FACULTAD DE EDUCACIÓN DE PALENCIA

UNIVERSIDAD DE VALLADOLID

COMPARATIVE ANALYSIS OF MATHEMATICAL PROBLEM STATEMENTS WITH ADDITIVE STRUCTURE IN ENGLISH AND SPANISH AND THEIR USE IN THE FOREIGN LANGUAGE CLASSROOM.

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Análisis comparativo de enunciados de problemas matemáticos de estructura aditiva en lengua inglesa y castellana y su uso en el aula de lengua extranjera.

TRABAJO FIN DE GRADO

EN EDUCACIÓN PRIMARIA

MENCIÓN DE LENGUA EXTRANJERA: INGLÉS

AUTORA: María Nieto Herreras

TUTORA: Patricia San José Rico

COTUTOR: Matías Arce Sánchez

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Resumen: En este Trabajo de Fin de Grado se pretende combinar la investigación con la puesta en práctica de las teorías pedagógicas para presentar los problemas matemáticos de estructura aditiva como una herramienta didáctica en el aula de lengua extranjera. Para ello, primero se exploran las características intrínsecas a este tipo de texto detallando su riqueza en el desarrollo de las competencias lingüísticas y matemática. Después, se realiza un análisis en el que se han tenido en cuenta un total de 348 problemas entre 7 editoriales en ambos idiomas, inglés y español. Finalmente, a partir de las similitudes encontradas tanto en los tipos de problemas utilizados por las editoriales como a nivel lingüístico (formato, estructuras, palabras clave, verbos y tiempos verbales usados, etc.), se dibuja su utilidad en el aula de lengua extranjera como recurso a partir del cual se puede desarrollar tanto lenguaje como pensamiento. Esto se refleja de forma práctica y concreta en una pequeña experiencia piloto en un aula de primer año del territorio irlandés en la que se enseña español.

Palabras clave: Problemas matemáticos de enunciado verbal, Matemáticas, lengua extranjera, educación competencial.

Abstract: This Final Degree Project aims to combine research with the implementation of pedagogical theories in order to present mathematical problems of additive structure as a didactic tool in the foreign language classroom. To this end, we first explore the intrinsic characteristics of this type of text, detailing its richness in the development of linguistic and mathematical competences. Then, an analysis is carried out in which a total of 348 problems between 7 publishers in both languages, English and Spanish, are considered. Finally, based on the similarities found both in the types of problems used by the publishers and at the linguistic level (format, structures, key words, verbs and verb tenses used, etc.), their usefulness in the foreign language classroom as a resource for developing both language and thinking is outlined. This is reflected in a practical and concrete way in a small pilot experience in a first-year classroom in the Irish territory where Spanish is taught.

Key words: Wordproblems, Mathematics, foreign language, competential education.

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Introduction

From my own experience, in order to learn a second language, you need to immerse yourself in it. It is a matter of practice that makes the language develop in the learner.

This practice should not be passive in any sense, but an active learning process in which the student can develop his/her communication skills at the same time as other key competences. Competency-based learning and transdisciplinary learning have become very popular in recent years, and with good reason.

Second language teaching must adopt a communicative approach, in which words are worked through in real contexts to ensure competent learning that develops thinking as well as language. A communicative approach based on expressing one's own ideas and discussing them with peers allows for the development of linguistic competence. A language is learned through its use, not through exercises devoid of meaning for the reader who performs them.

In this Final Degree Project, a linguistic analysis of verbal problems with mathematical statements, or word problems (WPs), is carried out with the aim of finding similarities between WPs written in English and Spanish that allow these texts to be used as a foreign language learning tool. Language plays a fundamental role in mathematical statements, so its use in the classroom allows the development of language skills while working on mathematical competence, creativity and the development of thinking within contextualized situations. The student interacts with the text, reads it, reflects on it, and completes it.

This analysis will identify the main grammatical structures, concepts, keywords, verbs, and words used by different publishers depending on each type of problem. This linguistic level will be evaluated to highlight the applications in the classroom that WPs have for second language learning. The recognition of the structure, format, semantic relationships, and vocabulary used allows the student to draw upon their own mathematical knowledge to apply it without resorting to a prior translation of the statement. It is the problem itself and its structure that guide the student in its resolution, thanks to the extensive exposure students have to WPs in their own language. If this system of presenting information coincides in a second language, that will help the students solve problems in another language by relying on their prior knowledge.

We must remember that problem solving involves not only knowing and understanding the words that make up the text, but also making sense of them. Without this step, we will not be able to work with the information properly and come up with a solution.

Despite the teaching of a second language being considered a specialty in Spain and being carried out by specialized teachers, these teachers also possess knowledge from other areas that can be applied in teaching the second language. For example, content from the music domain is widely used in the English classroom. However, it is not as common to find content from other subjects being integrated. In the case of mathematics, its application in the English language classroom is often related to using the calendar to learn how to say the date in another language, as well as telling time. However, in this Final Degree Project, the aim is to go beyond that and use mathematics as a tool to learn, practice, and reinforce language.

To develop this idea in depth, the first step will be to present the objectives pursued with this project. Following that, the justification can be found, which not only explains why this research is important, but also the reasons that led me to choose this research topic. Another section included in this project, and essential for understanding the rest of the content, is the theoretical framework. Here, not only are the relationships between the English and Spanish languages addressed, but also the definition of mathematical problem, its types, and the importance of language in them. Additionally, in this section, various didactic aspects that need to be taken into account when using WPs in the second language classroom are collected.

Following that is the methodology section, in which the analysis conducted among a total of 338 mathematical problems from different publishers in both languages is detailed. The results and subsequent reflection based on them are presented.

On the basis of the results obtained, a pilot experiment will be carried out to test the hypothesis in a real learning context. From this pilot experience, it will be possible to assess the potential of WPs as a learning resource to foster both language and mathematical thinking within a collaborative setting that encourages student participation. Based on these experiences, the goal is for students, apart from developing language and thinking, to learn how to deal with real-life situations in their non-dominant language.

Lastly, there are the conclusions where reflections are made not only on the results obtained but also on what the completion of this Final Degree Project has meant for me.

Objectives

Throughout this Final Project, the main objective is to analyse mathematical problems presented in verbal form and their application in the classroom as a potential communicative resource for teaching a second language. The main aim is to identify similarities that enable the creation of learning opportunities, where synergies derived from these similarities facilitate the learning of a second language based on one's prior knowledge of the first language and the resolution of such problems in their native language.

All of this is framed within a multidisciplinary perspective with the intention of creating a community of mathematical thinking based on realistic contexts derived from mathematical problems.

In this way, a deeper understanding of the second language is pursued through the use of a methodology based on communication, expression, and argumentation of ideas. The problem-solving process will be the central focus of this project, aiming to highlight the power of this tool in the development of linguistic competence.

Considering this, the specific objectives of this Final Project are the following ones:

- To propose an interdisciplinary methodology based on a contextual communicative approach to language teaching, thus moving away from the traditional method focused on vocabulary and grammar.
- To identify similar structures and expressions in verbal statement mathematical problems with additive structure between the English and Spanish languages.
- To present the potential that mathematics holds within the teaching of a second language.
- To develop an effective method for linguistic comparison of additive mathematical problem statements in Spanish and English.
- To utilize the data obtained in the analysis as a basis for making decisions that will help me to plan and design a didactic proposal for second language learning using WPs in a real classroom context.

Justification

The choice of using mathematical word problems (WPs) as centre of this Final Degree Project in the teaching-learning process of a second language is based on the need to change traditional methods of teaching a second language, which focus on the acquisition of grammar and vocabulary rather than on the use of the language in a realistic situation.

Mathematics is a mental activity based on finding strategies, formulating questions, interpreting data and results; in short, establishing relationships and constructing ideas. Mathematics can therefore be understood as a creative act. This approach to thinking from a creative perspective is not achieved through mechanical activities with specific content, but through experience, discovery and the construction of concepts (Fernández Bravo, 2010, p.17). Its use involves the transmission and reception of different kind of information which is used to generate new information, as is the case in communicative processes. According to Martínez et al. (2016, p.6), problem-solving is both a means and an end for learning mathematics, and a pivot for developing and applying mathematical concepts and skills. Mathematical problems have generally been given a central role in the Primary Mathematics Curriculum, both for their potential to motivate students, and for their ability to develop students' skills in when and how to apply their mathematical knowledge effectively in everyday situations. (Verschaffel et al. 2000, qt. in Martínez et al. 2016, p. 7-8)

Oral expression and comprehension, reading, calculation and logical and mathematical skills are, according to *Real Decreto 157/2022, de 1 de marzo, por el que se establecen la ordenación y las enseñanzas mínimas de la Educación Primaria*, learnings that must be facilitated at the Primary Education stage (p. 24388). Both the Spanish and Irish curricula are committed to the development of a competency-based education that supports students in realising their own potential and helps them to grow as individuals and as members of their community and society. (Primary curriculum Framework, p. 5. & *Real Decreto 157/2022*, p. 24386). Similarly, they both see the understanding and use of language and mathematical thinking as key competences. (Primary curriculum Framework, pp. 8-13. & *Real Decreto 157/2022*, pp. 24404 – 24407). However, the Spanish curriculum also includes plurilingualism, which is the appropriate and effective use of different spoken or signed languages for learning and communication (*Real Decreto 157/2022*, p. 24406). The development of this project is based on this educational proposal registered within both legal frameworks. The Irish primary curriculum does not include the teaching of Spanish as a second foreign language, this is left for the secondary stage, so it is not possible to make a comparison at this level between the curriculum for teaching Spanish in Ireland and English in Spain. It is possible to briefly compare the mathematics curriculum in both countries in order to understand its importance in this project. The Irish curriculum divides the

main categories of mathematics learning into the following strands: Algebra, Data and chance, Measures, Number and Shape and Space (Primary Mathematics Curriculum, p. 13). Similarly, the Spanish curriculum collects as main categories: Numeracy, Sense of measurement, Spatial sense, Algebraic sense, Stochastic sense and Socio-affective sense (*Real Decreto 157/2022*, p. 24486). This project relates directly to several of these categories present in both curricula through the WPS: algebra, number sense and socio-affective sense.

Mathematics is, according to the Irish Primary Mathematics Curriculum (2020, p.11), a human activity that develops in response to everyday problems and interactions. For his part, Verschaaffel (2020, p. 2) claims that word problems not only provide practice in everyday situations of applied mathematical concepts, but they also motivate learners and train them to think creatively. However, it is necessary to establish links between the content of school mathematics and other disciplines and contexts in order to guarantee a global approach that serves the students as a tool for interpreting reality (Albarracín, et al. 2018, p. 26). This communicative approach allowed students to express and discuss their thoughts and learn from mistakes.

Mathematics should not be seen as an isolated domain, reduced to the time in the morning when it is taught in the school context, but as an entity that is present at all times in our lives. In the same way, the teaching of a second language should not be reduced to a few hours a week, as is usually the case in the school. According to Mireia Trench (RTVE, 2021), the constant communication and interaction among speakers is the key to learn a second language. This means that it is not only necessary to have a lot of exposure to the new language, but also for the learner to interact with it.

By incorporating verbal statement problems in the second language classroom, we can develop language through the text while preparing students to apply their mathematical knowledge in real-world situations. This also promotes cross-curricular learning and helps students develop a deeper understanding of arithmetic operations in a setting other than the mathematics classroom. In the same way, this symbiosis could be used to introduce the second language into problem solving in school mathematics lessons. By creating an interdisciplinary bridge between them, it is possible to increase the time spent with the language and at the same time understand the usefulness of mathematics in other contexts.

According to OECD (2003), the development of mathematical competence implies in turn the development of other skills such as the ability to think and reason, to argue and to communicate among others. Communication involves understanding and expressing ideas both orally and in writing. These specific competences are of great value in the development of the learner's linguistic competence and therefore of great interest in the learning of a second language.

For all these reasons, the problems of verbal enunciation in foreign language teaching were chosen as the main focus of this project. In the absence of sufficient information on this teaching approach, it was necessary to carry out a preliminary analysis of the linguistic structure of WPs in both languages in order to confirm that their potential as a teaching tool is real and not just hypothetical.

Relation with the Competences of the Education Degree.

This section details the general and specific competences indicated by the University of Valladolid that have been developed in the course of this research work. The corresponding list of competences can be found in the appendix 1.

a. General Competences:

Within the general competences, work is specifically carried out on competence 1, paragraphs d and e, because this research emerges as a search for a new communicative approach teaching-learning strategy that serves to learn a second language through an interdisciplinary procedure. In order to develop something like this, it is necessary to be familiar with other teaching techniques and strategies, both in languages and in mathematics.

Throughout the document we can also see that links are constantly being made between theory and practice, which have helped to clarify the choices made in the development of both the main project and the design of the didactic proposal. This ability is set out in the general competence number two (section b).

Completing this research has also allowed me to develop my own analytical tools, collect data and analyse it according to predetermined criteria. In addition, this data was presented both graphically and in written form. This is related to the third basic competence, specially paragraphs a,b and c.

In addition, it is developed the fifth competence, section e, through the choice of a topic that brings together two disparate areas, such as mathematics and a second language. It is a statement of intent aimed at developing a teaching practice based on innovation and creativity.

b. Specific Competences:

In order to carry out this work, due to the scientific nature of this type of analysis, we have worked on specific competences related to educational processes and context, but also to learning and personality development.

Within Module A, which corresponds to basic training, it was necessary to become familiar with the students' learning processes, as well as their own way of being and being in the classroom, the context surrounding them and the context of the centre itself, in order to be able to design an appropriate intervention proposal. Furthermore, both the specific characteristics of the early years of primary school and the diversity that may exist in the classroom were taken into account when discussing and proposing didactic strategies.

Due to the nature of this project, which combines second language learning with the development of mathematical thinking, it has been possible to develop specific competences in both areas. In the case of mathematics, within Module B, corresponding to didactic- disciplinary learning, this project is closely related to competence 5, paragraphs b and c, and competence 6, from the teaching and learning of Mathematics section. In the case of the teaching and learning of languages subject, this project emphasises language as a tool for communication and is related to competence 7.

Finally, the specific competences of the optional module related to the foreign language have been developed. By resorting to bibliographic resources in English and writing the document itself in that language, proficiency at C1 level of linguistic competence in sub-section 1 is demonstrated. Furthermore, the presentation of didactic strategies accompanying the use of WPs in the classroom and the design and implementation in the classroom of the didactic proposal for teaching a foreign language demonstrate the development of sub-section 2.

Theoretical Framework

Language is a structured system of communication that uses sounds and writing to express information. It is an acquired system that allows individuals to convey meaning to others. Language acquisition is driven by the need to communicate with others. If the context changes, then the subject needs to adapt to the new code in order to be able to exchange information.

The main purpose of learning a second language is to enable the person to deal with daily life in a context which uses that language as the principal code for communication. A second language is not only a tool for communication, but also a new way to develop and establish mental connections. Thinking can be understood as speech without sound, and language as the external manifestation of thought (Vygotsky, 1998, p.2). Thus, it is evident that there is a direct correlation between thought and language. Language is inextricably linked to thought (Fernández Bravo, J.A. 2010, p.41).

Mathematics provides answers to real-world problem situations. In the school environment, these situations are usually presented to students in the form of written texts, which are called verbal math problems or Word Problems (WPs). Word Problems use situations extracted from daily life which help students to develop problem-solving skills that they can use in their own lives. Word Problems include verbal components that determine and guide the language used on them. These linguistic factors can be divided into structure (structural complexity of basic quantitative properties, vocabulary level and question wording/placing) and semantics (linguistic verbal cues, phrasing in cue words, conceptual rewording, semantic/object relation and presence of distractors). In WPs, relevant information is presented in the form of a short narrative which encode a quantitative relation between objects (Boonen et al., ct. in Daroczy et al. 2015, p.1).

The use of meaningful real contexts allows teachers to involve their students in the problem. They indirectly understand the usefulness of mathematics in real life, not just on paper or in school. These problems help us to understand the world around us and to decipher it.

According to Murcia (2019, p.26), problems must be based on contexts that are real and meaningful to the person solving them. Motivating contexts encourage mathematical thinking, argumentation, representation and communication. The linguistic richness of working with WPs lies not only in understanding the statement, which is fundamental, but also in explaining the process through argument, interpreting the solution, and communicating it to others.

Approximation to the Mathematical Concept of Word Problem

Based on the literature consulted, it can be stated that there is currently no consensus in mathematical literature regarding a clear definition of the concept of a 'problem.' In fact, the term 'problem' does not necessarily imply that each of the school tasks under the term 'word problem' is a real problem in the cognitive-psychological sense of the term (Verschaffel et al., 2020, p. 2). The literature consulted provides the following definitions:

> "A problem is a mental process that makes it possible to transform the unknown into knowledge." (my translation from Fernández, 2010, p. 26).

> "A problem is a situation that you do not know how to handle when it presents itself." (my translation from Wheathey & Kantowski, qt. in Fernández, 2010, p. 26)

> "A problem is the setting up of a situation with an unknown answer, which is not immediate, and which the student must solve using mathematical methods, and moreover, the student must have the will to do so." (my translation from Ortega et al., qt. in Arce et al., 2019, p. 152)

These definitions clarify that a problem depends on the subject facing it, more than on the task itself. The subject must think, model the situation, and make connections to find a solution. A problem is anything that triggers mental activity to find a strategy for answering the initial situation. For Fernández, what solves a problem is mental activity that is part of a creative intelligence (2010, p.27). Another factor which is often mentioned in the literature is the importance of the subject's willingness and compromise in finding a solution to the problem (Arce et al., 2019, p. 152).

In the mathematics classroom, a verbal statement problem refers to the variety of situations that are presented, typically with a mathematical structure embedded in a more or less realistic context, in which the student has to use mathematical strategies to find a solution. The information is presented mainly as a narrative text in oral or written form. (Martínez et al. 2016, p.7) If the strategy to solve the problem is already explicit in the statement, the subject no longer recognises it as a problem because he/she already knows how to solve it, thus losing its status as a problem.

The language used in the construction of the statement is therefore crucial, as it is this verbal expression that will introduce the initial situation, provide the data, and ask about the unknown information that is decisive for the solution of the problematic situation. Moreover, the statement also tells us what kind of problem it poses, according to its semantic category.

This information allows us to think that WPs are useful didactic resources because they arise from a realistic need of the student, which helps them connect with the task and mobilises their thinking.

There are different types of WPS according to the arithmetic operations used on them that are usually presented to the students depending on the age group, school, and curriculum. These include addition and subtraction word problems, as well as multiplication and division word problems. According to the number of mathematical operations used in the solving process, we can distinguish one-step problems (those which can be solved which only one calculation) and multi-step problems (those which require multiple calculations to solve them).

In this study we will focus on additive problems which can be solved in only one step. In general, these types of statements are proposed in the early years, as the aim is to introduce students to problem solving.

Additive problems are those in which the operations required to find a solution to the problem are addition or subtraction (Carrillo et al. 2016, p.32; Vergnaud, 1991. qt. in Martínez et al. 2016. p.9). Additive problems, in turn, have different subtypes depending on the relationship in which the quantities presented in the problem are involved.

- Change problems: an initial quantity is given; a transformation takes place and results a final amount. This transformation can be either incremental (addition) or decremental (subtraction). In them, the question can ask for the final amount, the initial quantity, or the quantity involved in the process of transformation. In these problems a temporal sequence is respected. Illustrative examples of each subtype with corresponding variations are given in Table 1.
- Combine problems: There are two static quantities which are part of a whole. The question can ask for the total quantity or for one of the independent quantities. This type of problem is relayed in the fact that the two quantities are related to each other by a certain reason, usually a semantic one. Illustrative examples of each subtype with corresponding variations are given in Table 2.
- Compare problems: two different structures are compared between them. One of them is used as reference for the other. In these problems, the relation between the quantities is expressed by linguistic structures which play a comparative role. The question can ask for the reference, the compared quantity; or the difference between the two quantities. Illustrative examples of each subtype with corresponding variations are given in Table 3.
    - Equalise problems: they can be considered within the compare problems. In these problems there are two different quantities which must be equal by a transformation at the end of the problem. The transformation can be done on the larger or the smaller quantity. In this case, we can also see two different types of problem, depending on the transformation needed to make the two quantities equal: addition or subtraction. These are some examples of them:

- "Jaxon has five cookies. Eli has two cookies. How many cookies does Eli have to buy to have as many cookies as Jaxon?"
- *"Elsa tiene una caja con 12 rotuladores. Clara tiene otra con 24 rotuladores. ¿Cuántos rotuladores más necesita Elsa para tener tantos como Clara?"*

Addition problems are strongly influenced by the semantic structure (De Corte and Verschaffel, 1987, qt. in Daroczy et al. 2015, p.3). The semantic structure is crucial for identifying the solution strategy of the WPs. Each problem will be different for students, and they will use different strategies to solve it. Depending on their category, mathematical problems vary considerably in difficulty. (Carrillo et al. 2016, p.43).

Table 1. Subtypes of change problems.

Change problems				
Subtype	Type of transformation	Unknown	English	Spanish
Ch. 1	Increasing (Addition)	The final amount	There were 6 ladybirds in the garden. 5 more ladybirds joined them. How many ladybirds were in the garden then?	*Juan tiene 5 canicas. Su amigo Pedro le da 3 canicas más. ¿Cuántas canicas tiene Juan ahora?*
Ch. 2	Decreasing (Subtraction)	The final amount	There were 6 ladybirds in the garden. 3 of them flew away. How many ladybirds are there now?	*Juan tiene 5 canicas y le da 1 a su amigo Pedro. ¿Cuántas canicas tiene ahora?*
Ch. 3	Increasing (Addition)	The quantity involved in the change	There were 6 ladybirds in the garden. Some ladybirds joined them. If there are 11 ladybirds now, how many ladybirds have joined?	*Juan tenía 5 canicas. Su amigo Pedro le dio algunas más. Si ahora Juan tiene 8 canicas, ¿cuántas canicas le dio Pedro?*
Ch. 4	Decreasing (Subtraction)	The quantity involved in the change	There were 6 ladybirds in the garden. Some of them flew away. If there are 3 ladybirds in the garden now, how many ladybirds flew away?	*Juan tenía 5 canicas. Le dio algunas a su amigo Pedro. Si ahora Juan tiene 3 canicas, ¿cuántas canicas le dio Juan a Pedro?*
Ch. 5	Increasing (Addition)	The initial quantity	There were some ladybirds in the garden. 5 more ladybirds joined them. If there are 11 ladybirds in the garden now, how many ladybirds were there at the beginning?	*Juan tenía algunas canicas. Su amigo Pedro le dio 3 canicas más. Si ahora Juan tiene 8 canicas, ¿cuántas tenía al principio?*
Ch. 6	Decreasing (Subtraction)	The initial quantity	There were some ladybirds in the garden. 3 of them flew away. If there are 3 ladybirds in the garden now, how many ladybirds were there at the beginning?	*Juan tenía algunas canicas y le dio 2 de ellas a su amigo Pedro. Si ahora Juan tiene 3 canicas, ¿cuántas canicas tenía al principio?*

Table 2. Subtypes of combine problems.

Combine problems				
Subtype	Type of transformation	Unknown	English	Spanish
Comb. 1	Increasing (Addition)	The final amount	There are two daisies, three roses and four daffodils in the vase. How many flowers are there altogether?	*En la clase de 1ºA hay 21 alumnos. En 1ºB hay 23 alumnos. ¿Cuántos alumnos hay en el primer curso en total?*
Comb. 2	Decreasing (Subtraction)	One of the parts	There are some daisies, three roses and four daffodils in the vase. If there are nine flowers altogether in the vase, how many daisies are in the vase?	*En primer curso hay 44 alumnos en total. En la clase de 1ºA hay 21 alumnos. ¿Cuántos alumnos hay en la clase de 1ºB?*

Table 3. Subtypes of compare problems.

Compare problems				
Subtype	Type of transformation	Unknown	English	Spanish
Comp. 1	Mentioning "more"	The difference	I have 17 balloons. My friend has 14 balloons. How many more balloons do I have than my friend has?	*Hoy cumplo 9 años. Mi hermano tiene 12 años. ¿Cuántos años tiene mi hermano más que yo?*
Comp. 2	Mentioning "less"	The difference	I have 17 balloons. My friend has 14 balloons. How many less balloons does my friend have than I have?	*Hoy cumplo 9 años. Mi hermano tiene 12 años. ¿Cuántos años menos que mi hermano tengo?*
Comp. 3	Mentioning "more"	The comp. quantity	I have 17 balloons. My friend has 3 balloons more than me. How many balloons does my friend have?	*Hoy cumplo 9 años. Mi hermano tiene 3 años más que yo. ¿Cuántos años tiene mi hermano?*
Comp. 4	Mentioning "less"	The comp. quantity	I have 17 balloons. My friend has 3 balloons less than me. How many balloons does my friend have?	*Hoy cumplo 9 años. Mi hermano tiene 3 años menos que yo. ¿Cuántos años tiene mi hermano?*
Comp. 5	Mentioning "more"	The reference	I have some balloons. My friend has 14 ballons. My friend has 3 more balloons than me. How many balloons do I have?	*Hoy cumplo años. Mi hermano tiene 12 años. Mi hermano tiene 3 años más que yo. ¿Cuántos años tengo yo?*
Comp. 6	Mentioning "less"	The reference	I have some balloons. My friend has 14 balloons. My friend has 3 balloons less than me. How many balloons do I have?	*Hoy cumplo años. Mi hermano tiene 12 años. Mi hermano tiene 3 años menos que yo. ¿Cuántos años tengo yo?"*

The Importance of Language in Problem-Solving.

Language is so important in mathematical problems that it is known that the difficulty of the problems is not only due to the complexity of the numerical relations, but also to other factors such as their belonging to one or another category, the nature of the content, the order and presentation of the information, the presence of keywords and the location of the unknown. (Vergnaud, 1991. qt. in Martínez, 2016. p. 11). According to Carrillo (2016, p.43), language and linguistic structure are enormously important in the comprehension phase of the utterance. To ensure real understanding of the statement, the reader must know all the terms involved. Verschaffel (2020, p. 4) agrees, adding that "different semantic structures play a crucial role in the construction of the situational model and its transformation into a mathematical model". In his view, a skilful WPs solving process requires a propositional text from which the reader receives clues to select the appropriate cognitive scheme. With all this information in hand, it is clear that the text is a key determinant in problem solving.

Within problem-solving processes, language takes two different approaches: language as an expression of the information that is communicated to the reader; and language as an expression of the thought that is to be conveyed (Fernández Bravo, J.A., 2010, p.41). Successfully solving WPS requires linguistic understanding of the WPs itself, understanding and establishing connections between text and arithmetic tasks, solving the arithmetic tasks (Nesher and Teubal, 1975, qt. in Daroczy et al. 2015, p. 4), and interpretation and expression of results. It is not enough to understand the terms involved in the statement, but to give them meaning and to be able to establish the mathematical relationships between them in order to solve the problem. According to Nesher (1982, p.384), it is the understanding of the text which enables the reader to choose the correct arithmetic strategy to solve it.

As mathematical competence develops, pupils are able to make these connections themselves from reading and to model the problem. However, in the early stages of primary school, pupils may need external support in modelling the problem. The text itself may make these connections clearer or more complex. This is reflected in what we mean by the difficulty of the problem. A problem is difficult if subjects find it difficult to make the necessary connections to solve it. In both English and Spanish, the difficulty of the problem increases according to the positioning of the unknown. For example, in the case of change problems, those that ask about the final quantity are the easiest, followed by those that ask about the transformation process. The most difficult are those that ask for the initial quantity. (Carrillo et al. 2016, p.43)

WPs allow the learning of the linguistic model that is expressed in the formulation of the mathematical statement of the problem. The student does not only learn numerical or

mathematical constructions such as 'total,' 'more than,' or 'how many/much,' but also establishes semantic connections between the concepts presented and their meaning within a context. Moreover, the student learns to order the different narrative structures thanks to the different combinations that can be presented in the WP statement, at the same time that they can learn to build focused questions. That is the reason why the use of WPs in a second language classroom can be very useful as learning resource.

The resolution process itself implies to be able to express the ideas that guide the student towards problem-solving. The situation contained in the problem is built up in the mind, the information is made sense of and then manipulated to reach a final conclusion. Although the solution is sometimes expressed as a single operation, the student is mentally following a process of verbal reasoning (*3 + 2 = 5; If I have three cards and I receive two more, then I have three plus two which is five. I have five cards now*). In schools, this process of reasoning can be asked to be explicit or shared aloud in pairs, groups or with the rest of the class. At the same time, the statement and the question can be read aloud by the students working not only on reading comprehension, but also on oral skills. These and other learning approaches that accompany the use of the WPs will be developed further below.

Key Words Method for Problem-Solving and its Disadvantages

As important as the nature of the verbal problems is the way in which these problems are conceived and used by teachers in the classroom (Depaepe, De Corte y Verschaffel, 2010, qt. in Martínez et al. 2010, p.7). Very often students are taught to look for certain linguistic structures in the statement that will help them to identify the nature of the problem and from there solve it, without considering the real meaning of the problem itself. Carrillo seems to agree with this idea when he says that once the operation to be used has been identified, the algorithm is applied mechanically without reference to the meaning of the operation (Carrillo, J. et al. 2016, p.11). In the same way, Schley and Fujita claim that WPs are often done just through a reductive process of translation of the problem sentences into equations (Schley and Fujita, 2014, ct. in Daroczy et al. 2015, p.8).

In words of Murcia, school problems often have a repetitive pattern that is easy to identify. (2019, p. 40). In Spanish, in the case of additive type problems, we can recognise the verbs '*juntar,*' '*añadir,*' '*reunir*' or the expression '*en total,*' or '*todo junto;*' and verbs such as '*quitar,*' '*regalar,*' '*dar,*' '*faltar*,' '*perder*' or the expression '*¿Cuántos más*?' for subtraction problems. In English we find the verbs 'to add,' 'to join,' or the expressions 'altogether' and 'in total' for additive problems; and 'to give,' 'to leave', 'to take' or 'difference between' for subtraction, as well as the expression 'less.' According to Nescher, (2000, qt. in Martínez, 2016. p. 28) teaching

problem-solving with the help of key words takes us away from the objective and instead of focusing on single words, one should consider the whole text and find the semantic dependencies that are present in the text. This is important when using WPs as a didactic resource, as it is important to avoid using key words as the main elements and to prioritise the comprehension of the statement as a whole.

Benefits of Learning a Second Language through WPs

Learning a second language implies not only the acquisition of skills such as listening, understanding, speaking, reading, and writing; it also implies valuing a new way of being in the world as part of another culture. Through the WPs, the students can explore different common situation in which English and Spanish people are involved every day. As mentioned before, this requires a carefully design of the statement according to realistic scenarios. Some of these scenarios can be derived from the use of strategies such as storytelling or role-playing in which the students are immersed.

The different skills which are required to master a language can be acquired via different techniques and strategies using WPs as learning resource:

- Listening and Understanding: The mathematical problem can be first read aloud by the teacher or by the students themselves to work on active listening and to provide the students with a model of the prosodic features of speech, which include pitch, volume, speed, rhythm or silence. The variations in speech help us to emphasise the main information of the problem and to work on the different intonation between the statement and question parts.
- Reading and Comprehension: Students need to identify the data, select the main information, interpret the text, and understand the question. There are two different strategies involved in the reading process: reading by ear and reading by eye. Reading by ear means that the reader builds each word letter by letter. The phonemes are used to help build the whole word, which is then identified and given a meaning. Reading by eye means that there is a direct relationship between graphology and semantics. These strategies are related to phonetic and global methods of learning to read. (Crystal, 2007, pp. 125-126).
- Writing and written interaction: the solution process is presented in a written form, which includes not only numerical operations, but also the explanation of the process and the final conclusion. Depending on the stage of the students, these explanations can be more or less detailed. According to Crystal (2007, pp. 127-128), around the age of seven, children begin to use the writing system as a way of expressing what they are talking about. At this stage, a spoken language pattern is clearly reflected.

From around the ninth year, writing begins to diverge from speech and develops its own patterns and organisation. Writing involves a planning stage, organisation of thought, preparation of an outline of what we want to say, rereading of what has been written, and self-correction.

In fact, some of the most recent proposals in mathematics teaching include letting students create their own problems by encouraging their creativity and use of the written word. This would need further work, but it could be interesting from a second language point of view, so that students dare to play with the linguistic concepts and structures they know.

- Responding and speaking: the whole process of solving the problem could be guided by the teacher creating an oral teacher-student and student-student discussion. This builds a thinking environment in the classroom where all ideas can be shared and discussed. Pupils learn from others in a cooperative way in which all take part.

According to the type of text used in each Word Problem, the students work on narrative, descriptive, and argumentative texts. They process the information provided in a chronological order and identify the features of the different elements of the problem in order to establish meaningful relationships between them. Later, in the solving process, they construct arguments and explanations that support their ideas to reach the final answer to the problem.

In this sense, we can see a discursive approach to learning mathematics. This is inspired by the ideas of Vygotsky, who claims that communication in mathematics is the source of generating ideas and demonstrating mathematical learning and development (Arce et al. 2019, p. 41). In the words of Albarracín (2018, p. 27-29), mathematical activity needs to be based on the argumentation and communication of ideas. When the student generates a discourse to express, argue and communicate their ideas to their peers or the teacher, that learning becomes evident. When this happens, we can say that we are in a participatory community in which thinking plays a central role and language is the vehicle that allows the learner to express him/herself and, in turn, articulate that same thinking in the process. In fact, the Irish Primary Mathematics Curriculum explicitly identifies being a communicator and using mathematical language as a key competence. This competence is subdivided into:

- Expressing thinking using mathematical language, signs, and symbols.
- Sharing and comparing ways of representing mathematical thinking and ideas (Primary Mathematics Curriculum, 2022, p. 6).

The Spanish framework foresees the use of mathematical language to share and construct new knowledge within the specific STEM competence number 4. (*Real Decreto* 157/2022, p. 22)

From this perspective, this project conceives learning as part of a social process in which a mathematical communicative discourse is generated that the learner is motivated to use. Each time, the students become more familiar with the components of the discourse itself, not only in numerical terms, but also in the second language.

According to Verschaffel (2020, p. 1), a relevant aspect in relation to word problem solving practices is the quality and quantity of the instructions the students receive during the process. This way, the teacher becomes a language model and a guide, always leaving the protagonist role to the child, who will be the one to solve the problem with his or her instructions. In these instructions, the teacher provides the learners with a new linguistic source which allows them to become familiar with the terms and to create their own mental or verbal discourse on the basis of them. He/She makes visible the thinking scheme that they need to follow to solve the problem. This creates an environment where thinking is visible and consciously present in the classroom. According to Ritchhart (2015, pp. 115-140), 'think – aloud' implies to build a narration of teacher's thinking process which illuminate and demystify the thinking process for students. Then, the students will be able to do their own thinking independently.

In addition, the use of WPs allows students to learn from their mistakes. In the process of constructing mathematical knowledge, errors appear systematically (Engler et al., 2004), which is why it is so important to propose activities that allow not only the detection and correction of these errors, but also the critical discussion of them in order to overcome them. Using mistakes as an opportunity to question and reflect on the student's strengths and weaknesses in problem solving enriches the learning process. In this cooperative problem-solving process, the student questions the error, reflects on it and can correct it in his or her mental structures. This creates a cognitive shock that makes the student develop both an active and a critical role in problem solving (Vizcarra & Gómez, 2016, p.34). In this way, the problem-solving process promotes self-esteem, self-identity and emotional management.

The use of WPs in a second language makes children become more confident and literate which increases their knowledge and control of both the second language, and the mathematical skills.

Spanish and English Language Specific Features.

This section aims to provide a general overview of the main differences and similarities between the two languages that are most relevant for the use of WPs in the second language classroom. However, a more detailed analysis of the differences between the texts used in mathematical problems in school texts in both languages will be carried out in the results section.

English and Spanish come from different language families. English comes from one of the branches of the Germanic language: West Germanic. This family comes from the migrations of the Germanic tribes who lived in northern Europe to central Europe. Spanish, on the other hand, belongs to the Italic family, whose main language is Latin. It is one of the Romance languages, like French, Portuguese, Italian and Romanian. (Crystal, 2007, p. 376-378). Although they do not have the same origin, the two languages share certain grammatical aspects and some lexical similarities because of the historical influence that French has had on the English language (Valenzuela, 2002, p. 28).

In terms of Whitley (1986, p.1), language consists of phonology, morphology, syntax, lexicon, semantics and pragmatics. Pragmatics is defined by Whitley as "the socio-cultural conventions for using the output of the other components." This last component is crucial in the communicative perspective of second language teaching, but all components must be taken into account because of their constant interaction with each other.

If we go deeper into the analysis between the two languages, we can see that the biggest differences between the two languages are at the phonological level (Valenzuela, 2002, p.29). This will affect our didactic proposal in its oral approach, as it will make it difficult for the student to produce the language and to recognise the word by its sound, especially in the case of English, where the grapheme and phoneme are not related by an univocal correspondence. Both languages use an alphabetic rather than a logographic system, specifically the Roman alphabet. English and Spanish share vowels and consonants which are written similarly, with the exception of the letter 'ñ', which is only present in the Spanish alphabet. However, when we look at the pronunciation of each grapheme, we find important differences between the two languages. Some of the most striking differences are the vowel variations. Spanish has only 5 sounds for the pronunciation of the 5 vowels (/a/, /e/, /i/, /o/ and /u/), while British English has a total of 12 vowel sounds (/a:/, /i:/, /u:/, / ɔ:/, /3:/, /I/, /e/, /æ/, /Λ/, /ɒ/, /ʊ/, and /ə/). The consonant systems of Spanish and English are constructed similarly. However, there are differences such as the sounds /r̄/ (corresponding to the grapheme 'rr') or /x/ (corresponding to the grapheme 'j'), which exist in Spanish but not in English, or the different pronunciation of the sounds /v/ and /b/ in English, which in Spanish are pronounced with sound /b/ for both graphemes 'b' and 'v'. These and other phonetic differences between Spanish and English make it difficult for learners to reproduce the message in its original pronunciation. However, repeated reading of the WPs at the beginning and subsequent discussion of the same concepts allows for constant repetition and thus improvement in pronunciation.

On the morphological level, however, we find greater difficulties in Spanish, due to all the inflectional derivatives it presents, such as the change of gender or the conjugations of the verb tenses. Spanish and English share some verb tenses, although the way of conjugating and

using them varies from one language to the other. In fact, according to Whitley (1986, p. 82), "the foremost challenge in Spanish morphology is the verb." However, in both languages, similarities can also be found such as the formation of the plural, which follows similar rules regarding the addition of the letter -s or -es at the end of the word; with the exception of irregular plurals in English which do not follow this rule. E.g. mouse - mice. Something that is very much present in WPs when dealing with quantities of elements. (Whitley, 1986, pp. 16-38)

Another aspect that is of special interest in our proposal is the great difference in the treatment and number of countable and uncountable nouns at the syntactic level. According to Valenzuela (2002, p.37), in both Spanish and English, countable and uncountable nouns behave differently. There are many more uncountable nouns in the English language, so it is common for learners to encounter difficulties and make mistakes in their use of the other language. Another element very present in WPs is the possessive determiner, which can be a problem, especially in the third person singular. For English speakers, it is necessary to make a distinction between the masculine and feminine, which is neutralised in Spanish. In addition, English can show possession by adding -'s- after the subject that possesses the object (e.g. Emma's dilemma) or by using a preposition (e.g. the dilemma of Emma), an option that does not exist in Spanish, which always requires a preposition (e.g. *El dilema de Emma*). (Whitley, 1986, pp. 151-152) In the case of demonstratives, elements that also appear frequently in WPs, we find differences in their formulation between English and Spanish. Spanish shows a greater variation as it has gender differentiation as well as number. Moreover, in the case of Spanish, demonstratives express distance in a way that includes the form '*eso/esa'* in addition to the variants '*esto/esta'* and '*aquello/aquella'* which do find their equivalent counterparts in English 'this' and 'that'.

As mentioned above, the order in which information is presented is a crucial factor in understanding mathematical problems. In general, the statements consist of 2-3 affirmative sentences with a question at the end, although this order can be changed, increasing the difficulty of the statements. English and Spanish have different types of questions, and the ones that interest us in the use of additive WPs are those that ask for an amount. These types of questions are called interrogative questions. It is easy for learners to distinguish between the different sentences because both languages have similar punctuation rules. In the case of Spanish, it is even easier to identify the question because it uses both signs, at the beginning and at the end of the question.

According to Whitley (1986, p.227), Spanish and English coincide impressively in their phrase structures. Both languages follow a similar subject + predicate syntactic structure in which the predicate is made up of a verb and different circumstantial clauses that accompany the verb. The most common complements in WPs are the direct and indirect complements and the locative and temporal adverbial clauses. In this sense, it should be noted that although the general

organisational plan is relatively similar between the two languages (Valenzuela, 2002, p.38), there are some little differences. We find that in English, the subject is always explicitly stated, while in Spanish it can be either implicit or explicit. Another important difference for WPs is the subject + adjective order. This structure is very present in the mathematical problems of the first levels. Examples:

- English: “Emma has made a bracelet for a friend. She used 5 red beads, 8 blue beads and 3 yellow beads. How many beads did she use altogether?” (GILL Education. *Mighty Maths*, 2024, p.37)
- Spanish: “*Aquí hay 8 botones redondos. También hay 5 botones cuadrados. ¿Cuántos botones hay en total?”* (SM. *Piensa Infinito*, 2020, p. 47)

In terms of lexical variety, we must consider another important factor, which is polysemy. The multiple meanings that a single word can have in another language are complex, so it is necessary to ensure that students are familiar with the intended meaning or, anticipate how these concepts can be introduced in the classroom context to ensure understanding of the statement. This is at the semantic level of linguistic analysis, and has a particular relationship with pragmatic-textual aspects. According to Whitley (1986), "it is impossible to study language in isolation from context. Language knowledge cannot be separated from the language of culture”. According to Valenzuela (2002, p.43), in general lines, there are great coincidences between both languages at this level. The aim of this study is to analyse the contexts presented in the different WPs in order to use them in the second language classroom.

In summary, Spanish nouns, pronouns and verbs are inflected differently from English, but noun and verb phrases have largely the same functions and placements in both languages. (Whitley, 1986, p. 227). This is crucial in order to confirm that there are enough similarities between the two languages to be able to use text structures in foreign language teaching. The following analysis of mathematical problems with an additive structure will allow us to know whether these similarities are still present in this particular type of text.

The Multilingual Classroom.

Different languages now coexist in the same spaces around the world. Multilingualism is more common today than it has ever been. Developing a multilingual classroom that embraces different languages and cultures helps students who have spent their lives in a monolingual environment to understand that people who speak more than one language are not the exception but the natural way of life for three quarters of humanity. (Crystal, 2007, p. 409)

The multilingual classrooms have their origins in the placement of heritage and immigrant languages which were recognised within the scholar context as a resource (Ruíz, 1984, qt. in Planas, 2018, p. 216). Spain and Ireland, which are the contexts in which this project is based, both have different co-official languages, such as Galician, Catalan or Basque in Spain, and Irish in Ireland. Within these contexts we find students who use one language at school and another at home. They develop their mathematical skills through their ability to speak mathematics.

In accordance with the line of thought that we have had in mind throughout this document, we know that a text (oral, written or visual) is more than a manifestation of a linguistic code, but a discursive message that requires the interpretation of the context and the culture in which it is stated. Setati (2008, p.108), considered learners as multi-discoursal people involved in different communities with different languages. The use of a language involves the recognition of discourses, creating form-function connections and building meaning (Planas, 2018, p. 218). The recognition of linguistic features in the text becomes a tool for building a meaning. The multilingual learner relies on this recognition of familiar patterns to establish relationships and infer meaning from the language in which the utterance is presented to the language he or she understands as the primary or native language. We are not talking here about using translation as a tool to solve the problem in the first language. But in the recognition of semantic, contextual and temporal structures that allow the identification of the type of problem already known, in order to subsequently develop the argumentation process in this second language.

Mathematics is usually reserved for the time allotted to the subject, which is usually taught in the main language: Spanish in Spain and English in Ireland. However, we can find schools that adopt a multilingual approach by teaching this subject in the co-official language, so that mathematical competence is developed in both languages. The aim of this project is to develop this competence also in the foreign language so that it can be used in other countries.

To Consider before Using WPs for Problem-Solving in a Second Language

The process of learning a second language starts with oral work and then moves on to written work. Therefore, the stage of learning that the learners are at is a determining factor for working with WPs in the classroom. Learners do not only need to be able to read with a certain level of literacy, both in terms of comprehension and in terms of fluency; they also need to be able to recognise concepts in written form.

The first step for problem-solving is the comprehension of the text presented. If there is no such understanding of the problem statement, the resolution process cannot take place. In words of David Crystal (2007, p.123), “Reading crucially involves appreciating the sense of what

is written." We read for the meaning of what is written. To read is to recognize and interpret language that has been written. This is of decisive importance in the problem-solving process as it is necessary to decode the statement in order to be able to work on it until an appropriate solution to the question posed is obtained. According to Daroczy, "the solver first integrates the textual information into an appropriate situation model, or a mental representation of the situation being described in the problem, which then forms the basis for a solution strategy" (2015, p. 4). In this way, a mental activity is generated in the subject who tries to shape the text by giving it a meaning with which to operate later to obtain a final solution. If there is no understanding of the data provided, the context in which the problem is given or the question posed, it will not be possible to work towards a solution, it will be incomplete or decontextualised.

This logical reasoning ability is part of the mathematical competence that is developed through the use of problems and benefits not only the student's mathematical skills, but also the ability to generate comparisons and inferences. These skills are closely related to language and the creation of concepts and meanings. Taking this into account, we know that mathematical problem solving is influenced by the subject's ability to create these logical reasoning processes and their own mathematical competence.

Both reading comprehension and mathematical competence are decisive factors for problem solving, which should be worked on in the classroom before attempting to bring a second language learning process using mathematical problems into the classroom.

In addition to the cognitive aspects mentioned above, the influence of the affective domain on learning must also be considered. The concept of affective domain linked to the mathematical domain has been widely studied in recent years. This is not so in the case of second language learning, despite certain similarities. In terms of McLeod (1992, qt. Arce et al. 2019, p.97), the affective domain in mathematics includes three major components: beliefs, attitudes and emotions. Some important beliefs we find in the mathematics classroom that limit their learning are 'I am not good at maths' or 'maths are not useful outside school.' These statements are also very common in the English classroom: 'I'm not good at languages' or 'why do I need English if I live in Spain.' In the case of attitudes, Hidalgo, Maroto and Palacios define attitudes as the positive or negative predispositions that cause a subject to perceive and respond to the object or situation in a particular way (2004, qt. in Arce et al. 2019, p.98). In both mathematics and second language learning, it is common to find students who reject the subject, especially in the higher grades. For this reason, it is essential to work on self-confidence in the early years of school with cross-cutting proposals to prevent the emergence of this type of belief. Finally, if we look at emotions, in many cases we can find feelings of fear or blockage when trying to solve a problem or communicate in another language, with frustration and anxiety. However, feelings of

satisfaction and joy at having achieved the goal are also common. This is particularly important in this case as both subjects are combined in the same activity, so the affective domain needs to be worked on beforehand in the classroom in order to create the best possible environment so that this does not limit any pupil.

There are specific cases in which we may find that students face certain difficulties working in this line of work, such as students with visual impairments and students with language disorders like dyslexia or dyslalia. In these cases, small modifications should be made to the presentation of the problem to fully include the students in the activity. The use of colours in the text or different fonts can help pupils with reading difficulties to identify written words. For example, a colour can be used for variations of the plural that are not part of the original word. Other options include the use of pictorial supports and oral supports so that the learner can listen while trying to read the problem, rather than just reading it.

Adaptations will always depend on the individual student. The success of using WPs as an opportunity to generate classroom debate in which the second language is used depends on the teacher's ability to involve all the students, since participation is a crucial factor in this proposal. Without it, the exchange of ideas and the communicative experience are not possible.

Methodology

In this section we plan the analysis that will help us to find out whether, as expected, there are enough similarities between the proposed Spanish and English WPs to be able to use the synergies between them as a tool for second language learning.

Verbal word problems, as mentioned above, are worked on in mathematics throughout the primary school years. In the Irish Curriculum, problem solving appears not only as an element that contributes to the development of strategic competences, but also as a central process in the development of children's mathematical proficiency (Primary Mathematics Curriculum, 2022, p.13). This is also the case in the Spanish curriculum, which also presents problem solving as an activity that is present in everyday life and through which other axes of the mathematical domain are put into practice, such as reasoning and computational thinking, representation of mathematical objects and management and communication through mathematical language. (*Real Decreto* 157/2022, p. 93)

Mathematics is generally covered in the classroom with the help of textbooks, which provide a guide to working through the content in a sequential way. Specifically for this project, the WPs considered in the analysis belong to textbooks from the first year of Primary Education. The books used for the analysis are current books that are being used in classrooms in both countries this year, in accordance with current educational legislation. These belong to the following publishers: SM (Ed. *Revuela*: 2022; Ed. *Piensa Infinito*: 2020), ANAYA (*Método ABN*: 2022), and Santillana (2022) in Spanish; and CJ Fallon (*Mathemagic*: 2023, *Master your Maths*: 2023), GILL Education (*Mighty Maths*: 2024). Outdated textbooks or textbooks containing only mathematical exercises and not verbal problems have been discarded from the analysis.

Design of the Analysis

In the first phase, a selection of the problems to be analysed was made from the seven selected publications belonging to the first year of the Primary Education Stage. This selection includes only one-step additive structure problems, in which the data is expressed in written form and not through images or symbols.

In this phase, the three main types of problems are considered: change, combination and comparison. However, for its application in the classroom, the meaning that the numerical element receives in each type must be taken into account. There are problems, especially comparison problems, in which the number does not have a meaning of quantity but of measurement. At this stage, problems of time, height, weight, age or money are frequently used with the aim of introducing pupils to the sense of measurement. Although these problems can be

very interesting for learning comparative structures, they are not the object of study in the present project because of their different conceptual meaning and their lack of lexical richness. It would be necessary to develop another study to talk about the number as a unit of measurement and its role in the two different languages.

Some proprietary analysis tools are then developed to compare the WPs in both languages in terms of their linguistic, semantic, and numerical elements. These tools make it possible to transform the various WPs into concrete elements that can be compared and analysed in order to extract similarities or differences between the two languages.

Looking closely at the textbooks, we can see that not all types of WP with additive structure (change, combine, compare and equalise) are uniformly present in the text. For this reason, a register was first drawn up to count the presence of the different types and subtypes in order to find out which are the most familiar at this stage.

Table 4. *Number of WPs by type, subtype and publisher.*

Publishers	**Type of Word Problem**														
	Change						**Combine**		**Compare**						
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**1**	**2**	**3**	**4**	**5**	**6**	**Eq.**
SM. *Revuela.*															
SM. *Piensa Infinito.*															
ANAYA															
Santillana.															
CJFallon. *Mathemagic.*															
CJFallon. *Master your Maths.*															
GILL Education. *Mighty Maths.*															

In addition to recording the presence of the different types of problems, which will be useful to know which type of enunciative structures the students are most familiar with, three other tables were created to analyse globally the linguistic structure of the different types of problems in both languages. Each table analyses a different type of problem, as the linguistic structures used in them differ from one type to another. The registered categories refer to:

- Vocabulary level: it refers to the types of words used in the problem. Specially, those that are relevant to the understanding of the problem. Within this level, a further distinction is made between the grammatical category of the words that appear and the thematic group to which they refer.

- Presence of key words: this section lists the words that are commonly used to identify the type of problem, and which form part of the pattern that appears repeatedly in mathematical problems, as mentioned above.
- Order of information: it shows where the different data and question are presented in the text.
- Type of number: it refers to the form in which they are expressed (numerical or written).
- Verbs used: it lists the verbs that appear repeatedly as main verbs in the different problems.
- Verb tenses used: it lists the different verb tenses that are most commonly used in each type of problem.
- Grammatical structure: This category includes the syntactic structure that usually appears in each type of problems.
- Temporal order: this category is only included in the change problems tables. This category refers to whether the change presented in the WPs follows a linear temporal sequence or jumps forward or backward in time.

These tables list the words, phrases and structures that are most frequently used in the various examples of problems under analysis. Later in the presentation of the results, the frequency with which these words appear will also be included in order to be able to analyse their importance for the process of teaching and learning a second language.

Table 5. Analysis tool.

Type of problem								
Publishers	**Vocabulary level**		**Presence of key words**	**Order of information**	**Type of number**	**Verbs used**	**Verb tenses used**	**Grammatical structure**
	Word class	**Topic**						
SM. *Revuela*								
SM. *Piensa Infinito*								
ANAYA								
Santillana.								
CJFallon. *Mathemagic.*								
CJFallon. *Master your Maths.*								
GILL Education. *Mighty Maths.*								

Note: This table shows the general observations made during the analysis of the set of problems presented by each publisher. It includes the features that are considered to be most important at the textual level and that need to be taken into account in order to be able to use mathematical problem statements as a teaching strategy. In order to complete this table, we considered verbs that appeared repeatedly in different problems, rather than isolated in a single problem. This is because the analysis seeks to analyse common and representative structures, so if it appears only once, it is not considered significant.

Table 6. Example of the analysis of two different problems.

Change problems								
Publishers	**Vocabulary level**		**Presence of key words**	**Order of information**	**Type of number**	**Verbs used**	**Verb tenses used**	**Grammatical structure**
	Word class	**Topic**						
SM. *Revuela.*	Nouns	Proper names Food	Cuántas Le quedan	Initial quantity + quantity involved in the change + Question	Numeral	Tener Comer	Pretérito perfecto simple	Subject + verb + Direct object
CJFallon. *Master your Maths.*	Nouns	Proper names Scholar material	How many To have left	Initial quantity + Quantity involved in the change + Question	Numeral	To have To give	Past simple	Subject + verb + Direct object + Indirect object
	Pronouns							

Note:

Problem 1. "*Uri tenía 5 fresas. Se comió 2. ¿Cuántas le quedan?*". Example extracted from SM. *Revuela,* 2022, p. 39.

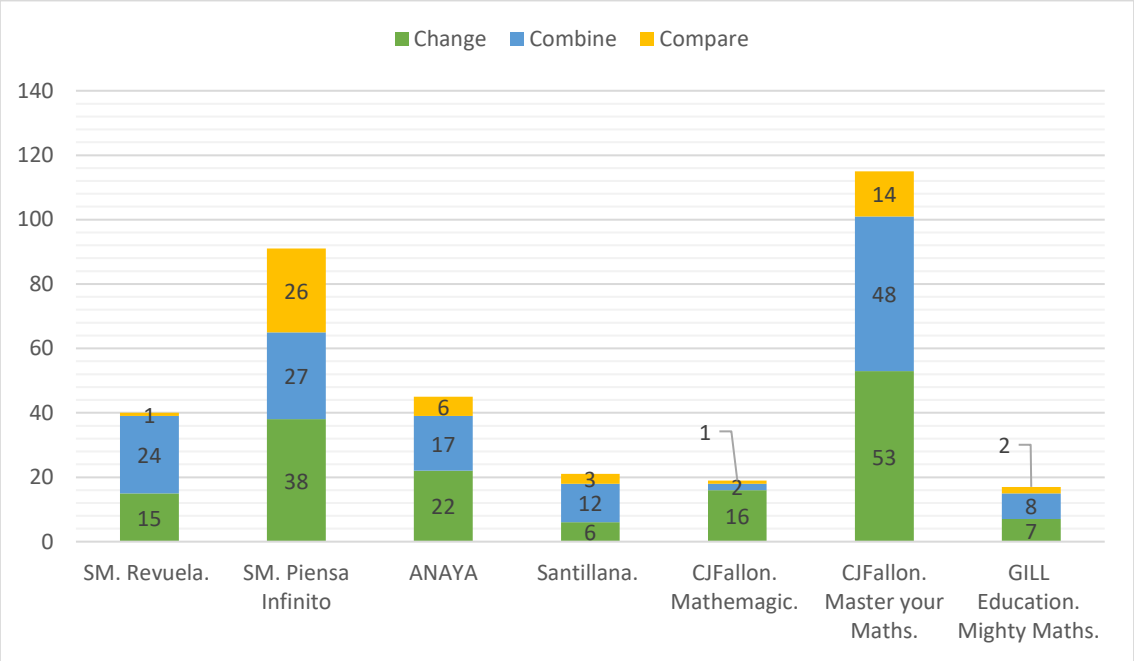
Problem 2. "Ann had 19 crayons. She gave 7 to Fiona. How many had she left?" Example extracted from CJFallon. *Master your Maths*, p. 31.

Results and Discussion

This section presents the results of the analysis of the various publications in relation with its interest as a didactic resource. The tables from which the data presented here have been taken can be found in the appendix 2.

Presence of each Type of Problem by Publishers

Figure 1. Graph of the number of each type of problem by publisher



After analysing the different publications, we found a greater number of change and combination problems in the first-year books. It is noteworthy that there is a clear difference in the prevalence of mathematical problems across different publishers. Among the Spanish publications, SM's *Piensa Infinito* edition has 91 WPs compared to its *Revuela* edition with only 40 WPs. Santillana is the publisher with the fewest problems within the Spanish framework, with only 21 problems, while Anaya is in the average with 45 WPs. In the Irish context, the difference is even clearer when comparing the 115 problems in the CJFallon edition of *Master your Maths* with the 19 problems in the *Mathemagic* edition of the same publisher and the 17 problems in the GILL Education edition.

If we take into account the type of problem, we can see in Table 4A (Appendix 2), that for all publishers, the most frequent problems are those of change, with 157 WPs, followed by those of combination, with 138. On the other hand, among the different publishers analysed, there are only 53 compare problems in total. Within the change rate problems, it is more common to

ask about the final quantity, and among these subtypes, those in which the change is a decrease are the most common. In the category of combined problems, those who ask about the whole are twice as many as those who ask about one of the parts. In the case of the comparative problems, however, there is no clear trend that is repeated across publishers, so it is difficult to draw conclusions about the results obtained on these problems. Overall, the results show that types 3 and 4, which ask for the quantity compared, are the most common, followed by types 1 and 2, which ask for the difference. Subtypes 5 and 6, which ask for the reference, and equalisation problems are rare at this level.

This will be important in choosing the optimal problems for use in the second language classroom, as those with which the learner is most familiar should be used to draw on their prior knowledge. So, at first it seems clear that the teacher should start with change problems, which ask for the final quantity after a change in quantity, or combination problems, which ask for the total quantity. According to Nesher, change problems are the easiest for the student, followed by combination problems and finally comparison problems. This is because the student sees the problem as a series of facts that are easy to interpret. Students do not find it difficult to solve the change problems 1 and 2, but those that ask for the initial quantity are more difficult. The same is true for combination problems. Those that ask about the whole rather than one of the parts are significantly easier. (1982, pp. 373- 393)

In the light of these findings, change problems seem to be the most appropriate ones to initiate the use of WPs in the foreign language classroom; however, their wide linguistic variety, as will be seen below, may make it more difficult for learners to cope with them initially. Especially in the case of English learners with Spanish as a second language, it could be difficult to face this type of WP due to the conjugation variations of the verb. From a didactic point of view, it seems best to start with the combination problems, because they are mathematically simple and linguistically rich but accessible for the students.

Language

The main results found in the analysis concerning the linguistic structures involved in the WPs analysed are shown below.

Structure and Format of WPs

Firstly, I would like to mention the format. This varies from publication to publication, from WPs presented in text only to others accompanied by images.

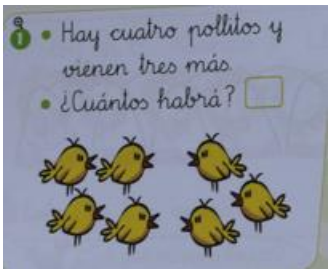


Figure 2. Example of a change problem extracted from ANAYA (2022). *Método ABN*. p. 20.

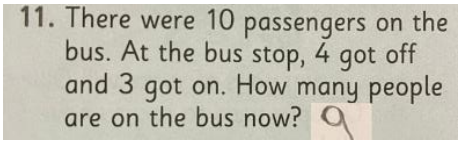


Figure 3. Example of a change problem extracted from CJ Fallon (2023). *Master your Maths*. p. 11.

In addition, we find a similar text structure in both languages, consisting of one to three affirmative sentences followed by a final question. The similarity in format and structure allows students to identify the parts of the problem immediately, even without knowing the words in it. A distinction is made between the parts in which the data are presented and the question in which the unknown is asked. This helps us to develop the concepts of affirmative, negative and question statements. In the case of second language acquisition, it is interesting, at least at the beginning, to accompany the elements with an image that helps the reader to understand the statement or that acts as a pictorial legend, as in the case of pictographic stories. However, these visual aids should be used to facilitate reading and comprehension, not as a substitute for the written text (the same linguistic level is not developed when confronted with the sentence 'I have four dogs' as if we only find the words 'I have' accompanied by a picture with four dogs). Within the classroom, the use of manipulative flashcards can help not only with comprehension, but also as mediators that students use as a tool to construct the problem situation and rely on both to solve it and to explain it to their peers. In this example, the students could be given the written text on the one hand and a container with different animals cut out on the other. The students have to identify the animal that represents the word 'dog' and collect four of them. This strategy is not only useful for the student, but also for the teacher to check the student's understanding and problem-solving skills.

Combine problems are generally the shortest, while change problems are the longest. This is because the combination problems follow a simple structure. In the case of problems of change in their structure, adverbial complements of time and indirect objects, which usually refer to a second person involved in the action, are more common. In both types of problem, although to a lesser extent, circumstantial complements of location sometimes appear. Those with a different syntactic structure are the comparison problems, which always include in their predicate, in addition to the indirect object, an adverbial phrase related to quantity, such as 'less than' or 'more than.'

Linguistic Variety and Richness

In comparative problems where the number is the unit of measurement of a quantity (Ana is 7 years old. Her sister is 3 years older. How old is her sister?), there is less linguistic variety as they all ask for the same unit of measurement. This makes them less interesting for second language teaching beyond the purely comparative structure. For this reason, the linguistic analysis will focus more on problems where the number appears as a unit to quantify an element. With this type of tasks we develop number sense in relation to the concepts they represent.

The main linguistic interest in the use of WPs in the foreign language classroom lies in the concepts on which the problem is based, as well as the context surrounding them. Thus, nouns, verbs, adverbs of place and time, adjectives, pronouns and possessives appear as linguistic units of great interest for language learning.

If we look at the nouns used in the mathematical problems of the first years, we can see that in many cases it coincides with the basic vocabulary of a second language: numbers, animals, family, food, school materials, ways of transport, jobs, people (terms such as 'friend,' 'boy,' 'girl,' 'adult,' or 'teenager') and common objects ('ballons,' 'flowers,' 'books,' 'cards,' 'furniture,' and so on). The most common nouns in WPs are food and animals, followed by people and family, which act as subjects whenever there is no proper noun. Proper nouns appear in almost all sentences, which can be an advantage for learners in identifying the subject, as they are written with a capital letter in both languages. Less frequently, but also with a significant frequency, are school materials and ways of transport. Clothes appear very sporadically in the WPs analysed. The category 'common objects' or 'other' includes a wide range of objects that are frequently used in the WPs because they are close to the context of learners' everyday life and are therefore also of great interest in second language teaching, even though they are not included in any thematic block.

Personal pronouns also appear in the text, although less frequently. These are terms that are often used as basic elements in the first years of second language learning. In addition, the WPs themselves help us to relate the subject to its corresponding pronoun by sometimes presenting the proper noun in the first sentence and then the personal pronoun. This is frequent in problems written in English, but not in those written in Spanish, due to the obligatory nature of the explicit subject in the English language.

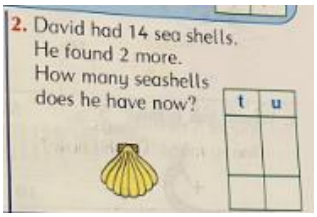


Figure 4. Example of a change problem extracted from CJ Fallon. (2023, p.61). in which we can find the subject 'David' related to his personal pronoun 'he.'

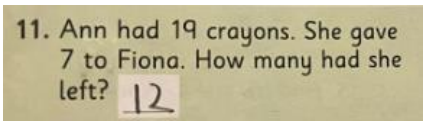


Figure 5. Example of a change problem extracted from CJ Fallon. (2023, p.31). in which we can find the subject 'Ann' related to his personal pronoun 'she.'

Another element that appears frequently, especially in combination questions, are adjectives. In this grammatical category, the use of colours to describe the different parts of the whole stands out. Adjectives relating to shape also appear, but more sporadically, or to personal characteristics (*Hay 13 niños y 11 niñas en la clase. ¿Cuántos alumnos hay en total?* In this WP, the terms 'niño' and 'niña' show a gender characteristic to differentiate the total number of students in two parts). This is particularly useful in the early stages of learning and practising colours. The use of colours or shapes as descriptions can also appear when discussing elements of other problems. For example, if it is an animal problem, we can discuss in class that an elephant is big and a mouse is small; or about the different colours of a lemon, an orange or an apple in the WPs that work with fruit as the main element.

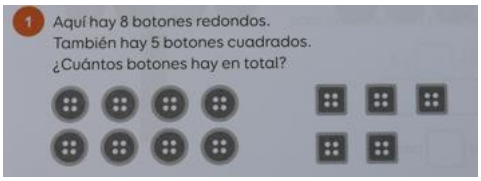


Figure 6. Example of a combine problem extracted from SM (2020). *Piensa infinito*. p.47. in which we can find vocabulary related to shapes and common objects.

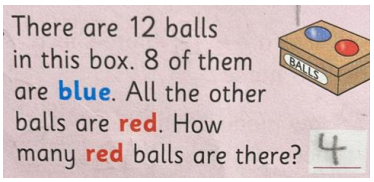


Figure 7. Example of a combine problem extracted from CJFallon (2023). *Master your maths*. p.40. in which we can find vocabulary related to common objects and colours.

For example, numbers are often used in the text to describe the quantity that accompanies the direct object as a determiner. They may be in numerical form or in written form (much rarer, less than 25%). For correct understanding, it is advisable to use the numerical form first and then to establish the relationship between the written and numerical forms. It is necessary to teach from the numerical expression to the written expression of the number, not the other way round. During the discussion or the correction that accompany the solution process, counting can be practised as a group, reinforcing both the meaning of each number with the fingers, and its pronunciation.

In those problems where the initial quantity is asked, it is common for adverbs of indeterminate quantity such as 'some' and '*algunos/as'* to appear. With this type of WP, it is

possible to introduce students to the distinction between concrete and indeterminate quantities through a concrete situation that could be accompanied by manipulative materials to ensure a better learning experience and understanding.

In addition, complements relating to location and time were found in the various WPs in both languages, so that they could be learned in context rather than as isolated words. As circumstantial adverbs of time, it is common to find the parts of the day (morning, afternoon, evening, night), the days of the week, or the months of the year. Less frequent is the presence of times or expressions such as 'this year,' or 'next year'. Temporal connectors such as 'now' and 'then' appear very frequently in change problems as part of their key words.

Adverbs of place also appear with a medium frequency in combination and change WPs, but their variety is greater: parts of the house (rarely), of the city (street, shop, bakery, etc.; often), of the landscape (field, pond, tree; very often) or specific terms like 'outside' or 'inside.' The structure prep + art + noun is common in both languages and can therefore be easily interpreted by students. However, the different use of prepositions in English and Spanish can make this recognition difficult ('*en el colegio*/at school,' '*en el coche*/in the car,' *'en el tren*/on the train'). WPs can therefore be an excellent way of learning these prepositions in context. Examples:

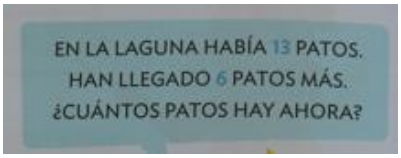


Figure 8. Example of a change problem extracted from Santillana (2022). C*onstruyendo mundos*. p.24. in which we can find two complements relating to place: '*en la laguna*,' and time: '*ahora*.'

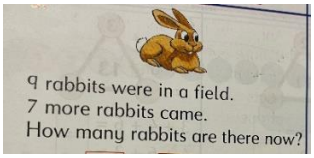


Figure 9. Example of a change problem extracted from CJFallon (2023). *Mathemagic*. p.60. in which we can find two complements relating to place: 'in a field,' and time: 'now.'

Thus, change problems have a greater variety of verbs depending on these contexts: 'to sell,' 'to buy,' 'there is/are,' 'to have,' 'to give,' 'to take,' 'to give away,' 'to take away,' 'to eat,' 'to add,' 'to spend,' 'to lose.' These are the most common, with a frequency of over 50%, but there are others, such as 'to distribute,' 'to follow,' 'to collect,' 'to join,' 'to need,' 'to come,' 'to find,' 'to leave,' 'to get,' 'to fall,' 'to make' and 'to use,' which appear only in concrete contexts.

The most common verbs in combine WPs are 'to have,' 'there is/are,' and 'to be.' These verbs appear in more than 75% of the change problems analysed. In these problems, verbs common to change problems such as 'to sell,' 'to need,' 'to join,' 'to get' or 'to collect' also appeared, but with a frequency of less than 25%. The same is true for the comparison problems, related to the development of numerical sense, in which the verb 'to have' stands out with a frequency of more than 75%, whereas the verbs 'there is/are,' 'to be,' and 'to do' occur much more rarely.

As for the verb tenses, in general we can say that in both languages the present, past and future tenses appear in the change problems, with the past tense being the most predominant in these; the present tense is the dominant verb tense in the combination problems. The least varied problems are the comparison problems, where only the past and present tenses appear.

However, there is a difference between the two languages and that is the use of the passive, which is quite common in problems written in English, but does not appear in those written in Spanish. In Spanish textbooks, statements are written in the active voice, while in English-language editions, the passive voice structure is very common due to its extensive use within the language. In practically all word problems involving change, we encounter the key phrase 'to have left or to be left' in contrast to the Spanish expression '*quedan*'(remain). This type of voice, which is understood as a compound tense, is formed in both languages with the verb 'to be' + (past) participle. It is usually learned at much higher levels of language study (secondary stage). However, word problems can be a good way to familiarize students with these structures upon which they will delve deeper into in subsequent stages.

Another important difference between the two languages at this level is the verb conjugation which varies based on the person performing the action. in English, this conjugation change is typically only noticeable in the third person singular (he/she/it), where an '-s' is added to the base form of the verb (e.g., 'he eats,' 'she runs'). In contrast, languages like Spanish exhibit more extensive conjugation changes across all persons ('*yo,' 'tú,' 'él/ella,' 'nosotros/nosotras,' 'vosotros/vosotras,' 'ellos/ellas'*), resulting in different verb forms for each person. This is particularly important for change problems, as mentioned before, because they present the most variation by constructing a narrative text in themselves with a sequence of temporally ordered events.

If we look at the key words collected in the different problems, we can see that they are the same in both languages as their counterparts in the other language. However, these words are not similar to each other, with the exception of the expression 'in total.' The most frequent expressions in change problems are temporal expressions like 'now/*ahora*' and 'then/*entonces*,' as well as verbs like 'to give/*dar*' or 'to join/*unir*', in addition to the expression 'to be left/*quedan*.' Regarding combination problems, the most frequent ones are 'altogether/*todo junto'* and 'in total/*en total*.' These results align with what was anticipated in the theoretical framework.

Overall, when analysing the problems, we see a consistent structure between both languages. There is a similar structure between them, and the terms in one language are direct counterparts of the other. However, there are some verbs that may cause confusion for the learner because of their polysemy. For example, the expression *'quedan 3 plátanos'* can be difficult to understand

because the verb '*quedar'* is associated with the verb 'to meet' in English, which does not have the same meaning as in the sentence. The same applies to the verb 'to leave,' which refers to the idea of going away from a place. In WPs context, however, it has a different meaning. This can be a difficulty on first contact with WPs containing such polysemous terms. However, it can also help students to understand polysemy better and encourage the creation of additional opportunities to practise polysemous words and phrases.

Because of this linguistic variety, we can see WPs as a type of text that allows foreign language teachers to introduce many terms and expressions into the classroom. The design of the WPs must be guided not only by the mathematical competence we want our students to develop, but also by the type of text and concepts they should learn according to their curricular level.

Importance of the WPs Elements according to the Foreign Language Curricula

According to *Real Decreto* 157/2022, in the field of foreign languages, elementary linguistic units that express entities, possessions, quantities and numbers are included in the basic knowledge of the communication block. The basic vocabulary related to interpersonal relationships, housing, places, and the immediate environment are also included in this block. All these elements are present in the WPS because, as mentioned above, they are based on realistic contexts close to the reader.

The greatest linguistic variety is found in the problems of change. These are placed in a greater variety of contexts, which are accompanied by a greater variety of nouns and verbs according to these contexts. The most common contexts are places where animals live, where a certain number of animals join or separate from the original group; the shop, where a seller sells a certain amount of a product or the buyer buys a certain amount of a product; or meals, either the preparation of a meal or the act of eating something.

According to this curriculum, mathematical problems include elements considered as basic knowledge belonging to the three cycles into which primary education is divided. In this way, we understand that WPs are a type of text with a sufficiently flexible structure to be used as a didactic tool for learning a second language throughout primary school.

These results allow us to affirm that there are enough similarities between the WPs in both languages, Spanish and English, to be used as a didactic resource in the second language classroom. The potential of this resource will be discussed throughout the following section as well as through the design of a real pilot study carried out in a primary school classroom.

After the analysis, we can claim that mathematical problems allow us to develop different linguistic structures in the classroom. These structures are different according to the type of

problem used and its context, so that one type or another is chosen according to what needs to be taught. For example, problems of change help us to develop narrative text structures, while problems of combination help us to develop descriptive texts. Comparative problems can be seen as expository texts that seek to analyse differences and similarities. Change problems allow the development of cause-effect relationships, and combination problems allow the development of part-whole relationships. In this way, the relationship between the development of language and patterns of thought becomes clear.

Didactic Proposal

Having carried out the analysis, and with the aim of verifying that WPs could indeed be used in the classroom for teaching purposes, I designed a small pilot study consisting of two main sessions in which WPs were the main resource. In this case, the use of WPs serves as an activity to review what has been learned in a playful way.

The main objectives of this didactic proposal are:

- To develop a competency-based education centred on problem-solving and the expression of ideas in a second language classroom.
- To promote students' confidence in their linguistic and mathematical abilities.

Learning Context

This experience was carried out in a Year 1 classroom in a school in Ireland. The average age of the pupils is 7 years old and there are 28 pupils in the classroom. It should be noted that primary school pupils in Ireland learn Irish as a second language rather than other languages, so their exposure to Spanish is limited, lasting only two months. To ensure the best possible educational response, the first experience was conducted in a teacher-guided manner in a large group, while the second had a hybrid structure between group and individual work based on three levels of differentiation tailored to each student's linguistic and mathematical needs and abilities.

There are four pupils in the class with undiagnosed reading difficulties and one of them struggles to process information. This has been taken into account in the presentation of the structures by using colour coding to help these pupils identify the words they already know (red is used for nouns, while green is used for gender and number differences).

Design of the Proposal

For this pilot test it was decided to use combination problems as the subject of the study because they have a simple structure with little variation. This is a descriptive structure that has allowed the learnt vocabulary about animals, numbers, colours, and food to be reinforced and practised, in addition to the verbs 'to have' and 'there is/are.'

Two sessions have been conducted as a trial run: the first with the aim of familiarising students with short texts in Spanish using the WPs; and the second with the aim of using these texts to put into practice the linguistic structures learned previously. In the first phase, only subtype 1 combination problems are introduced, while in the second phase, both type 1 and type 2 problems are mixed.

The vocabulary and structures students encounter in the WPs were presented in advance and worked on orally and in writing to ensure comprehension and identification, as a reminder of their previous knowledge. Then, the gamified dynamic with the WPs was run at the centre of the learning experience to put all this knowledge in practice.

The first experience was also intended to make the students lose their fear of dealing with a text in Spanish as it was the first time they were presented with a textual fragment instead of isolated words or sentences. In this case, the descriptive text was processed through the farm animals and the second one related to a journey and the food that each pilgrim has in the different stops along the way. Both were done thanks to a gamification-based dynamic using a Genially presentation (available at appendices 3 and 4). The students were first introduced to the game as this was the first time they had been exposed to a similar activity. Once it was established that they understood what they were being asked to do, they were asked about their feelings about the activity. Most of the students reported that they thought they were not able to understand and solve mathematical problems in Spanish.

A similar method was used to solve the different problems in both lessons. In the first one, the problem was first read by a student, with help if necessary, and then read a second time by the teacher. The students were then asked if they knew the solution to the problem and asked to say it using the sentence they had been given. This was followed by a short discussion in English about the strategy they had followed to solve the problem. They were always asked to use the Spanish vocabulary they knew in their explanations as much as possible. The purpose of this discussion was again to check that the meaning of the different elements of the problem statement had really been understood, in addition to make the students use the second language. The second experience followed the same gamification-based structure as the first, using *El Camino de Santiago* instead of the farm as the context. In this experience, the students solved 2 problems in big group and another 2 individually. On this occasion, the statement was read, like in the previous experience, twice, first by a student and then by the teacher. However, this time each student had time to write the solution and problem-solving strategy before correcting them. The different problems were given to the students in written form with sufficient space to draw the elements involved in the problem, the operation they used to solve it, and finally the solution. This aims to assess the students' understanding of the statement as well as whether they have chosen the appropriate problem-solving strategy. At the end of the experience, a group discussion is conducted for each of the problems solved, allowing students to share their ideas with the rest of the classmates using Spanish as much as possible.

At the end of each experience, a survey was given to the students to test their understanding of the WPs, the difficulty of the WPs and whether they had enjoyed the experience.

Results of the Proposal

Globally, the proposal has been successful because foreign languages have been used in a natural, thoughtful and communicative way. Additionally, the proposed objectives have been achieved, with a significant number of students increasing their confidence both in using Spanish, and their ability to solve mathematical problems in another language.

During both experiences, it was observed that WPs represent a motivating challenge for the students. The majority of them wanted to participate by either reading the problem or providing a solution. The level of understanding of the statements varied from one student to another. This can be attributed to two reasons: the progression in complexity of the presented statements and the assistance provided through the colour code, which facilitates the identification of words involved in the statements. Also, there was a great variety in the mathematical skills of the students; many found difficulties in solving type 2 combination problems despite solving type 1 problems perfectly and understanding the overall problem meaning.

On the basis of direct observation during the experience, it was possible to assess the linguistic level of the different students taking part in the discussion. In addition, during the second experience, the written answers collected made it possible to assess both the level of comprehension and the mathematical competence of the students. 5 of the 25 students who completed the second experience successfully solved the 4 problems proposed, demonstrating a high level of competence both in terms of understanding of the Spanish language and mathematical competence. Another 12 students solved three of the four problems correctly but had difficulties with those that asked for one of the parts, a difficulty that is more related to mathematical competence than to linguistic competence, whereas 7 other students successfully solved 2 out of the 4 problems. In this group there is evidence of attentional lapses that led to the failure of the problem. There was only one student who could only solve one problem out of four and no student who could not solve any of the problems. It should be noted that the latter student has information processing difficulties. In fact, WP 2 and 4 of the second experience do not specify that there are only two types of fruit in the basket. This could lead to confusion among the students who may doubt whether there is a third type of fruit in the fruit bowl.

Thanks to the results of the survey completed by the students after both experiences, we can see that despite encountering difficulties and initial apprehension towards the experience, the majority of the students enjoyed it and liked using mathematics in Spanish teaching. This is significant because we can assert that by the end of the experience, the fear of facing problems in Spanish had disappeared, replaced by a positive feeling and increased self-confidence.

Conclusion

Generally, research such as that conducted here is usually divided into two complementary works, each supporting the other. However, engaging in both analysis and a didactic experience, even if it was only a pilot experience, has allowed me to discover and corroborate the potential of mathematical problems as textual units for teaching a second language in a much more comprehensive and realistic way.

Furthermore, the development of this study has not only enabled me to generate comparison tools, but also to use them for a specific purpose and concrete methodological strategy, thus enhancing my research competence. Similarly, conducting the analysis has allowed me to relate the different results to their direct didactic application, enabling me to make decisions based on them that contribute to creating a specific classroom proposal. With all of this, and with the variety of reflections that intertwine with theory throughout the entire document, it can be seen that the objectives regarding my growth as a future teacher specializing in foreign language teaching have been achieved thanks to the completion of this research.

This experience was carried out in an English-speaking context with the learning of Spanish as a foreign language. However, the results obtained allow us to conclude that it would be possible to use WPs in a Spanish-speaking classroom for learning English as a foreign language. In addition, since exposure to English in Spanish classrooms begins in Infant Education, it is expected that the results will be even more promising than those obtained in the pilot study.

There are enough similarities in the structures of the WPs of both languages to be able to introduce this tool as a pedagogical resource for the foreign language in the classroom. This research has laid the foundations for the use of WPs in the foreign language classroom, which will need to be further developed in future studies to fully exploit its potential. However, it serves as a starting point and provides inspiring results towards this end.

This study offers the possibility of teaching a second language through a communicative approach, based on sharing ideas and discussing them in order to build common knowledge. All this, using WPs as textual resources that help to give a realistic context to the information, while the reader completes the text with its resolution process and final answer. Many teachers use different types of texts such as stories or news articles to develop this type of concepts in a second language, but the power of WPs is that they involve the reader. The reader needs to solve the problem, not just read or understand it. They need to do something with the information they have received. Understanding the text is crucial to reach the correct solution, so the reader is motivated to read the text as comprehension becomes a necessity.

Rather than putting language at the service of mathematics, the aim is to create a transdisciplinary approach in which we practise language while developing mathematical thinking in the classroom. The WPs thus appear as texts that the teacher uses to generate not only language production but also thinking.

Bibliographic References

Albarracín, L., Badillo, E., Giménez, J., Vanegas, Y., Vilella, X. (2018). *Aprender a enseñar matemáticas en la Educación Primaria.* Síntesis.

Arce Sánchez, M., Conejo, L. Muñoz, J.M. (2019). *Aprendizaje y enseñanza de las matemáticas*. Síntesis.

Carrillo Yáñez, J., Contreras, L. C., Climent, N., Montes, M.A., Escudero, D.I., Flores, E. (Eds.). (2016). "Problemas aritméticos" In *Didáctica de las matemáticas para maestros de Educación Primaria* (pp. 31-52). Colección Didáctica y Desarrollo. Paraninfo: universidad.

Crystal, D. (2007). *How language works.* Penguin books.

Daroczy, B., Wolska,M., Meuerers, D., & Nuerk, H.C. (2015). "Word problems: a review of linguistic and numerical factors contributing to their difficulty." *Frontiers in Psychology*, *6*, 348, 1-13. https://doi.org/10.3389/fpsyg.2015.00348

Engler, A., Gregorini, M.I., Müller, D., Vrancken, S., Hecklein, M. (2004). "Los errores en el aprendizaje de la matemática." *Premisa*, pp. 23-32.

Fernández Bravo, José A. (2010). *La resolución de problemas matemáticos: Creatividad y razonamiento en la mente de los niños*. Grupo Mayéutica-Educación.

Martínez, M., Mandujano, O.Vega, L.A., and Llaven, M. I. (2016). "El papel de los problemas de enunciado verbal en la enseñanza de las matemáticas en la educación primaria desde la perspectiva de los profesores." *REIIE, 2*, (1), 5 - 31.

Murcia, J.A. (2019). "Un tren sale de Madrid." In *Y me llevo una.* (pp. 23 – 45). Nordicalibros. Edelvives.

Nesher, P., Greeno, J.G., and Riley, M.S. (1982). "The development of semantic categories for addition and subtraction." *Educational Studies in Mathematics*, *13*, 373-394.

Organisation for economic co-operation and development. OECD. (2003). *"The PISA 2003 Assessment Framework." Mathematics, Reading, Science and Problem Solving Knowledge and Skills,* (pp. 14-18).

Planas, N. (2018). "Language as resource: a key notion for understanding the complexity of mathematics learning." *Educational Studies in Mathematics*, *98*, 215-229.

Ritchhart, R. (2015). *Creating Cultures of Thinking: The 8 Forces We Must Master to Truly Transform Our Schools.* JOSSEY-BASS.

RTVE. (May 17, 2021). "Where languages are born" [Video file]. In *The brain hunter*. RTVE. Retrieved May 21, 2024, from https://www.rtve.es/play/videos/el-cazador-de-cerebros/donde-nacen-idiomas/5897642/

Setati, M. (2008). "Access to mathematics versus access to the language of power: the struggle in multilingual mathematics classrooms." *South African Journal of Education*, *28*, 103-116.

Valenzuela, J. (2002). "Lingüística contrastiva inglés-español: una visión general." *NormaLingua: Revista de lingüística de la Universidad de Murcia*, *5* (2), 27-45.

Verschaffel, L., Schukajlow, S., Star, J., Van Dooren, W. (2020) "Word problems in mathematics education: a survey." *ZDM – Mathematics Education*, *52*, 1-16.

Vygotsky, L.S. (1998). "Aproximación al lenguaje." In *Pensamiento y lenguaje* (pp. 1-5). Pueblo y Educación.

Vizcarra, F., Gómez, S.A. (2016). "El error como oportunidad para reflexionar y tomar decisiones asertivas en el aprendizaje de las matemáticas." *Revista Mexicana de Bachillerato a Distancia*, *16* (8), 34-42.

Whitley, M. S. (1986). *Spanish-English Contrasts: A Course in Spanish Linguistics*. Georgetown University Press.

Legislative Framework

- Ireland:

Primary Curriculum Framework (2002). For Primary and Special Schools. National Council for Curriculum and Assessment (NCCA). An Roinn Oideachais. Department of Education.

Primary Mathematics Curriculum (2022). For Primary and Special Schools. National Council for Curriculum and Assessment (NCCA). An Roinn Oideachais. Department of Education.

- Spain:

Real Decreto 157/2022, de 1 de marzo, por el que se establecen la ordenación y las enseñanzas mínimas de la Educación Primaria.

Reference of the Textbooks Analysed

- SM (2022). *Revuela.* ISBN-13: 978-8413926506
- SM (2020). *Piensa Infinito*. ISBN-13: 978-8413188317
- ANAYA (2022). *Método ABN.* ISBN-13: 978-8469894439
- Santillana (2022). *Construyendo Mundos.* ISBN-13: 978-8468071176
- CJ Fallon (2023). *Mathemagic*. ISBN: 9780714414409
- CJ Fallon (2023). *Master your Maths.* ISBN: 9780714421698
- GILL Education (2024). *Mighty Maths.* ISBN: 978-1-8045-80257

Appendix

Appendix 1. Relation with the Competences of the Education Degree

c. General competences:

1.That students have demonstrated possessing and understanding knowledge in an area of study (Education) which is based on general secondary education and is typically at a level that, while supported by advanced textbooks, also includes some aspects involving knowledge from the forefront of their field of study. This competence will be concretized in the knowledge and understanding for the practical application of:

d. Principles and procedures used in educational practice.

e. Main teaching-learning techniques.

2.That students are able to apply their knowledge to their work or vocation in a professional manner and possess the competencies typically demonstrated through the elaboration and defence of arguments and problem-solving within their field of study (Education). This competence will be concretized in the development of skills that prepare the graduate to:

b. Be able to critically analyse and argue the decisions that justify decision-making in educational contexts.

3. That students have the ability to gather and interpret essential data (typically within their field of study) to make judgments that include reflection on essential social, scientific, or ethical issues. This competence will be concretized in the development of skills that prepare the graduate to:

a. Be able to interpret data derived from observations in educational contexts to judge their relevance in appropriate educational practice.

b. Be able to reflect on the meaning and purpose of educational practice.

c. Be able to use effective procedures for information retrieval, both from primary and secondary sources, including the use of computer resources for online searches.

5.That students have developed the learning skills necessary to undertake further studies with a high degree of autonomy. The realization of this competence implies the development of:

e. The promotion of initiative and an attitude of innovation and creativity in the exercise of their profession.

d. Specific competences:

A. Basic Training Module:

Subject: Learning and Personality Development.

1. To know and understand the characteristics of primary school students, their learning processes, and the development of their personality, in family, social, and school contexts.
2. To know, appreciate, and reflect on the problems and demands posed by heterogeneity in the classrooms, as well as to be able to plan practices, measures, programs, and actions that facilitate attention to the diversity of students.

Subject: Educational Processes and Contexts.

4.Understand and appreciate the demands of scientific knowledge, identifying research methods and strategies, designing educational research processes, and utilizing appropriate methods.

B. Didactic-disciplinary Module:

Subject: Teaching and Learning of Mathematics.

5.Identify and understand the role of mathematics in the world, make informed judgements and use mathematics in the service of constructive, engaged and reflective citizenship.

b. Analyse, reason, and communicate mathematical proposals.

c. Plan and solve mathematical problems linked to everyday life.

6.Appropriately transform mathematical knowledge into teachable knowledge through appropriate processes of didactic transposition, verifying students' progress and the teaching-learning process itself through the design and implementation of both formative and summative assessment situations.

Subject: Teaching and Learning of Languages.

7. Use language as a tool for communication and for understanding reality, while developing the skills and abilities necessary for interpreting and creating literary texts.

D. Optional module

Subject: Foreign Language (English/French).

1.Communicative competence in Foreign Language (English/French), advanced level C1, according to the European Framework of Reference for Languages.

2.Planning what is to be taught and assessed in relation to the foreign language in question, as well as selecting, devising and developing teaching and learning strategies, and to select, devise and develop teaching strategies, types of activities and teaching resources.

Appendix 2. Complete Comparative Analysis Tables

Table 4A. *Number of WPs by type and publisher.*

Publishers	Total	Type of Word Problem															
		Change						Combine		Compare							
		1	2	3	4	5	6	1	2	1	2	3	4	5	6	Eq.	
																1	2
SM. *Revuela*.	40	1	14	0	0	0	0	13	11	0	0	0	0	0	0	1	0
SM. *Piensa Infinito*	91	14	19	1	2	1	1	17	10	3	3	11	8	0	0	0	1
ANAYA	45	5	12	1	0	1	3	11	6	0	0	3	1	2	0	0	0
Santillana.	21	3	3	0	0	0	0	8	4	0	0	1	2	0	0	0	0
CJFallon. *Mathemagic*.	19	15	1	0	0	0	0	2	0	1	0	0	0	0	0	0	0
CJFallon. *Master your Maths*.	115	12	34	4	3	0	0	38	10	6	2	5	0	1	0	0	0
GILL Education *Mighty Maths*.	17	1	6	0	0	0	0	7	1	2	0	0	0	0	0	0	0
Total 348		51	89	6	5	2	4	96	42	12	5	20	11	3	0	1	1
		157						138		53							

Table 5A. Analysis tool. Change problems.

Change problems									
Publishers	**Vocabulary level**		**Presence of key words**	**Order of information**	**Type of number**	**Verbs used**	**Verb tenses used**	**Grammatical structure**	**Temporal order**
	Word class	**Topic**							
SM. *Revuela*	Nouns	Proper Names Food Animals People Ways of transport Other	Cuántas/os Quedan Repartir Sobrar Más Esta mañana Por la tarde Entre los dos/todos	Data 1 + Data 2 + Question	Numerical Written	Tener Vender Comprar Repartir Haber Seguir Comer Hacer Coger Usar Recoger	Presente Pretérito perfecto simple Pretérito perfecto compuesto Futuro	Adverbial phrase (time) + Subject + verb + direct object	Linear
	Sequencing linkers	Parts of the day This year Next year							
	Placing phrase	Position Nature and city landscape							
	Pronouns								
SM. *Piensa Infinito*	Nouns	Proper names Escolar material Food Jobs Animals Family Sports Other	Cuántos/as Quedan Más Ahora Después En total El resto Por la mañana Por la tarde Al final	Data 1 + Data 2 + Question Question + Data 1 + Data 2	Numerical	Haber Tener Regalar Dar Vender Coger Quitar Añadir Comer Comprar Encontrar Repartir Gastar	Presente Pretérito perfecto simple Pretérito perfecto compuesto	Subject + verb + direct object + indirect object + adverbial phrase (time)	Linear Backwards
	Sequencing linkers	Parts of the day At the beginning							
	Possessives								

	Adjectives	Colours				Unir Recoger			
ANAYA	Nouns	Own names Animals Food Escolar material People Jobs	Cuántos/as Más Ahora Quedan Sobran Quitar X de ellas. Por la mañana Por la tarde A lo largo del día Aún	Data 1 + Data 2 + Question Question + Data 1 + Data 2	Naturals Numerical Written	Tener Dar Vender Comprar Devolver Quitar Perder	Presente Presente continuo Pretérito perfecto continuo Pretérito perfecto simple Pretérito perfecto compuesto Futuro Condicional	Adverbial phrase (time) + Subject + verb + direct object + indirect object + Adverbial phrase (place)	Linear
	Sequencing linkers	Parts of the day							
	Placing linkers	Nature and city landscapes Position							
Santillana	Nouns	Own names Animals Ways of transport Jobs	Cuántos/as Faltan Quedan Ahora Más Al principio Después	Data 1 + Data 2 + Question	Numerical	Tener Haber Regalar Repartir Usar	Presente Pasado Pretérito perfecto compuesto Pretérito pluscuamperfecto	Adverbial phrase (time) + Subject 1 + verb + direct object. + adverbial phrase (place)	Linear
	Sequencing linkers								
	Placing phrases								
CJFallon. *Mathemagic*	Nouns	Own names Animals Food Sports	How many More Now Altogether Then Another Are left	Data 1 + Data 2 + Question	Numerical	There is/are To be To come To buy To give To find To have To fall	Present Past simple Passive	Adverbial phrase (time) + Subject 1 + verb + direct object.	Linear
	Sequencing linkers								
	Pronouns								

CJFallon. *Master your Maths*	Nouns	Own names People Animals Food Family Escolar material Ways of transport Money Others Jobs	How many More Then Now Are left To have left To give away Taken away So far X of them Still Over the	Data 1 + Data 2 + Question Data 1 + Question + Data 2	Numerical Written	There is/are To have To join To leave To fall off To need To give To eat To get To lose	Present Past simple Conditional Passive Past continuous	Subject 1 + verb + direct object. Subject 1 + verb + direct object. Subject 1 + verb + direct object. Subject 2 + verb + direct object.	Linear
	Pronouns								
	Placing phrases	Nature landscapes							
	Sequencing linkers	Parts of the day Days of the week							
GILL Education. *Mighty Maths*	Nouns	Own names People Animals Food Family Other	How many More Then Now Are/were left	Introduction + Data 1 + Data 2 + Question	Numerical	To make To have To give There is/are To buy To eat To sell To win To need	Present Present perfect Past simple Passive	Subject + verb + direct object + indirect object	Linear
	Pronouns								
	Sequencing linkers								

Table 5B. Analysis tool. Combine problems.

Combine problems								
Publishers	**Vocabulary level**		**Presence of key words**	**Placement of question**	**Type of number**	**Verbs used**	**Verb tenses used**	**Grammatical structure**
	Word class	**Topic**						
SM. *Revuela*	Nouns	Own names Ways of transport Animals Family Food Other	Cuántos/as En total El resto son Las/Los demás X de ellos/as	Data 1 + Data 2 + Question	Numerical	Haber Comer	Presente Pretérito pluscuamperfecto Condicional	Subject + verb + object direct + adverbial phrase (place) Subject (implicit) + verb + object direct
	Adjectives	Colours Size						
	Placing adverbs	Position Landscapes						
SM. Piensa *Infinito*	Nouns	Own names People Food Animals Other	Cuántos/as De las X … El resto son… También En total Las demás son…	Data 1 + Data 2 + Question	Numerical	Tener Haber Juntar Ser	Presente	Subject + verb + object direct + adverbial phrase (place)
	Adjectives	Colours Shapes						
	Placing phrases	City places Position						
ANAYA	Nouns	Animals Food People Escolar material	Cuántos/as X de ellos En total Y los/as demás De los que X son… Entre A y B También Además	Data 1 + Data 2 + Question	Numerical Written	Haber Ser Tener	Presente Condicional	Subject (implicit) + verb + object direct + adverbial phrase (place)
	Adjectives	Colours						
	Placing phrases	Nature landscapes Position						

Santillana	Nouns	Own names People Food Clothes Ways of transport Other	Cuántos/as En total Entre los dos/X	Data 1 + Data 2 + Question	Numerical	Haber Ir Recoger Necesitar Faltar	Presente Pretérito pluscuamperfecto	Subject + verb + object direct + adverbial phrase (place) Subject (implicit) + verb + object direct
	Adjectives	Colours						
	Placing phrases							
	Time phrases	Este mes						
CJFallon. *Mathemagic*	Nouns	Own names Escolar material Sports Other	How many Altogether	Data 1 + Data 2 + Question.	Numerical	To be There is/are	Present Past simple	Subject + verb+ adjective + direct objective Present
	Pronouns							
	Adjectives	Colours						
CJFallon. *Master your Maths*	Nouns	Own names Family Animals Food Ways of transport Escolar material Time Others	How many Altogether And The rest are… Over the … X of them In total In one .. and … In another	Data 1 + Data 2 + Question.	Numerical Written	To have To be There is/are To sell To get To need	Present Past simple	Subject (noun or impersonal pronoun) + verb + direct object. + Adverbial phrase (Place) + Adverbial phrase (Time)
	Pronouns							
	Adjectives	Colours						
	Sequencing linkers	Days of the week Parts of the day						
	Placing phrases							
GILL Education. *Mighty Maths*	Nouns	Own names Animals People Food Ways of transport Other	How many Altogether In total And	Introduction + Data 1 + Data 2 + Question	Numerical	To have To be To buy To sell	Present tense Past simple	Subject + verb + adjective direct object + Place
	Adjectives	Colours						
	Placing phrase							

Table 5C. Analysis tool. Compare problems.

Compare problems								
Publishers	**Vocabulary level**		**Presence of key words**	**Placement of question**	**Type of number**	**Verbs used**	**Verb tenses used**	**Grammatical structure**
	Word class	**Topic**						
SM. *Revuela*		-	-	-	-	-	-	-
SM. *Piensa Infinito*	Nouns	Own names Food People Escolar material Animals Other	Cuántos/as Menos Más Más que Menos que Más alto que	Data 1 + Data 2 + Question Question + Data 1 + Data 2	Numerical	Tener Hacer Encontrar Comprar	Presente Pretérito perfecto simple Pretérito perfecto compuesto	Subject + verb+ direct object. + Adverbial phrase (quantity) + indirect object
	Pronouns							
	Adjectives	Colours						
ANAYA	Nouns	Own names People Food	Cuántos/as Más que Menos que	Data 1 + Data 2 + Question	Numerical	Tener Haber	Presente Pluscuamperfecto Condicional	Subject + verb+ direct object. + Adverbial phrase (quantity) + indirect object
	Possessives							
	Pronouns							
Santillana	Nouns	People Animals Measures	Cuántos/as Más que Menos que Hoy Ayer	Data 1 + Data 2 + Question	Numerical	Haber Ser Pesar	Present Pasado Pretérito perfecto compuesto	Subject + verb+ direct object. + Adverbial phrase (quantity) + indirect object
	Pronouns							
	Sequencing linkers	Hoy Ayer						
CJFallon. *Mathemagic*	Nouns	Own names Escolar material	How many More than	Data 1 + Data 2 + Question	Numerical	There are To have	Present Past simple	Dummy subject + verb + adjective + direct object
	Adjectives	Colours						
	Pronouns							

CJFallon. *Master your Maths*	Nouns	Own names Family Escolar material Food Ways of transport Age Others	How many More Less than Fewer than Older than by	Data 1 + Data 2 + Question	Numerical Written	To have To be	Present Past simple Past continuous Passive Conditional	Subject + verb+ direct object. + Adverbial phrase (quantity) + indirect object
	Possessives							
	Pronouns							
GILL Education. *Mighty Maths*	Nouns	Own names Money Other	How many Less than The difference between	Data 1 + Data 2 + Question	Numerical	To have To weigh	Past simple Passive	Subject + verb+ direct object + adverbial phrase (quantity) + indirect object
	Pronouns							

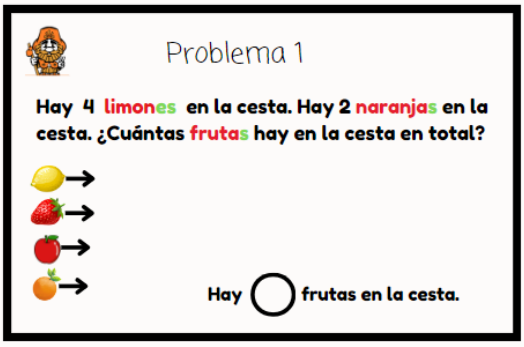
Appendix 3. Genially Presentations for Didactic Proposal.

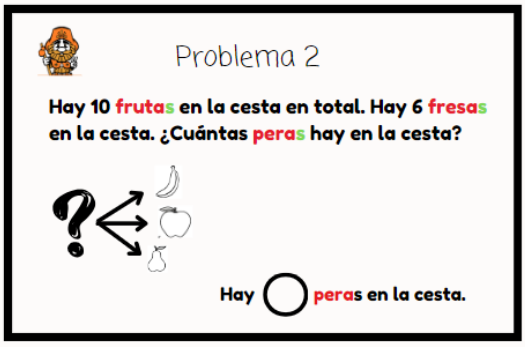
Session 1: https://view.genial.ly/6621515deda3f300143596ef/interactive-content-escape-room-granja-matematicas-1o-primaria

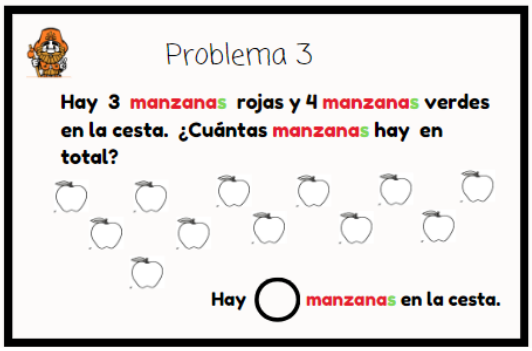
Session 2: https://view.genial.ly/66317b0d3773f10014de2382/interactive-content-escape-camino-de-santiago

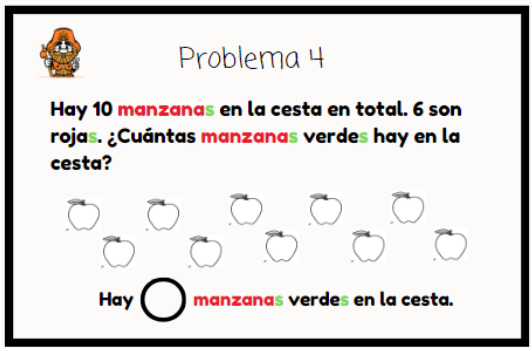
Appendix 4. Problem-Solving Worksheets for Students in Session 2 according to Differentiation

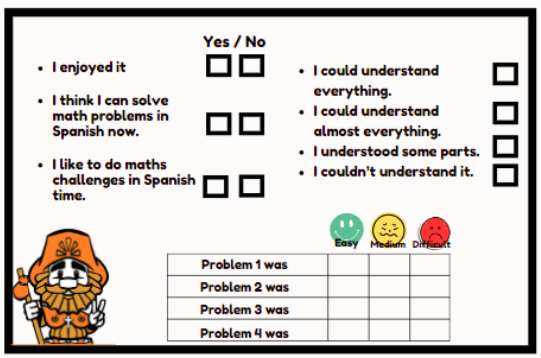
A. Low level of difficulty



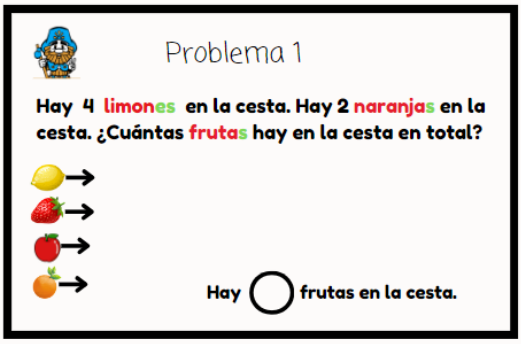


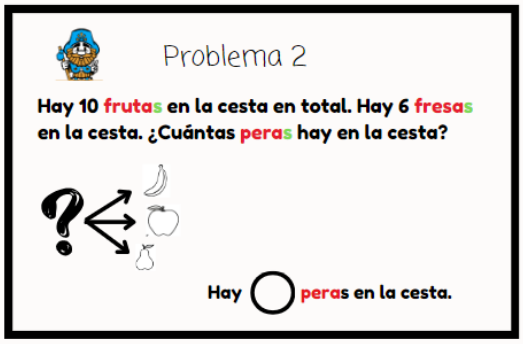


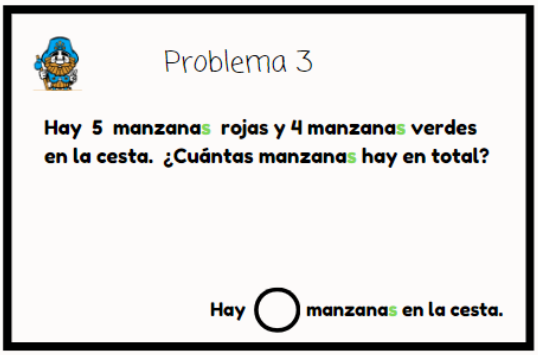


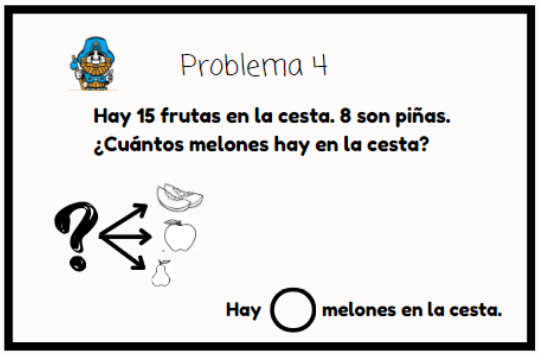


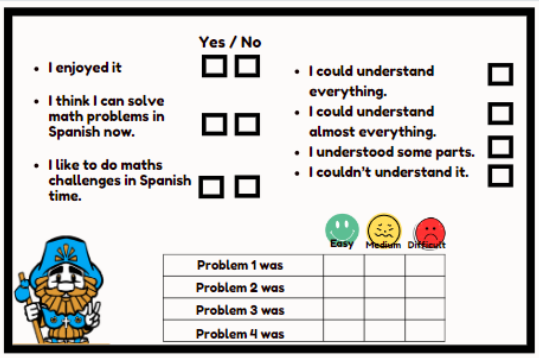
B. Medium level of difficulty.











C. High level of difficulty.