Discussing about data		1		1		1												1	1		1	6
Writing about data		1		1	1			1			1	1				1	1				1	9
Generalizing																						
Reporting				1							1		1							1	1	5
Total	4	2	2	5	3	6	3	3	2	2	5	3	5	5	2	3	3	2	3	3	5	
Simple experiment																						
Simple illustration						1							1	1								3
Simple observation	1		1	1				1	1		1				1						1	8
Simple searches		1			1		1			1		1				1	1	1	1	1		10
Total																						21
Cooperative learning		1										1							1			

APPENDIX 9 Quantitative analysis. Book 4 (L1)

	Unit 1						Unit 2				Unit 3						Unit 4				
Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Pages of the book	13	22	23	26	26	26	29	38	40	44	47	49	53	54	55	58	61	65	70	74	79
Posing questions that can be investigated empirically		1													1	1					
Doing experiments or hands-on activities													1	1							1
Observating and measuring			1	1				1					1		1						1
Collecting and recording data	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1	1	1
Representing data			1	1	1						1			1			1		1		1
Formulating hypothesis and making predictions																					
Looking for evidences and regularities		1			1					1			1		1						1
Controlling variables																					1
Learning data/theory/model					1					1						1	1				1
Explaining results and conclusions		1								1			1		1	1					1
Discussing about data																					1
Writing about data	1		1		1	1	1	1	1		1	1		1			1	1	1	1	1
Generalizing																					
Reporting		1														1	1				1
Total	2	5	4	3	5	2	2	3	2	4	3	2	4	4	4	5	5	2	3	2	11
Simple experiment																					1
Simple illustration								1		1			1								
Simple observation			1	1										1	1		1	1			
Simple searches		1			1	1	1		1		1	1				1			1	1	
Cooperative learning	1						1		1	1	1						1				1

Unit 5						Unit 6							Unit 7			
22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
81	83	90	91	94	94	97	100	103	105	108	108	108	110	115	122	
									1	1	1					6
			1	1			1	1	1	1	1			1		11
			1	1			1	1	1	1				1	1	14
1	1	1			1	1						1	1			26
					1	1				1	1	1				13
			1				1	1	1							10
									1		1					3
				1	1									1	1	9
				1	1				1	1	1					11
									1							2
1	1	1	1			1						1	1		1	23
					1											1
		1							1							6
2	2	3	4	4	5	3	3	3	8	5	5	3	2	3	3	
									1							2
		1		1			1	1		1	1			1		10
			1													7
1	1	1			1	1						1	1			17
																47
1						1						1			1	

APPENDIX 10

Quantitative analysis. Book 5 (L2)

	Unit 3 Plants		
Activities	1	2	
Pages of the book	41	44	
Posing questions that can be investigated empirically		1	1
Doing experiments or hands-on activities	1	1	2
Observating and measuring		1	1
Collecting and recording data		1	1
Representing data	1		1
Formulating hypothesis and making predictions		1	1
Looking for evidences and regularities		1	1
Controlling variables		1	1
Learning data/theory/model			
Explaining results and conclusions		1	1
Discussing about data		1	1
Writing about data			
Generalizing			
Reporting		1	1
Total	2	10	
Simple experiment		1	1
Simple illustration			
Simple observation	1		1
Simple searches			

APPENDIX 11

Quantitative analysis. Book 6 (L1)

	Unit 3 Plants			
Activities	1	2	3	
Pages of the book	59	60	65	
Posing questions that can be investigated empirically	1			1
Doing experiments or hands-on activities				
Observating and measuring	1			1
Collecting and recording data	1	1	1	3
Representing data		1		1
Formulating hypothesis and making predictions			1	
Looking for evidences and regularities			1	
Controlling variables				
Learning data/theory/model			1	1
Explaining results and conclusions	1			1
Discussing about data				
Writing about data		1		1
Generalizing				
Reporting				
Total	4	3	4	
Simple experiment				
Simple illustration			1	1
Simple observation	1	1		2
Simple searches				0