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Grado en Educación Primaria

Trabajo Fin de Grado

BRINGING SCIENCE TO LIFE:
THE BENEFITS OF STORYTELLING IN
NON-LINGUISTIC DISCIPLINES

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RESUMEN

Este Trabajo Fin de Grado focaliza en la lectura como destreza fundamental para la enseñanza de una lengua extranjera en niveles de la Educación Primaria. El primer objetivo, por ende, es dar cuenta de los beneficios de la lectura en el proceso de enseñanza y aprendizaje de lenguas. El segundo objetivo se dedica a la presentación de distintas formas de incorporar la lectura en el aula. El tercer y último objetivo es crear una retahíla de posibles recursos literarios que se pueden utilizar para la asignatura de Ciencias Naturales.

Palabras clave: Lectura en Voz Alta, Lectura Compartida, Lectura Voluntaria, Aprendizaje Incidental, Literatura Infantil, Ciencias Naturales.

ABSTRACT

This Final Degree Project focuses on reading as a fundamental skill for the teaching of a foreign language at the Primary Education level. The first objective, therefore, is to account for the benefits of reading in the process of teaching and learning languages. The second objective is dedicated to the presentation of different ways of incorporating reading in the classroom. The third and final objective is to create a collection of possible literary resources that can be used for the subject of Natural Science.

Key words: Read-alouds, Shared Reading, Free voluntary reading, Incidental learning, Children's literature, Natural Science

1. INTRODUCTION

The following *Trabajo Fin de Grado* (TFG) is the product and synthesis of four years of undergraduate work and study carried out at the University of Valladolid between the years 2015 and 2019. Although the formal construction of this paper began in the fall of 2018, this TFG has been ruminating in my subconscious since I began teaching English as a Foreign Language in 2005.

Many are aware that the field of education is characterized by the "pendulum effect" which in turn makes this specific field of study susceptible to educational trends and fads that cause the public and many teachers to believe in certain "myths or beliefs" related to language learning and teaching.

For years as a private English teacher, multiple clients would inform me that what they really needed in order to become linguistically competent and the only thing they really wanted were conversation classes. Coincidentally, these students were always the students who had studied the longest and yet never achieved a competent level in English. Nevertheless, they were insistent that they were going to learn English following an "immersion method" but within the context of Spain.

The belief that you only need exposure to learn a language has percolated into the Spanish Educational System. Proof of this is the high sum of money spent every year to bring over auxiliary conversation partners from abroad to cover the demand of creating an immersion environment within a foreign context.

Unfortunately, this listening only mentality or belief to language teaching and learning is a highly inadequate way of becoming fully competent in a language for the following reasons:

1. It foments educational malpractice.
2. It supplies an extremely limited and restricted scope of linguistic input.
3. It ignores the existence of different types of learning styles (visual, audio y kinetics) focusing on only one learning style.

A more adequate way of becoming fully competent in a language is through working and developing the basic skills necessary to become not only linguistically competent but developing communicative competence as well as through the acts of reading and shared reading.

2. OBJECTIVES

The following TFG has three specific objectives. The first objective is to highlight the importance of reading in Primary Education. At present time there is, in many contexts, no emphasis placed on this process while the Decree 26/2016, of July 21 specifically states within the section of methodological orientations that: "It is essential to establish reading strategies within the classroom from the first levels, using different techniques such as listening to the teacher read aloud, shared reading, library books, newspapers and magazines, articles of interest to students and teaching methods related to the learning of letter sounds, word groups and syllables" (pg. 34467).

The second objective is to give an account of the universal benefits of reading and ways of incorporating reading in the classroom.

The third and final objective is to create a collection of possible literary resources that can be used specifically to enrich the learning experiences in the subjects of Natural Sciences. In order to do this, not only the specific scientific content of several books have been analysed but also the level of the linguistic input found within them, determining which of the purchased books are appropriate for the Spanish Educational Context.

Apart from the three specific objectives that I have mentioned above, the overall aim of this paper is to create a discussion within the field of language teaching. The current educational trend that focuses specifically on listening and exposure to the second seems to be greatly hindering the initiatives of many foreign language teachers.

Learning a language is a long and arduous process and the four skills—listening, speaking, reading and writing—are necessary in order to improve our linguistic competence. Although many will try to sell quick fixes and miracle remedies, without hard work, learning a second language is nowhere near as straightforward and simple as learning our first language.

3. THEORETICAL JUSTIFICATION

More than a decade has passed since the Orden Edu/6/2006, from the 4th of January, gave way to the creation of Bilingual sections within publicly funded schools. Although a considerable amount of time has passed, the debate surrounding bilingual education continues to be a hot topic.

As of today, more than 500 primary and secondary schools are operating a bilingual section (Consejería de Educación, 2018). This increasing scope of bilingual education in Spain has caught most people by surprise. Many are unaware that this bilingual initiative stems from European policy that aims to create a united plurilingual society (Beacco and Byram, 2007), thus better preparing individuals for the globalized and interconnected future that awaits us.

Although many parents agree that the knowledge of a second language opens doors within the labour market, many are very hesitant as to how one should proceed in gaining this knowledge. In many cases, they fail to see the bigger picture and focus rather on what they have at hand, their present and past experiences with language learning as an isolated subject. Many have formed and maintain an unwavering opinion as to what they think is a right or wrong way to learn languages, but few have stopped to think about how language teaching has evolved throughout the years nor have they stopped to think about the process of language acquisition and learning. Most base their opinions on anecdotal evidence and few (learners and teachers alike) have stopped to compare their anecdotal evidence to scientific evidence.

3.1 Theoretical approaches to how languages are learned

How languages are learned is a mysterious and miraculous phenomenon. All of us have learned to speak a language, yet very few of us have stopped to appreciate how we have achieved this amazing feat. It wasn't until the late part of the 19th century and early part of the 20th century that people began to analyse and study languages at all. Not until the works of Ferdinand Saussure did people think that languages could be studied as a science using data collection and analysis. This interest of studying language as a science gave way to the birth of the field of study known as Linguistics (Johnson, 2001, pg. 40).

The field of Linguistics has heavily influenced the way we learn and study languages as well as being responsible for creating trends and fades regarding how people think that languages are actually learned.

As the field of linguistics has grown and expanded throughout the years, it has shaped different theoretical approaches that have influenced how we as a society think languages are learned. As of today, there are three basic theoretical approaches to how first languages are learned that continue to influence the foreign language learning classroom.

The first of the three basic theoretical approaches to first language learning, *behaviourism*, began to make its presence in the language learning classroom in the 1940s and 1950s. Most are aware that the behaviourist school of thought is very present in our current educational system with the use of operant conditioning (reinforcement and punishment) being used on a daily basis. But few are aware of how the behaviourist theory has entered the language learning classroom. If your language teacher has ever told you to repeat and repeat, you have directly experienced this approach to language teaching and learning. Behaviourists believe "that language learning is the result of imitation, practice, feedback on success and habit formation" (Lightbrown and Spada, 2003, pg. 9), the core principals of behavioural psychology.

But what behaviourists don't account for is our ability to use and create language that we have not been exposed to before; extrapolating structures and meanings and applying them to other contexts. The second of the three basic theoretical approaches to how first languages are learned, *innatism*, believes that we, as humans, are less like Skinner's dog than the behaviourists assumed and have an innate predisposition for learning languages. These innatists, like Norm Chomsky, noticed that children are capable of discovering specific grammatical rules and applying them correctly in new situations without specific instruction. This observation led innatists to believe that humans "are biologically programmed for language" (pg. 15) and that "language develops in just the same way that other biological functions develop." (pg. 15). Chomsky also argued that apart from learning languages, we are able to acquire them using a device we have in the brain that he referred to as a "language acquisition device (LAD)". This LAD is what could possibly cause children, on a universal level, to "develop language in similar ways and on a similar schedule, in a way not very different from the way all children learn to walk." (pg. 15). If you have ever had a language teacher who didn't believe in correcting your mistakes, thinking that they would eventually fix themselves you have then experienced the influence of innatism in the language learning classroom (Lightbrown and Spada, 2003, pg. 15-17).

The third theoretical approach to how first languages are learned that has made itself present in the foreign language classroom is called *interactionism*. The interactionist position is a

reaction to the two previous theoretical approaches. These researchers asked what role the environment played in our first language learning experiences arguing that language develops entirely from social interaction. Psychologists like Piaget and Vygotsky placed an increased emphasis on the environment that surrounds the learner. Vygotsky in particular argued that "in a supportive interactive environment, the child is able to advance to a higher level of knowledge and performance than he or she would be capable of independently" (Lightbrown and Spada, 2003, pg. 23). If perhaps within the language learning classroom you have been asked to debate a topic with a classmate, you have felt a consequence of this third theoretical approach to how first languages are learned.

3.2 The myths that lead to educational malpractice

As alluded above, these theoretical approaches to first language learning have entered into the foreign language classroom. The aim of this paper however is not to argue how these theories have helped to create Second Language Acquisition theory but rather to show how a novel understanding of the workings of these theories have, in some cases and contexts, caused language teachers in Primary Education to focus only on one theory.

If an educator believes the most efficient way of learning is through repetition, they will support their beliefs in behaviourists' theories and perhaps create a language learning environment that only fosters this type of activity. Such environments can be found in classrooms that use the *audiolingual method*. In the audiolingual method the learner's native language is rarely used and grammar points are briefly introduced but the main focus is on the repetition of drills that incorporate the grammar point. People who support this idea believe "that learning a language is largely a question of habit formation, and for this reason a good part of the lesson is spent on drills, in an attempt to make using the grammar point an automatic habit" (Johnson, 2001, pg. 10).

If one believes that "learners can 'pick up' a foreign language in much the same way as children 'pick up' their native language" (Johnson, 2001, pg. 10) they will support their beliefs in innatist language learning theories and look to create an immersion setting within a foreign context.

However if one bases their instruction on interactionists theories of how languages are learned they may try to enrich their learning environment using *TPR* "where a close relationship between words and actions is developed" (Johnson, 2001, pg. 9) or spending time creating input that is more comprehensible for the learners.

The behaviourists, the innatists and the interactionists have all contributed to how we as a general pubic feel that first languages are learned. These theoretical approaches have heavily influenced second language acquisition theory (SLA). Unfortunately, a novice understanding of the theoretical approaches to how first languages are learned can lead to educational malpractice in the foreign language classroom leading some teachers to abide by the theories that they remember rather than looking to grasp a more universal comprehension of the subject on a whole. It could be for this reason that we so frequently see the pendulum effect within language learning environments and classrooms. A successful teacher needs to be aware that a mix of methodologies that are supported by all three of the basic first language acquisition theories is the best approach to follow in all classrooms.

3.3 Natural Input and its limitations

Currently, the Spanish Educational System and Spanish society as a whole is literally immersed in an *immersion craze*. As mentioned previously, as of 2018 more than 500 primary and secondary schools are operating a bilingual section (Consejería de Educación, 2018).

In a foreign setting, it is very difficult to offer enough varied and rich input for the children to be able to truly acquire a fluent command of the foreign language. The input in many cases is specifically limited to what the children can understand, creating a certain holding pattern from which it is very difficult to move on from.

Another aspect in this listening only approach that seems to be frequently overlooked is that for learning to actually occur some sort of cognitive challenge needs to be present. Many times simple conversation with a native speaker or fellow classmate does not provide enough cognitive challenge for it to be motivating or interesting for the students. As Do Coyle states in "Planning Tools for Teachers" (2005, pg. 9), "the greatest challenge for CLIL teachers is to develop materials and tasks which are linguistically accessible whilst being cognitively demanding."

As language teachers we have to ask ourselves, if we believe in this speaking and listening approach to language teaching, if we really think we are capable of providing enough varied, rich and cognitively challenging input within the confines of a school setting to create truly proficient English speakers.

3.4 Learners and their individual learning styles

Another question of concern within this speaking / listening only approach to language teaching and learning apart from the question of whether teachers are truly able to provide enough varied and rich input to create proficient levels in the foreign language, is the question of learners and their individual learning styles. Learning styles are considered "cognitive, affective, and physiological traits that are relatively stable indicators of how learners perceive, interact with and respond to the learning environment" (Keefe, 1979, pg.4). Many different learning styles have been identified by educators and psychologists alike and they include "just about every imaginable sensory, communicative, cultural, affective, cognitive and intellectual factor" (Brown, 2000 pg. 114). Although there is a plethora of learning styles that should be taken into account when preparing lessons for foreign language students, for the sake of this paper, I wish to focus on the differences between visual and auditory learning styles.

According to Brown in (2000) *Principles of Language Learning and Teaching* "visual learners tend to prefer reading and studying charts, drawings, and other graphic information, while auditory learners prefer listening to lectures and audio tapes" (pg. 122). Research carried out in the United States during the late 1970s and early 1980s demonstrated that learners have four basic channels for learning: visual, auditory, kinaesthetic, or tactile. Dunn and Dunn (1979), after distributing self-reporting questionnaires to students to discover their preferred learning styles, discovered "that 20-30% of school age children appear to be auditory learners, that 40% are visual, and that the remaining 30-40% are tactile/kinaesthetic, visual/tactile, or some other combination" (Reid, 1987, pg. 90). Furthermore, "Price, Dunn, and Sanders (1980) found that very young children are the most tactile/kinaesthetic and that there is a gradual development of visual strengths through the elementary grades, and that only in fifth or sixth grade can most youngsters learn and retain information through the auditory sense" (Reid, 1987, pg. 90). If this holds to true, it would seem that a teaching approach based solely on listening should be deemed inadequate for young learners of a foreign language.

In a more recent article "Lessons on Effective Teaching from Middle School ESL Students" (2006) a group of six Mexican immigrant students from Texas were examined to determine their learning styles among other things. The study found that this specific group of ESL students "were not auditory learners and did not like just being told what to do. They preferred a visual support be provided in each lesson, and they all liked concrete examples" (pg. 41-42).

This being said, it would seem that a teaching approach that is based solely on creating auditory input for the students is only attending to the needs of a small percentage of the class. As a profession, we should be looking for ways to meet all the demands and requirements of the students and not just a few. One way of catering to these visual learners, which seem to be the majority of learners in Primary Education, is through reading and shared reading.

4. FOMENTING READING WITHIN THE BILINGUAL CONTEXT

As mentioned in the objectives section of this document the Decree 26/2016, of July 21, specifically states within the section of methodological orientations that: "It is essential to establish reading strategies within the classroom from the first levels, using different techniques such as listening to the teacher read aloud, shared reading, library books, newspapers and magazines, articles of interest to students and teaching methods related to the learning of letter sounds, word groups and syllables" (pg. 34467). In order to carry out these activities a wide range of materials and books in the L2 language are necessary.

Yet, it seems schools are hesitant to dedicate funds towards the acquisition of reading material in English. Perhaps, the schools are afraid of the acquired resources not being used or perhaps they are unsure of how to integrate English readings into the classroom activities or they are unsure as to what resources they should acquire. As mentioned previously one of the objectives in this paper is to highlight the universal benefits of reading and ways of incorporating reading in the classroom.

4.1 The benefits of free voluntary reading

The act of 'free voluntary reading' (FVR), as Krashen has coined the termed, refers to the act of reading because you want to. It involves no book reports and in some cases it doesn't even involve finishing the book if you don't like it (Krashen, 2004, pg.1).

In the book *The Power of Reading* (2004) Krashen argues that "FVR is the missing ingredient in first language "language arts" as well as intermediate second and foreign language instruction," (pg. 1) while stating that FVR (pg. x) "is one of the best things a second language acquirer can do to bridge the gap from the beginning level to truly advanced levels of second language proficiency."

Krashen presents a multitude of reasons and evidence that supports the benefits of FRV. The most pertinent of the findings to the context of Primary Education is in regards to reading and "incidental" learning. Incidental learning can best be described as learning that occurs without the learner being aware of it. Incidental learning is tested through read and test studies where students are provided with passages that contain unfamiliar words. The students are asked to read the passages for meaning and then they are tested to see if they have acquired some of the meanings of the new or unfamiliar words. Krashen uses the Clockwork Orange study (Saragi, Nation and Meister 1978) to argue his point. In this specific study students were asked to read the book *A Clockwork Orange* a novel by Antohony Burgess that contains words from a slang called 'nadsat'. The students were asked to simply read the book for comprehension. Within the book there was a total of 241 'nadsat' words and the findings showed that "an average of 76 percent—subjects picked up at least 45 words, simply by reading a novel" (Krashen, 2004, pg.14).

The idea that an individual can *pick up* or acquire new vocabulary simply by reading is incredible. It must be said that this study was carried out in the reader's native language and that perhaps in an L2 situation the findings would be less impacting. However, Krashen mentions a study that was carried out by Herman in 2003, where two groups of ESL students were tested on unknown words found in the book *Animal Farm*. One group was given a list of words to memorize and the other group was asked to read the book. The readers who memorized the list initially scored better on the vocabulary test but after three weeks, when they were tested again, there was no difference between the two test groups and those who actually read the book improved their scores (Krashen, 2004, pg.15).

Traditionally schools focus a great deal of attention to the teaching and learning of vocabulary through definitions. This perhaps is not the best route to take whether it's your first or second language considering the ease at which we tend to forget the things that we have memorized. Yet, when we acquire a word, we gain a lot of knowledge implicit in that specific word such as "many nuances of meaning and complex grammatical properties" (Krashen, 2004, pg. 19). These are elements that are not learned when one memorizes a list of vocabulary words with corresponding synonyms (Krashen, 2004, pg. 19). The article "Shared Reading to Build Vocabulary and Comprehension" (2011) supports Krashen's claim when they discuss how the use of cloze passages within a text encourages readers to use their knowledge of context to discover a word and at the same time they also discover not only synonyms of various words but how their meanings can change depending on the context that they are used in.

Although it seems obvious that FVR is a beneficial activity, few children within the Spanish public school system have the opportunity to engage in FVR due to a lack of available and appropriate books within the schools. It seems the British Council has identified this problem leading them to write the "Spanish/English primary integrated curriculum. Language and Literacy" (2015). In it, they suggest creating reading areas to motivate children to enjoy reading, stating that these areas should "ideally contain a range of fiction and non-fictions texts selected to suit the interest, cognitive level and range of ability of the children. Authentic texts and real books should be provided" (pg. 21). The British Council warns against accumulating books that have the sole purpose of being easily decodable. They also suggest allowing children to bring the books home and providing audio to the books so that the children can listen to them outside the school setting. All of these actions are simple ways to create a space for FVR to take place within school and outside of the school setting thus creating the opportunity for incidental learning to occur.

4.2 The benefits of shared reading

But what if perhaps a school decides to invest in resources expanding their school libraries and creating spaces for reading in English to take place and no one takes advantage of them. In that case, it will be left to the teachers to get the ball rolling and motivate their students to read by the simple act of reading to their students.

The act of reading to children and discussing what is read while reading is known as *shared reading* or *shared storybook reading*. This involves discussing not only what occurs in the book but also the pictures words and letters as well as feelings or responses to the books content (K. Beauchat, K. Blarney and S. Walpole, 2009). The article "Building Preschool Children´s Language and Literacy One Storybook at a Time" (2009) reminds education professionals that shared reading also supports oral language development. The article states (pg. 28), "During shared storybook reading, teachers develop children's language when they reflect upon and seize oral language development opportunities before, during and after reading. The teacher has a captive audience and a context to model rich and descriptive language (e.g. Whitehurst, Arnold, et al, 1994). (…) Hearing sophisticated comments provides children models for their own language." In addition to these benefits, within a bilingual classroom, shared reading can also create an opportunity for the teacher to correctly recast and expand on the non-native student's spontaneous responses.

Shared reading is also a very motivating way to present and practice vocabulary. While reading, the teacher can either point to the pictures of the words or ask students to actively participate by pointing to specific words within the picture. This is a very authentic way of engaging students while fomenting the reading comprehension process as well as simultaneously assessing their comprehension. The article "Shared Reading to Build Vocabulary and Comprehension" (2011) supports this idea stating that a shared reading methodology is an effective way to increase vocabulary in at risk children. It also adds that the explicit instruction during shared reading "raises these children's levels of word consciousness, which in turn might increase their abilities to notice and learn unknown words more independently and incidentally" (pg. 272).

The rereading of parts of the text also allows less time to be spent on decoding and more time to be spent on comprehension, comprehension not only of the meaning of the words but comprehension related to the implied connotations of the words (Kesler, 2011, pg. 274). Another benefit to shared reading is that the teacher can adapt and repeat parts of the story while reading, allowing them to emphasize certain structures, sequences or sounds within the book. This level of engagement and interaction is being lost through the overuse of electronic and digital media and it is something educational professionals need to be aware of.

5. THE BENEFITS OF LITERATURE

The universal benefits of reading as well as the benefits of incorporating the methodology of shared reading into the language classroom is something that should not be overlooked by the language teacher. It is also important to emphasize that the specific activity of reading is not something that should be limited specifically to linguistic disciplines, like Literature, History or Social Studies. Incorporating literature and the reading of children's literature within non-linguistic disciplines, such as mathematics and science has a multitude of benefits that should be closely considered.

The first and most beneficial aspect of including literature within non-linguistic disciplines is that it fosters creativity and feeds the imagination, two elements that are usually not innately associated with the fields of science or mathematics, yet they are the key factors to any great discovery.

Unfortunately, some (educators and students alike) still associate Mathematics and Science with memorizing facts and obtaining knowledge. It is often forgotten that Mathematics and Science are subjects that help us to understand and interact with the world around us. As educators, we should look towards teaching these non-linguistic disciplines through constructivist principles giving children "the opportunity to process and apply knowledge in meaningful situations" (Fredericks, 2008, pg. 5).

The use of Children's literature in these areas engage children in such a way that it fosters the creation of meaningful situations. At the same it allows educators to transversally develop the competences or capabilities associated with the non-linguistic disciplines such as Mathematics and Science, as referred to in the next paragraphs.

5.1 The benefits of literature in the non-linguistic discipline of Mathematics

Many mathematical skills can be fostered and developed through the use of literature. If one closely analyses the elements of the mathematical competences or capabilities outlined by PISA as Margarita Marin has in the article "Contar las matematícas para enseñar mejor" (2007) they will see that many of the skills that a good mathematician needs to acquire can be developed through the use of stories and children's literature. PISA's Assessment and Analytical Framework (OECD, 2019, pg. 80-81) includes seven fundamental mathematical capabilities, of them the capabilities of Communication, Reasoning and Argument, and

Devising Strategies for Problem Solving are perhaps the most pertinent in relation to the capabilities that are fostered through reading and shared reading.

When PISA defines the capability of *communication* it explains that:

> "Mathematical literacy involves communication. The individual perceives the existence of some challenge and is stimulated to recognise and understand a problem situation. Reading, decoding and interpreting statements, questions, tasks or objects enables the individual to form a mental model of the situation, which is an important step in understanding, clarifying and formulating a problem. During the solution process, intermediate results may need to be summarised and presented. Later on, once a solution has been found, the problem solver may need to present the solution, and perhaps an explanation or justification, to others" (pg. 80).

When one reads a story or is read a story a similar process occurs to that which mathematical literacy defines. First the reader "perceives the existence of some challenge" and then they are stimulated to predict possible outcomes while they are reading. This predicting involves interpreting and forming mental models of all the possible outcomes.

If we continue on and analyse the mathematical capability of *reasoning and argument* which is defined by PISA as involving "logically rooted thought processes that explore and link problem elements so as to make inferences from them, check a justification that is given, or provide a justification of statements or solutions to problems" (pg. 81), we can see that as one advances in their literary competences they develop similar skills. A competent reader becomes very capable of making inferences, exploring and linking problem elements within the story or text.

When a child begins to write stories, they very closely follow the mathematical processes that are involved in *devising strategies for solving problems* which is defined by PISA as involving "a set of critical control processes that guide an individual to effectively recognise, formulate and solve problems (…) devising a plan or strategy to use mathematics to solve problems arising from a task or context, as well as guiding its implementation" (pg. 81). It is hard to argue that these processes are not an integral part of story writing; formulating and solving problems and devising a plan or strategy are basic skills necessary to be able to produce stories.

5.2 The benefits of literature in the non-linguistic discipline of Natural Science

When analysing the field of Natural Science the Decree 26/2016, of July 21 states that "Natural Science helps us to discover the world in which we live, to understand our environment, to understand the interaction of people with the natural environment, to recognize the contributions of scientific and technological advances to our daily life and to value the work of those people who have contributed to the progress of human beings, understanding that science is immersed in a sociocultural context and therefore, influenced by the social and cultural values of society" (pg. 34216). PISA's Assessment and Analytical Framework (2019) supports this holistic vision of Natural Science by using a threefold description of the scientific competence. The scientific competence includes not only *content knowledge* (theories, information and facts) but also *procedural knowledge* and *epistemic knowledge* (understanding of the rationale for the common practices of scientific enquiry) (pg. 99).

The use of literature within science can help children develop all three areas of the scientific competence defined by PISA (2019). *More Science Adventures with Children's Literature* argues that when children's literature "is made a significant part of the science program, children can become involved in activities and gain experiences that they may not be exposed to in a text-based program" (pg. 13). They base their use of literature in the science classroom on the following precepts:

1. Literature provides an ever-expanding array of information in a welcome and familiar format to students.
2. Literature extends the science curriculum beyond any textbook constraints.
3. Literature relates to children's lives in diverse and divergent ways.
4. Literature, both fiction and nonfiction, helps children understand science as a universal quest for information and knowledge.
5. Literature assists children in developing positive attitudes about themselves, people in their immediate environment, and peoples from around the world.
6. Literature provides vicarious *and* first-hand experiences with all science disciplines.
7. Literature provides students with new information and knowledge unobtainable in any other format.
8. Literature stimulates creative thinking and problem-solving abilities in a variety of contexts.
9. Literature opens up the world and draws students in to make self-initiated discoveries.
10. Literature is fun!

Source: Fredericks, A. D. (2008). More Science Adventures with Children's Literature: Reading Comprehension and Inquiry-Based Science. (pg. 13) Place: Teacher Ideas Press.

6. A LITERATURE–BASED APPROACH TO SCIENCE INSTRUCTION

Although we have seen the benefits of including literature in the non-linguistic disciplines, traditionally the only reading that occurs in a Natural Science classroom is the reading of text books to obtain facts or vocabulary. Information is usually broken down and dissected into bits and pieces with the aim of making certain information easier to memorize. However, if our aim is to move towards a more constructivist approach to the teaching of Natural Science, the use of fiction can help in this process. C. Butzow and J. Butzow state in *Science through Children's Literature: An Integrated Approach* (2000, pg. 4) that "fiction can be used as a foundation for contemporary science instruction". They continue by saying that:

> "Children may find it easier to follow ideas that are part of a story line than to comprehend facts as presented in a textbook. A story puts facts and concepts into a form that encourages children to build a hypothesis, predict events, gather data, and test the validity of the events. Using fiction, the lesson becomes relevant and conceptually in tune with the child's abilities."

Through the use of fiction, children in essence are learning the basis of the scientific method. Also the use of fiction allows children to easily see that science forms a part of everyday life in a way that is "understandable, motivating, and conceptually compatible with the child's developmental stage" (pg. 4). The authors argue a very interesting point. If one of the aims of Natural Science is to help the child understand the world around them, then presenting them with the information in a contextualized format seems like it would better aid in this process.

The advantages that are inherent within a literature-based methodology are seemingly endless and should not be overlooked by educators. Fredericks (2008, pg. 13-14) highlights many of these advantages.

<p align="center">Advantages of literature-based instruction</p>

- It emphasizes and celebrates an individual's multiple intelligences in a supportive and creative learning environment.
- It focuses on the processes rather than the products of science.
- It reduces and/or eliminates the artificial barriers that often exist between curricular areas and provides and integrative approach to learning.
- It promotes a child-centred science curriculum—one in which children are encouraged to make their own decisions and assume a measure of responsibility for learning.

- It stimulates self-directed discovery and investigation both in and out the classroom.
- It assist youngsters in developing relationships between science ideas and concepts, thus enhancing appreciation and comprehension.
- It stimulates the creation of important science concepts through first hand experiences and self-initiated discoveries.
- More time is available for instructional purposes. Science instruction does not have to be crammed into limited, artificial time periods, but can be extended across the curriculum and throughout the day.
- The connections that can and do exist between science and other subjects, topics and themes can be logically and naturally developed. Teachers and librarians can demonstrate relationships and assist students in comprehending those relationships.
- Science can be promoted as a continuous activity—one not restricted by textbook designs, time barriers, or even the four walls of the classroom. Educators can help students extend science learning into many aspects of their personal lives.
- Teachers and librarians are free to help students look at a science problem, situation, or topic from a variety of viewpoints, rather than the "right way" frequently demonstrated in a teacher's manual or curriculum guide.
- There is more emphasis on teaching students and less on telling students.
- Teachers and librarians can promote problem solving, creative thinking, and critical thinking processes within in all dimensions of a topic.

Source: Fredericks, A. D. (2008). More Science Adventures with Children's Literature: Reading Comprehension and Inquiry-Based Science. (pg. 13-14) Place: Teacher Ideas Press.

After analysing the multiple advantages to teaching Natural Science through literature, it is easy to conclude that this methodology fosters a more holistic, constructivist and contemporary approach to teaching that is conceptually orientated, emphasizing applications and problem resolution while being an efficient means of motivating the learner to interact with information in a contextualized format (C. Butzow and J. Butzow, 2008, pg.4). At the same time, it fosters the development of the student's scientific competences.

6.1 Reading children's literature with fresh eyes

Now that it has been established that children's literature is a viable means of developing the mathematical and scientific competences defined by PISA as well as fostering a more constructivist and holistic science classroom, it is necessary to take a look at children's literature with fresh eyes; eyes that look beyond the surface level of content and see the inner workings of the story. C. Butzow and J. Butzow (2008, pg. 23) state that "traditionally, science writing has been considered nonfictional in nature. As a result, scientific facts and concepts in a fictional piece of literature are often overlooked because people are not specifically looking for them in this genre or because their accuracy is suspect."

A good example of this is *The Very Hungry Catepillar* by Eric Carle, a very popular story that is present in most school libraries. First published in 1969, it still remains a classic in Primary Education but few educators are aware of the mathematical and scientific concepts that are present in the story. The story accompanies a caterpillar as he eats and eats until he builds himself a house and goes to sleep. The scientific content related to Natural Science is easier to spot, the life cycle of a butterfly, whereas the mathematical content being well integrated into the story is a little more difficult to identify. According to Marin (2008) *The Very Hungry Caterpillar* contains mathematical aspects such as: the sequence of the days of the week, the numerical series for ordering and counting, the attribute size of objects and the heavy / light qualitative measure of the magnitude of weight. A closer examination of the scientific contents reveals that the question of habitat could easily be analysed by older children expanding even further into a discussion on appropriate diets for a caterpillar and how the habitat where the insect lives can influence its diet.

6.2 Resources for enriching the Natural Science curriculum and classroom

Reading is one of the most basic resources educators can use to enrich their science classes. Fredericks (2008, pg. 23) states that "reading is very much like science simply because reading—in its purest state—is how we look for answers formed inside our own heads. Like science, reading involves an active engagement with a subject or topic. It is not something done to us, but rather something that we control, manipulate, and investigate. Science instruction should be a means of helping students understand the world around them, teaching them to "seek the answers to self-initiated queries." (Fredericks, 2008, pg. 23).

6.2.1 The basics of reading comprehension

Before one begins to incorporate the reading of fiction and non-fiction books in their classroom it is necessary to understand that "the success of reading comprehension instructions is highly dependent of the opportunities provided to students for actively engaging in the dynamics of text." (Fredericks, 2008, pg. 25).

Fredericks (2008) suggests following a transactional approach to reading. In this approach it is understood that the reader and the text have an "active and energetic relationship" (Fredericks, 2008, pg. 23). This dynamic relationship is influenced by the reader's previous knowledge and unique backgrounds which converts reading into a constructive process implying "that there is an interaction between the reader's prior knowledge and the 'knowledge' in the text." (Fredericks, 2008, pg.27).

Fredericks (2008) has identified six reading principals that are necessary for reading comprehension to successfully develop. They are as follows:

Principle	Description/Explanation
Tapping into background knowledge (schema)	Background knowledge forms the foundation and the structure for all reading experiences. What readers know affects what they can learn.
Mental imagery (visualizing)	Good readers create "mind pictures" as they read. Visualizing the characters, elements, or events of a story is critical to overall comprehension.
Predicting and inferring	Good readers are able to combine background knowledge and text knowledge as they read. This helps them make "educated guesses" about the content of text throughout the reading process. These "educated guesses" take place in advance of reading as well as during the act of reading.
Questioning	Readers continually ask themselves questions throughout the text. This is done to check or confirm an understanding of the book or story. Metacognitive questions are ways in which readers self-assess their understanding as well as stay engaged with the dynamics of a story.
Identifying important ideas	Good readers are able to separate important from unimportant information in text. They can identify critical details and separate them from extraneous material.
Synthesizing and summarizing	Good readers are able to pull together all that they have read into an inclusive statement. Their comprehension is based on their ability to synthesise and summarize setting, characters, plot, theme and point of view into a single statement.

Source: Fredericks, A. D. (2008). More Science Adventures with Children's Literature: Reading Comprehension and Inquiry-Based Science. (pg. 30-31) Place: Teacher Ideas Press.

The science and language teacher needs to recognize the importance of developing these six comprehension principles within the classroom, fostering and promoting the way in which students interact with the text while understanding that it is a vital relationship that needs to be encouraged and developed.

6.2.2 Strategies to develop reading comprehension

In order to promote the way in which students interact with a text Fredericks (2008) suggests some possible comprehension strategies that can be used in the classroom. The majority of the strategies are straightforward and can be easily adapted to foreign language learners. In this section, only the strategies that can be easily adapted to foreign language learners and foreign language contexts will be presented.

The first strategy was developed by Moore and Moore (1986) and is called "possible sentences". The activity "assists students in (1) learning new vocabulary, (2) generating appropriate story predictions, (3) developing individual (or group) purposes for reading, and (4) stimulating their intellectual curiosity about a book or story." (Fredericks, 2008, pg. 34).

The activity consists of presenting the students with vocabulary from the book and asking them to create possible sentences they think they may find in the book. Then the students read the book to check if their predictions were right. The next step is to modify or revise the sentences so they better adapt to the contents of the book. The activity foments student's predictive abilities as well as helping them develop connections between prior knowledge and textual knowledge (Fredericks, 2008, pg. 34).

The next activity that adapts well to a foreign language context is called "concept cards". The activity is designed to "allow students to tap into their background knowledge about the topic of a book, share that information with classmates, and make predictions about the content of a piece of literature." (Fredericks, 2008, pg. 35). To carry out the activity, the teacher must first select 20 to 25 words from the book, mixing familiar and unfamiliar words, and then print sets of the words on index cards to be distributed to the students. The students than have to use their background knowledge and predictive skills to organize the words into categories. The next step is to have the students compare and share their categories and read the book looking for the words, making possible adjustments to the categories. The activity wraps up by having students discuss and justify any changes that they thought were necessary to make.

Another interesting activity presented by Fredericks (2008) that would work well in a second language classroom is called MM & M (Metacognitive Modeling and Monitoring). "MM & M provides readers with an opportunity to 'see' inside the mind of a reader as he or she goes through the reading process." (Fredericks, 2008, pg. 36). The activity consists of the teacher modelling, out loud, the internal dialogue that occurs while one is reading. First, the teacher

must select a passage from a book and then read it to the class. While reading, the teacher verbalizes their thought process. This verbalization process consists of five parts. It requires the teacher to verbalize thought processes in accordance with: making predictions, describing mental images, sharing analogies or background knowledge, thinking through difficult parts or vocabulary and demonstrating strategies for repairing comprehension (Fredericks, 2008, pg. 35).

A student directed activity suggested by Fredericks (2008), known as "Question Master", is aimed at "providing students with opportunities to initiate their own questions through the reading process." (Fredericks, 2008, pg. 39). This list of possible questions that Fredericks (2008) has provided is as follows.

Self-Initiated Reading Queries	
Before reading	- Is this similar to anything I have read before? - Why am I reading this? - Why would this information be important for me to know? - Do I have any questions about the text before I read it? If so, what are they?
During reading	- Am I understanding what I'm reading? - What can I do if I don't understand this information? - Why am I learning this? - Are these characters or events similar to others I have read about? - How does this information differ from other things that I know? - Why is this difficult or easy for me to understand? - Is this interesting or enjoyable? Why or why not? - Do I have any questions about this text that have not been answered so far? - What information do I still need to learn?
After reading	- Can I write a brief summary of the story? - What did I learn in this story? - Where Can I go to learn some additional information on this topic? - Did I confirm (or do I need to modify) my initial purpose for reading this text? - Is there anything else interesting I'd like to find out about this topic? - Do I have some unanswered questions from this text?

Source: Fredericks, A. D. (2008). More Science Adventures with Children's Literature: Reading Comprehension and Inquiry-Based Science. (pg. 38) Place: Teacher Ideas Press.

Fredericks (2008) also suggests enriching readings by using what is called Directed Reading-Thinking Activity (DRTA). DRTA's are "designed to allow students to make predictions, think about those predictions, and verify or modify the predictions with text, as well as stimulate a personal involvement with many different kinds of reading materials. DTRAs are guided by three essential questions, which are inserted throughout the reading and discussion of a book. " (Fredericks, 2008, pg. 43). The posed questions are as follows: "What do you think will happen next?, Why do you think so? and How can you prove it?" The questions incorporate the use of prior knowledge to make hypotheses, the justification and evaluation of predictions; three basic scientific skills that should be developed in students (Fredericks, 2008, pg. 43).

One more fun activity that can be used to support reading comprehension is called "The story pyramid" (Waldo, 1991). This is a great activity to help students create a triangular outline of the story and consists of using the following information to form a pyramid:

"Line 1: Name of the main character

Line 2: Two words describing the main character

Line 3: Three words describing the setting

Line 4: Four words stating the problem

Line 5: Five words describing the main event

Line 6: Six words describing a second main event

Line 7: Seven words describing a third main event

Line 8: Eight words stating the solution to the problem"

(Fredericks, 2008, pg. 47)

6.2.3 Possible literary resources to enrich the science classroom

The books *More Science Adventures with Children's Literature (2008)*, *Science through Children's Literature: An Integrated Approach (2000)* and *Teaching Science through Trade Books* (2012) contain a list of literary resources appropriate for the science classroom along with suggested possible activities. A list of the suggested books is provided in the annex section of this document.

After analysis, the following books could be considered appropriate resources for the Natural Science classroom within the Spanish context. All of the books are very easy to read aloud

to the class and contain contents related to the Spanish Natural Science Curriculum. A brief summary of these resources are as follows.

Title: *Parts*

Author: Tedd Arnold

Illustrator: Tedd Arnold

Story brief:

An entertaining and hilarious story of a little boy who thinks he's falling apart only to find out that the things that keep occurring to him are all part of the process of growing.
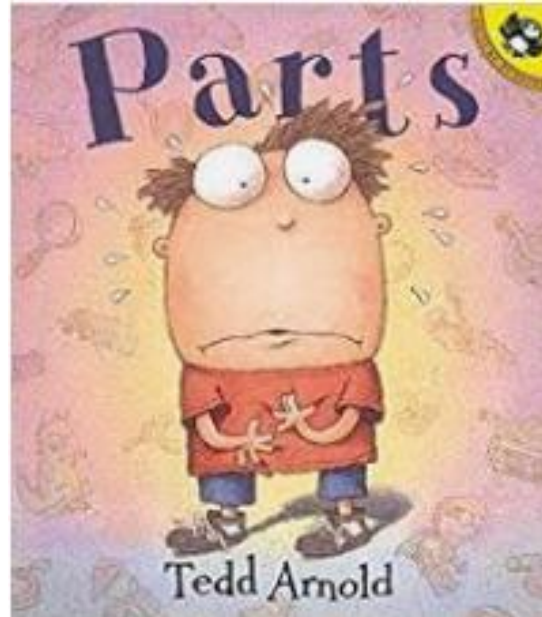
Science contents:

- Personal health; The human body and its functions

Appropriate for grades:

- 1st to 4th graders

Supports the evaluable learning standards:

- 3rd grade: Observes and identifies the changes in the human body in the different stages of life and describes its main characteristics.

Title: *Monsters Don't Eat Broccoli*

Author: Barbara Jean Hicks

Illustrator: Sue Hendra

Story brief:

Do monsters eat broccoli? The reader comes to find out that monsters much prefer other strange and crunchy things…buildings, wheels and trees; trees that look much like the broccoli that you and I eat.

Science contents:

- Personal health; The function of nutrition in the human being; Food and nutrition; Plants

Appropriate for grades:

- 1st to 4th graders
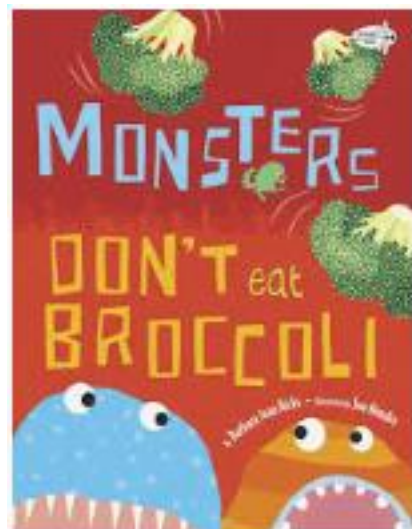
Supports the evaluable learning standards:

- 1st grade: Classifies foods according to their origin and their contribution to the diet.
- 1st grade: Identifies a plant and the parts that form it and the function of each of them.
- 2nd grade: Identifies healthy eating habits, and applies the information to design a balanced diet.

Title: *Move!*

Author: Steve Jenkins, Robin Page

Illustrator: Steve Jenkins

Story brief:

Animals have many different ways of moving. Some jump, some walk, some swim. This book helps children identify all the different types of locomotion that exists as well as the special ways some animals have to move.

Science contents:

- Classification of animals

Appropriate for grades:

- 1st and 2nd grade

Supports the evaluable learning standards:

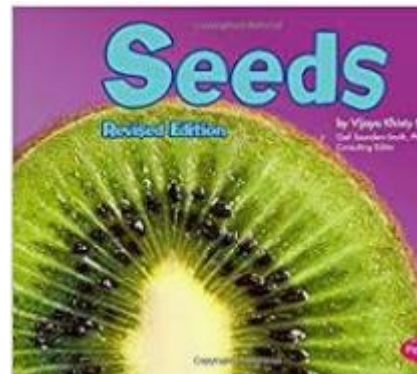- 1st grade: Observes, describes and associates the physical traits and behavioural patterns of the animals.
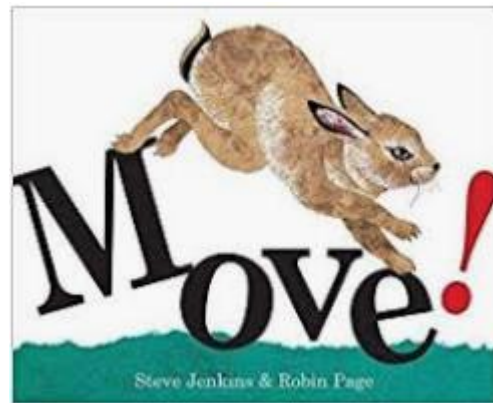
Title: *Seeds*

Author: Vijaya Khisty Bodach

Story brief:

This story teaches children that plants need seeds. It contains great illustrative pictures that highlight different seeds and how some of them grow and travel.

Science contents:

- Plants; Seeds; The Plant life cycle

Appropriate for grades:

- 1st, 2nd and 3rd graders

Supports the evaluable learning standards:

- 1st grade: Observes directly and indirectly plants.

Title: *Dandelions: Stars in the Grass*

Author: Mia Posada

Illustrator: Mia Posada

Story brief:

This story, presented as a poem, examines the life cycle of a dandelion. Its rhythm and beautiful drawings catch the attention of children and adults alike. The well incorporated scientific content makes it a great story to introduce into the science class.
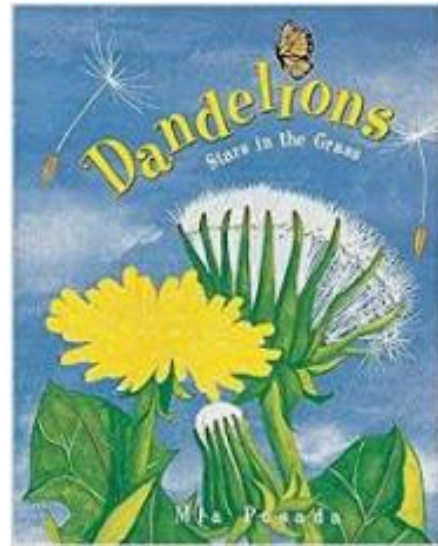
Science contents:

- Plants; The plant life cycle; seeds; Invasive species and protected species.

Appropriate for grades:

- 1st to 6th graders

Supports the evaluable learning standards:

- 5th grade: Recognizes the dangers of invasive species.

Title: *Pumpkin Circle: The Story of a Garden*

Author: George Levenson

Illustrator: Shmuel Thaler

Story brief:

This story shows how a simple seed can turn into a great pumpkin and the process that occurs. It also includes the common insects that frequent a garden.

Science contents:

- Plants; The plant life cycle; seeds; Insects; Ecosystems

Appropriate for grades:

- 1st to 6th graders

Supports the evaluable learning standards:

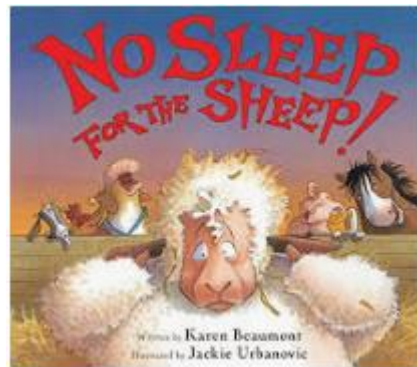- 4th grader: Observes and identifies the main characteristics and components of an ecosystem.

Title: *No Sleep for the Sheep*

Author: Karen Beaumont

Illustrator: Jackie Urbanovic

Story brief:

In this story a poor sheep tries to get some sleep but is constantly interrupted by all the animals on the farm. It's an extremely rhythmic and addicting story to read. The repetition of phrases makes it easily adaptable to a play format.

Science contents:

- Animals; Healthy habits

Appropriate for grades:

- 1st to 3rd graders

Supports the evaluable learning standards:

- 1st and 2nd grade: Observes and identifies the general characteristics of living things and classifies them according to the characterisitics.

Title: *Flicker Flash*

Author: Joan Graham

Illustrator: Nancy Davis

Story brief:

A collection of poems about different light sources makes this a great book to use in art class. The words of the poems are used to create images.
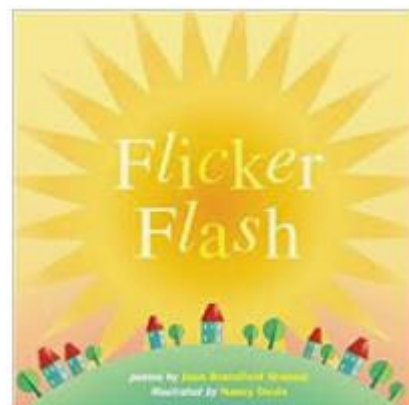
Science contents:

– Light and light sources

Appropriate for grades:

– 1st to 6th graders

Supports the evaluable learning standards:

– 4th grade: Plans and carries out simple experiences to observe and study reflection and refraction, and the decomposition of white light, making explanatory predictions about the results.

Title: *My Five Senses*

Author: Aliki Brandenberg

Illustrator: Aliki Brandenberg

Story brief:

A great story to use for beginners who are just starting to explore their senses. Engaging text and great pictures help young readers understand how they use their senses.
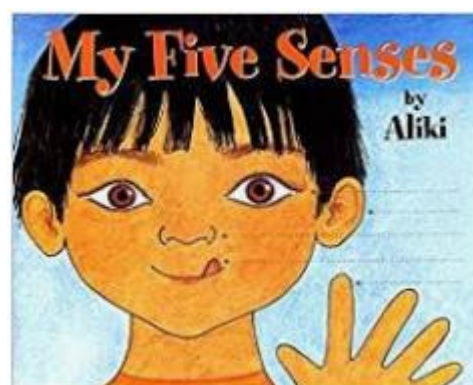
Science contents:

– The five senses

Appropriate for grades:

– 1st graders

Supports the evaluable learning standards:

– 1st grade: Recognizes the five senses.

Title: *If You Find a Rock*

Author: Peggy Christian

Illustrator: Barbara Hirsch Lember

Story brief:

This poetic text talks about all the different imaginative ways a rock can be used. A great story that helps bring wonder and creativity to units about rocks.
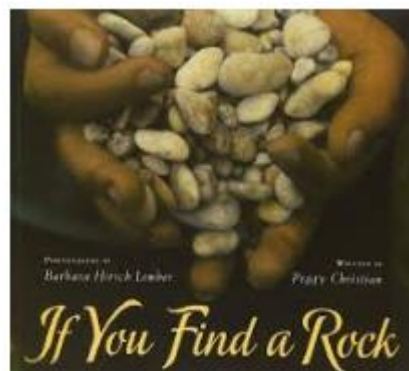
Science contents:

– Rocks

Appropriate for grades:

– 2nd to 3rd graders

Supports the evaluable learning standards:

– 2nd grade: Describes some rocks and minerals classifying them according to their color, shape, and plasticity.

– 3rd grade: Observes, identifies, and explains the composition of rocks by naming some of their types.

Title: *How Do You Lift a Lion?*

Author: Robert E. Wells

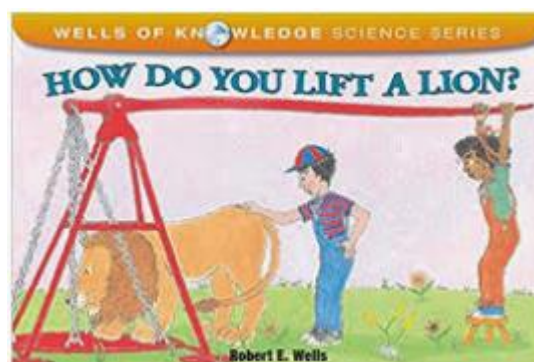**Illustrator:** Robert E. Wells

Story brief:

A simple story about all the amazing things you can do with the help of simple machines. Levers, pulleys, ramps and wheels are covered in the book in a fun and dynamic way.

Science contents:

– Simple machines

Appropriate for grades:

– 1st to 3rd graders

Supports the evaluable learning standards:

- 1st grade: Identifies different types of machines.
- 2nd grade: Identifies different types of machines and classifies them according to their use and function.
- 3rd grade: Identifies and explains some mechanical operators (axis, wheel, pulley, inclined plane, gear, brake) recognizing how they function and work.

Title: *A Drop Around the World*

Author: Barbara McKinney

Illustrator: Michael S. Maydak

Story brief:

Can you follow a drop of water around the world? This book helps students do exactly that and at the same time it helps students understand the water cycle and its importance.

Science contents:

- States of water; The water cycle

Appropriate for grades:

- 3rd to 6th graders

Supports the evaluable learning standards:

- 3rd grade: Describes the phases in which the water cycle occurs: evaporation, condensation and precipitation.
- 3rd grade: Explains how water is distributed on the planet and identifies and names water masses and water courses explaining how groundwater is formed, how it emerges and how it is accessed.
- 4th grade: Identifies and describes the alterations and imbalances that human beings produce in the natural environment and the causes that cause them.
- 5th grade: Explains the causes and consequences of climate change and responsible actions to stop it.
- 6th grade: Locates on a map the relief of Europe, its hydrographic slopes and its climates.
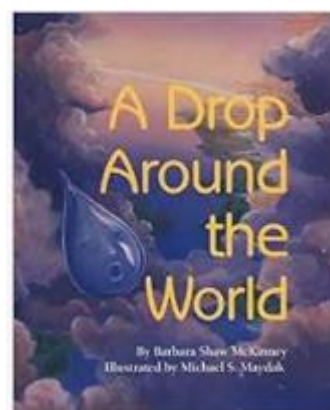
7. CLASSROOM LIBRARY MANAGEMENT

Most teachers and educators gradually begin to collect books throughout their careers. These books are valuable resources that are in many cases purchased with private rather than public funds. This use of one's own money limits, in many cases, the opportunities for students to take these resources home for free voluntary reading.

Fortunately, in this day and age of technology, there are many online resources to help teachers manage and utilize their personal resources for the benefit of their students. Although it is possible to manage one's personal library through a pen and paper approach (writing down the title and name of a person who takes a book) there are many free and cheap alternatives available.

After doing some online research and trying out a couple of the different services offered online, I would like to recommend the use of the online web service Book Retriever. It has a minimal cost and is very user friendly. It's intuitive and web-based interface is easy to set up and use. In just a couple steps you can either manually upload books to create a library or use their free scanning app for iPhones and Android to add books.

Once your library is created, you can then begin to check out books. The web service allows teachers to create a class list and then assign books to different students. An activity log allows the teacher to see which checked out books are overdue and who checked them out. There is also an option to flag some books as missing.

Another additional benefit to using this web service is that it includes the prices of each book on the book check out page allowing the teacher and the students to be aware of how valuable these resources really are.

The classroom library should be a dynamic and interactive experience for the students. At younger ages the students will need help from their teachers to check out and check in books but, as they grow, the students can be in charge of running this online service developing the digital competences that are so necessary in this day and age. Using an online web service to manage the classroom library is an excellent means of incorporating ITC in the classroom.

8. DISCUSSION

The Spanish Law (Decree 26/2016, of July 21) indicates that read-alouds, shared readings and library books are a necessary part of the learning process. Educators should remember that a teaching method that works on all of the basic skills to become not only linguistically competent but communicatively competent should be sought after through the use of varied and appropriate resources.

As seen, reading and shared reading are classroom activities that if carried out in the correct fashion, can be highly engaging. Teachers should develop engaging and dynamic reading strategies that differ from the traditional reading methods of reading stories line by line, student by student and make an active effort to bring books and their content matter to life.

In addition, read-alouds and shared readings are not experiences limited just to younger children and can be effective for engaging students from preschool to high school (Royce, Morgan, Ansberry, 2012). Allen backs this view (2000, pg. 44): "Given the body of research supporting the importance of read-aloud for modelling fluency, building background knowledge, and developing language acquisition, we should remind ourselves that those same benefits occur when we extend read-aloud beyond the early years. You may have to convince your students of the importance of this practice, but after several engaging read-alouds they will be sold on the idea." Royce, Morgan, Ansberry (2012, pg. 7) add to this idea by saying that "Reading aloud provides [the teacher] the opportunity to model [their] own enthusiasm for reading, which can , in turn, provide encouragement for older students to want to read more." This excitement can directly transfer over to the content being studied.

9. LIMITATIONS AND FUTURE RESEARCH

The three main books used to develop this TFG were *Teaching Science through Trade Books*, *More Science Adventures with Children's Literature* and *Science through Children's Literature: An Integrated Approach*. These are three excellent resources for the bilingual Science Teacher in the Spanish Educational System, however, it must be said that these resources were created specifically in accordance with the American Educational System attending to the teaching standards that are followed in the United States.

Further studies are needed in order to develop materials specifically for the context of Spain. It would be necessary to determine if public school libraries are actually equipped with enough materials to adequately comply with the Spanish Law (Decree 26/2016, of July 21)

that indicates that read-alouds, shared readings and library books are a necessary part of the learning process.

It would be interesting to carry out case studies that analyse the differences in learning outcomes of schools that have ample reading material in English and schools that have limited resources.

Finally, the development of specific educational resources for the Spanish educational market based on children's literature would be of great help to this field of investigation. This would involve identifying which non-fiction and fiction books published for the English speaking market adapt well to the bilingual Spanish/English context due to their linguistic content and then identifying the contents and evaluable learning standards that can be developed with these reading materials. As C. Butzow and J. Butzow (2000, pg. xix) state "well-chosen fiction can enable children to understand and remember scientific concepts."

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11. ANNEXES

Books recommended by *Teaching Science through Trade Books* (2012) organized by topic area:

<u>Engineering, Technology and Applications of Science</u>

1. *Goldilocks and the Three Bears* by Jan Brett
2. *June 29, 1999* by David Wiesner
3. *You Can Use Magnifying Glass* by Wiley Blevins
4. *Hidden Worlds: Looking Through a Scientist's Microscope* by Stephen Kramer
5. *Measuring Penny* by Loreen Leedy
6. *How Tall, How Short, How Faraway* by David A. Adler
7. *Giraffe Graphs* by Melissa Stewart
8. *Tiger Math: Learning to Graph From a Baby Tiger* by Ann Whitehead Nagda and Cindy Bickel
9. *The Great Graph Contest* by Loreen Leedy
10. *Collecting Data in Animal Investigations* by Diana Noonan
11. *Welandia by Paul Fleishcman*
12. *Just a dream by Chirs Van Allsburg*
13. *Pond walk* by Nancy Elizabeth Wallace
14. *Salamander Rain: A Lake and Pond Journal* by Kristin Joy Pratt-Serafini
15. *Into the Woods: Who's Been Here?* By Lindsay Barret George
16. *The Woods Scientist* by Stephen R. Swinburne
17. *Odd boy out: Young Albert Einstein* by Don Brown
18. *Reaching for the Moon* by Buzz Aldrin
19. *How is a Pencil Made?* by Angela Royston
20. *Transformed: How Everyday Things Are Made* by Bill Slavin
21. *How Do You Know What Time It Is?* by Robert E. Wells
22. *On Time: From Seasons to Split Seconds* by Gloria Skurzynski
23. *How a House Is Built* by Gail Gibbons
24. *Bridges! Amazing Structures to Design, Build, and Test* by Carol A. Johmann and Elizabeth J. Rieth
25. *Imaginative Inventions* by Charise Mericle Harper
26. *So You Want to Be an Inventor?* by Judith St. George

<u>Physical Science</u>

27. *Let's Try It Out in the Air: Hands-On Early-Learning Science Activities* by Seymour Simon and Nicole Fauteux
28. *I Face the Wind* by Vicki Cobb
29. *Mirrette on the High Wire* by Emily Arnold McCully
30. *The Man Who Walked Between the Towers* by Mordicai Gerstein
31. *I Fall Down* by Vicki Cobb
32. *Floating in Space* by Franklyn M. Branley
33. *Roller Coaster* by Marla Frazee
34. *Roller Coaster! Motion and Acceleration* by Paul Mason
35. *Animals in Flight* by Steve Jenkins and Robin Page

36. *How People Learned to Fly* by Fran Hodgkins
37. *Why Should I Save Energy?* By Jen Greene
38. *Flick a Switch: How Electricity Gets to Your Home* by Barbara Seuling
39. *I Get Wet* by Vicki Cobb
40. *A Drop of Water: A Book of Science and Wonder* by Walter Wick
41. *Pancakes for Breakfast* by Tomie dePaola
42. *Acids and Bases: Why Chemistry Matters* by Lynette Brent

Life Science

43. *Seeds* by Vijaya Khristy Bodach
44. *Seeds* by Ken Robbins
45. *Pumpkin Circle: The Story of a Garden* by George Levenson
46. *How Many Seeds in a Pumpkin?* by Margaret McNamara
47. *Planting a Rainbow* by Lois Ehlert
48. *The Reason for a Flower* by Ruth Heller
49. *Lucas and His Loco Beans: A Bilingual Tale of the Mexican Jumping Bean* by Romana Moreno Winner
50. *A Monarch Butterfly's Life* by John Himmelman
51. *Seashells by the Seashore* by Marianne Berkes
52. *Seashells, Crabs, and Sea Stars* by Christiane Kump Tibbitts
53. *Triops: A Very Unusual Create* by Helen Pashley and Lori Adams
54. *Crab Moon* by Ruth Horowitz
55. *Red Eyes or Blue Feathers: A Book About Animal Colors* by Patricia M. Stockland
56. *Hide and Seek: Nature's Best Vanishing Acts* by Andrea Helman
57. *Animal Defenses: How Animals Protect Themselves* by Etta Kaner
58. *Beaks!* By Sneed B. Collard III
59. *The Emperor's Egg* by Martin Jenkins
60. *Penguins!* by Gail Gibbons
61. *Going Home: The Mystery of Animal Migration* by Marianne Berkes
62. *Great Migrations: Whales, Wildebeests, Butterflies, Elephants, and Other Amazing Animals on the Move* by Elizabeth Carney
63. *Who Goes There?* By Jennifer Ericsson
64. *White Owl, Barn Owl* by Nicola Davies
65. *I See a Kookaburra! Discovering Animal Habitats Around the* World by Steve Jenkins and Robin Page
66. *The Salamander Room* by Anne Mazer
67. *I Took a Walk* by Henry Cole
68. *Secret Place* by Eve Bunting
69. *Gregory, the Terrible Eater* by Mitchell Sharmat
70. *Science News for Kids: Food and Nutrition* by Tara Koellhoffer
71. *What's Inside Me? My Bones and Muscles* by Dana Meachen Rau
72. *Movers and Shapers* by Patricia Macnair
73. *Hear Your Heart* by Paul Showers
74. *The Heart* by Seymour Simon
75. Germs Are Not for Sharing by Elizabeth Verdick
76. *What Are Germs?* by Alan Silverstein, Virginia Silverstein, and Laura Silverstein Nunn

77. *If You Find a Rock* by Peggy Christian
78. *Rocks: Hard, Soft, Smooth, and Rough* by Mathew John
79. *Let's Go Rock Collecting* by Roma Gans
80. *The Rock Factory: A Story About the Rock Cycle* by Jacqui Bailey
81. *Dirt* by Steve Tomecek
82. *A Handful of Dirt* by Raymond Bial
83. *Fossils Tell of Long Ago* by Aliki
84. *Dragon in the Rocks: A Story Based on the Childhood of the Early Palaeontologist Mary Anning* by Marie Day
85. *Prehistoric Actual Size* by Steve Jenkins
86. *Boy, Were We Wrong About Dinsosaurs!* by Kathleen Kudlinski
87. *Earthquakes* by Ellen J. Prager
88. *Earthquakes* by Seymour Simon
89. *The Blizzard* by Betty Ren Wright
90. *Hurricanes* by Gail Gibbons
91. *Fluffy, Flat, and Wet: A Book About Clouds* by Dana Meachen Rau
92. *The Man Who Named the Clouds* by Julie Hannah and Joan Holub
93. *The Cloud Book* by Tomie dePaola
94. *Weather Forecasting* by Gail Gibbons
95. *Day and Night* by Margaret Hall
96. *Somewhere in the World Right Now* by Stacy Schuett
97. *Phases of the Moon* by Gillia M. Olson
98. *The Moon Book* by Gail Gibbons
99. *Out and About at the Planetarium* by Becki Shipe
100. *The Constellations: Stars and Stories* by Chris Sasaki

Books recommended by *More Science Adventures with Children´s Literature* (2008):

1. *The Dinosaurs of Waterhouse Hawkins* by Barbara Karley
2. *Actual Size* by Steve Jenkins
3. *Under One Rock: Bugs, Slugs and Other Ughs* by Anthony D. Fredericks
4. *Hurricanes* By Seymour Simon
5. *Rocks in His Head* by Carol Otis Hurst
6. *Song of the Water Boatman and Other Pond Poems* by Joyce Sidman
7. *Parts* by Tedd Arnold
8. *W is for Wind: A Weather Alphabet* by Pat Michaels
9. *Antarctic Journal: Four Months at the Bottom of the World* by Jennifer Owings Dewey
10. *The Tarantula Scientist* by Sy Montgomery
11. *Outside and Inside Mummies* by Sandra Markle
12. *Over in the Jungle: A Rainforest Rhyme* by Marianne Berkes
13. *The Flower Hunter: William Bartram, America's First Naturalist* by Deborah Kogan Ray
14. *The Tsunami Quilt: Grandfather's Story* by Anthony D. Fredericks
15. *A Mother's Journey* by Sandra Markle
16. *Earthshake: Poems from the Ground Up* by Lisa Westberg Peters
17. *Eyes and Ears* by Seymour Simon
18. *The Sea, the Storm, and the Mangrove Tangle* by Lynne Cherry
19. *Science Verse* by Jon Scieska and Lane Smith
20. *Near One Cattail: Turtles, Logs and Leaping Frogs* by Anthony D. Fredericks

21. *Leaf Man* by Lois Ehlert
22. *Reaching for the Moon* by Buzz Aldrin
23. *Nature in the Neighborhood* by Gordon Morrison
24. *Following the Coast* by Jim Arnosky
25. *Hidden Worlds: Looking Through a Scientist's Microscope* by Stephen Kramer
26. *The Star People: A Lakota Story* by S.D. Nelson
27. *Guts: Our Digestive System* by Seymour Simon
28. *Forces of Nature* by Catherine O'Niell Grace
29. *Red Eyes or Blue Feathers: A Book About Animal Colors* by Patricia M. Stockland
30. *G is for Galaxy: An Out of This World Alphabet* by Janis Campbell and Cathy Collison
31. *Flotsam* by David Wiesner
32. *Plantzilla* by Jerdine Nolen
33. *Diary of a Worm* by Doreen Cronin
34. *Around One Cactus: Owls, Bats and Leaping Rats* by Anthony D. Fredericks
35. *What Do You Do with a Tail Like This?* By Steve Jenkins and Robin Page

Books recommended by *Science through Children's Literature: An Integrated Approach* (2000) organized by topic area:

Life Science

1. *A Tree Is Nice* by Janice May Udry
2. *The Tiny Seed* by Eric Carle
3. *Everette Anderson's Nine Month Long* by Lucille Clifton
4. *Before You Were Born* by Jennifer Davis
5. *Make Way for Ducklings* by Robert McCloskey
6. *Two Bad Ants* by Chris Van Allsburg
7. *The Very Busy Spider* by Eric Carle
8. *The Grouchy Ladybug* by Eric Carle
9. *Swimmy* by Leo Lionni
10. *Verdi* by Janell Cannon
11. *Micheal Bird-Boy* by Tomie dePaola
12. *Chipmunk Song* by Joanne Ryder
13. *Gregory, the Terrible Eater* by Mitchell Sharmat
14. *I Have a Sister, My Sister Is Deaf* by Jeanne Whitehouse Peterson

Earth and Space Science

15. *It's Mine* by Leo Lionni
16. *Hill of Fire* by Thomas P. Lewis
17. *Everybody Needs a Rock* by Byrd Baylor
18. *The Gift of the Tree* by Alvin Tresselt
19. *Keep the Lights Burning, Abbie* by Peter and Connie Roop
20. *The Very Last First Time* by Jane Andrews
21. *The Magic School Bus Lost in the Solar System* by Joanna Cole

Physical Science

22. *The Big Snow* by Berta Hader and Elmer Hader
23. *Arthur's Eyes* by Marc Brown
24. *Shadow* by Blaise Cendrars, translated by Marcia Brown
25. *The Secret Birthday Message* by Eric Carle
26. *How Big Is a Foot?* By Rolf Myller
27. *Choo Choo: The Story of a Little Engine Who Ran Away* by Virgina Lee Burton
28. *Who Sank the Boat?* By Pamela Allen
29. *The Enormous Carrot* by Vladimir Vagin
30. *Strega Nona's Magic Lesson* by Tomie dePaola
31. *The Big Balloon Race* by Eleanor Coerr
32. *The Glorious Flight* by Alice Provensen and Martin Provensen