Master's Degree in Advanced English Studies (Cognitive Linguistics/Literature) and Bilingual Education

(Research Profile)

Mathematical word problem solving in secondary education bilingual students of 10th grade in Andalusia, Spain

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Abstract

This research takes place in a bilingual high school in Andalusia where CLIL approach is followed (Content and Language Integrated Learning). The purpose of this study is to find out if the use of the second language in mathematic tests has any influence in the process of word problem solving by bilingual secondary students, affecting the assessment practice. Students from two groups from 4th of ESO, who take part in the bilingual program, were selected to pass a test using the PISA 2006 and 2012 released mathematics items. The reading comprehension level of the students is analysed by the use of a standardized-based assessment, as it is considered to be an important factor in solving word problems. PISA questions were divided in two booklets A and B, both with questions in Spanish and English. The questions that are in English in one booklet are in Spanish in the other. The selection of the word problems is made according to the actual level of reading-comprehension and mathematical competence of the students. A questionnaire was passed to learners in order to analyse if some contextual factors are affecting the mathematical performance in the second language, besides including some questions related to the bilingual history of the students and their perception about solving word problems in English. Results show that solving word problems is affected by the use of the second language but it also depends on the mathematical difficulty.

Resumen

Esta investigación se lleva a cabo en un instituto de educación secundaria en Andalucía dónde se emplea un enfoque AICLE (Aprendizaje Integrado de Contenidos y Lengua Extranjera). El propósito de este estudio es averiguar si el uso de la segunda lengua en las pruebas de matemáticas tiene alguna influencia en el proceso de resolución de problemas por parte de los estudiantes de secundaria, afectando a la práctica de la evaluación. Se seleccionaron estudiantes de dos grupos de 4ª de ESO, que forman parte del programa bilingüe, para realizar una prueba utilizando los estímulos liberados de PISA 2006 y 2012. Se analizó el nivel de comprensión lectora del alumnado utilizando una evaluación basada en estándares, ya que se considera que es un factor importante en la resolución de problemas. Las preguntas PISA se dividieron en dos cuadernillos A y B, ambos con preguntas en español e inglés. Las preguntas que están en inglés en un cuadernillo están en español en el otro. La selección de los problemas se realizó de acuerdo al nivel real de comprensión lectora y a la competencia matemática de los estudiantes. Se pasó un cuestionario al alumnado para analizar si algunos factores del contexto están afectando al desempeño matemático en la segunda lengua, incluyendo además algunas preguntas relacionadas con la historia bilingüe del alumnado así como su percepción a la hora de resolver problemas en inglés. Los resultados muestran que la resolución de problemas se ve afectada por el uso de la segunda lengua pero que también depende de la dificultad matemática.

1. Introduction

Word problems first appeared in ancient Mesopotamia, between 2002 and 1000 BCE. Swetz (2012) indicates that word problems are composed to teach mathematics, besides they have been used as the primary mean of instruction for thousands of years. According to Bernardo they have always been an important part of mathematics education, in which the linguistic component is a fundamental part because problem elements are embedded within a text (2002).

One of the most difficult assignments a bilingual teacher faces everyday is the balance between the linguistic and the cognitive demands of students tasks. Cummins states that language and content will be acquired most successfully when students are challenged cognitively but provided with the contextual and linguistic supports or scaffolds required for successful task completion (2000). Hence linguistic demand should be enough to make advancement possible but not too high to avoid the development of the content.

Providing an adequate assessment of mathematical performance in bilingual contexts is essential, as it is likely to give a misleading impression of students' academic potential. (J. Cummins, 2000). The bilingual approach in the Spanish Region of Andalusia leads to an interweaving of language and content (Content and Language Integrated Learning – CLIL henceforth). Therefore it is very important to study if assessment of content matter is influenced or not by the proficiency level in the second language (L2 henceforth) in this particular context.

The study is conducted in IES Luis de Góngora, a high school placed in the city centre of Cordoba (Andalusia, Spain) where bilingual education has a CLIL approach. This research takes place with two bilingual groups for a total of 53 students from fourth year of secondary education (4^{th} ESO - 10^{th} grade) who are preparing for further non-compulsory education (academic option facing Bachillerato). The Majority of students has been in this bilingual program since they started High School (1^{st} ESO - 7^{th} grade), but for an adequate classification of students in the study, according to their English proficiency level, objective standardizeds-based assessment tests will be used (J. Cummins, 2000), with focus on the reading skills.

Similar studies regarding comprehension of language as a factor to be considered when assessing mathematics skills has been conducted in the past (Abedi & Lord, 2001; D. D. Cummins, Kintsch, Reusser, & Weimer, 1988; Moschkovich, 2007). They have been promoted with primary education migrant learners in bilingual settings. In the present research secondary students will be evaluated to establish the effect of language proficiency in CLIL origin bilingualism, where mathematics is conducted in English to English as a foreign language learners whose mother tongue is Spanish.

Abedi and Lord (2001) show that there is a real interaction between language and mathematics achievement. The research included a math test with items that where simplified in

terms of language, modifying vocabulary not related to mathematics and some linguistic structures, and compared to the original ones. They think that this interplay has to be considered in mathematics assessment research and practice. Anyway language adjustments must be considered carefully. Lorenzo (2008) establishes three different categories that teachers in bilingual contexts use: simplify the text (it could make the test almost meaningless), elaborate it (as an attempt to reduce complexity, it can result in texts too wordy and redundant due to the use of cohesion devices) or rediscursify (the outcome is a student centred text with coherent remaining ideas and enough complexity to challenge the student learning processes).

Other factors that could affect the performance of the students is their perception towards the solution of word problems in L2, as previous studies reflect that students prefer items that are simpler linguistically (Abedi & Lord, 2001).

Finally some contextual variables like parents occupation and education, home possessions and family structure will be analysed as they may have an impact in the academic achievement (Sirin, 2005; White, 1982).

In the next section the objectives of the research will be established. Then we will describe the theoretical foundation for this study. To begin with we will explain the basics from bilingualism and CLIL to continue with the characteristics of bilingualism in Andalusia. Then interactions between language and content (in L1 and L2) and intertwining of L2 and word problem solving processes are analysed. Another aspect to be considered is the classification of students according to their English reading comprehension proficiency level. Finally the study of socio economic factors and its relation to the academic achievement will clarify the use of a context questionnaire.

Then the methodology of research is described, including the classification of students according to their CEFR reading comprehension level, collection of released PISA items that are available in both Spanish and English, and elaboration of the questionnaires to measure socioeconomic variables and how the use of L2 affects the perception of the word problem solving processes.

Finally we will describe the research design and analyse all the data to obtain different results. Those results lead us to different conclusions which have important pedagogical implications.

2. Objective and research questions.

After this brief introduction the objective of the project must be clearly established. As mentioned above the main purpose is finding out if the use of the second language in the word problem solving processes has an influence when assessing the mathematical content. Although previous researches indicated there can be an impact in the mathematical performance when

word problems are presented in L2, it has not yet been studied in Andalusian context. After a decade of bilingualism in the region it seems important to know whether the performance of those students learning mathematics through a second language is adequately assessed.

To sum up the aims of this paper four research questions have been made:

A) Is the word problem solving process affected by the use of L2?

B) Is the reading comprehension level of students in the L2 a key factor in word problem solving processes?

C) How the combined action of language and mathematical difficulty affects the word problem solving processes?

D) Is there an interaction between contextual factors and the word problem solving processes *in the L2*?

3. Theoretical background

3.1. Bilingualism and CLIL

According to the different models of bilingualism by García (2009), the type of bilingual education that it is done in Europe is *additive*, adding a new language to the students' mother tongue, *dynamic*, because it is adapted to the purpose, the context and the functions of the language needed, and provides *enrichment*, as it involves teaching through the second language.

In general terms the bilingual education in Europe follows a CLIL Methodology. In the definition given by Coyle, Hood and Marsh "Content and Language Integrated Learning (CLIL) is a dual-focused educational approach in which an **additional language** is used for learning and teaching of content *and* language to pre-defined levels." (2010). CLIL is not just teaching the content in a different language but through it, it is not a completely new methodology but a combination of them, it is not a restrictive and limited way of teaching and learning but a very flexible way adapted to the context and to the particular group of students involved in the process. CLIL is content-driven and student-centred, and it must be also theoretically rigorous and transparent in practice.

Meanwhile the Spanish educational model, with regulation competences in the different regions, lead to a variety of models. From model close to immersion programs in Madrid where the subjects are taught in a second language to CLIL models in Andalusia where subjects are taught through a second language.

3.2. Bilingualism in Andalusia

In agreement with regional regulations from Andalusia, bilingual high schools must have at least two content subjects (which must cover a minimum of 30% of the schedule per

week –9 out of 30 hours–) in a foreign language, L2. A minimum of 50% of the contents in those subject must be instructed through L2. When assessing content subjects the linguistic level of learners in L2 is only considered to improve their qualifications (Orden 28 de junio, 2011).

Bilingual teachers must have a B2, C1 or C2 linguistic accreditation according to the Common European Framework of Reference for Languages (CEFR Henceforth), although C1 will be required in the future (Junta de Andalucía, 2016). The methodology approach must include CLIL, integrated curriculum (for language and content subjects) and European Language Portfolio; besides recommendations from CEFR must be followed. Bilingual schools have a linguistic assistant for 12 (full-time) or 6 (part-time) hours per week. They collaborate with teachers to promote oral conversation with students (Orden 28 de junio, 2011).

According to the last guidance document created by the Regional Government (Junta de Andalucía, 2016), "Strategic Plan for Language Development in Andalusia. Horizon 2020." (in Spanish *"Plan Estratégico de Desarrollo de las Lenguas en Andalucía. Horizonte 2020."* – PEDLA henceforth) CLIL approach is extremely useful to increase L2 exposure and to promote motivation. It requires extra training in the methodology and good competence in the language. This is why the minimum required CEFRL level for bilingual teachers is going to move from current B2 to C1 presumably before 2020.

As stated in PEDLA the number of public bilingual schools will rise from 1020 in the academic year 2016/2017 to 1160 in 2019/2020, aiming to communication with the five skill of CEFRL. The pluricultural factor must also be considered as one of the most important ones. Another objective of PEDLA is the competence level of students: at the end of compulsory education (4^{th} of ESO – 10^{th} grade) 50% of students enrolled in bilingual schools should reach a B1 CEFRL level, which will advance to B2 for 50% of students at the end of Bachillerato.

3.3. Interactions between language and content (L1 and L2)

Measure of performance in any content area is likely to measure language itself (Oller, 1997). According to Cummins the dimensions of language development include acquisition of Graeco-Latin lexicon, the specialized vocabularies of content areas, and ability to interpret and use more sophisticated syntax. However the academic language proficiency is transferred across languages, allowing students to make stronger progress in L2 having developed literacy in their L1 (2000).

Mathematics and any other discipline has a complex and specialized language different from everyday conversation (Sigley & Wilkinson, 2015). Therefore proficiency in language affects mathematical achievement on instructional and testing levels (Kempert, Saalbach, & Hardy, 2011).

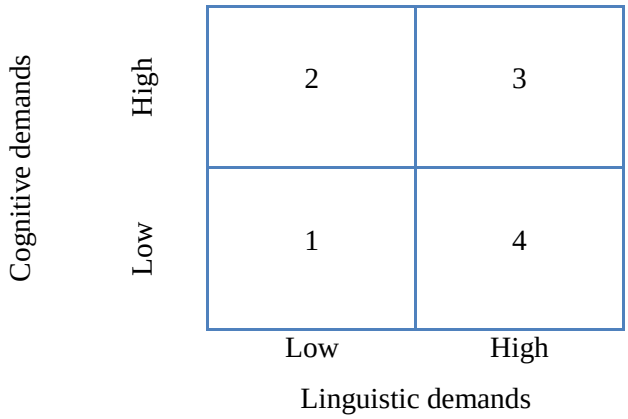

Figure 3–1: The CLIL Matrix (Coyle et al., 2010)

In Figure 3–1 focus should be directed to quadrant 2 because the language is not going to impede learning. Nevertheless moving periodically to quadrant 3 will lead to a progression in language learning without affecting the cognitive challenge of the learner. Quadrant 4 point to the linguistic potential of the students whilst quadrant 1 could be used to build initial confidence in learners (Coyle et al., 2010).

Word problems could be included in quadrant 3. This should be a goal to achieve in the linguistic performance of our learners. It may happen that the linguistic demand is too high for a particular group of students, so in order to assess their mathematical skills some adaptations could be provided, hence moving to quadrant 2. Otherwise if the task is in quadrant 2 there is a risk of not engaging the linguistic proficiency of the students.

According to Abedi (2002), linguistic complexity of test items unrelated to the content being assessed may at least be partly responsible for the performance gap between ELs and non-ELs. Problematic features appear at three levels: syntactic (involving complex sentences, multiple subordinate clauses, nested constructions, long noun phrases and passive voice without agent), lexical (concerning unfamiliar words, unfamiliar phrases, and unfamiliar connotations of words with multiple meanings) and background (instruction should focus on the background knowledge in word problems, sentence and paragraph level, and word phrases) (Moschkovich, 2015).

3.4. Interactions between L2 and word problem solving

The link between language and mathematics is especially evident in the case of word problems. It is known that children's performance on arithmetic word problems is a reliable predictor of their later mathematical competence. (Kempert et al., 2011). In fact a highly technical, precise and densely structured language is required by the mathematics register (Sigley & Wilkinson, 2015), where solving arithmetic problems is a cognitive task that relies on language processing (Van Rinsveld, Brunner, Landerl, Schiltz, & Ugen, 2015).

So the learning of mathematics is more strongly related to language processes than has been assumed (Kempert et al., 2011). According to Bialystok (2001), as language and mathematics share common critical features such as abstract mental representation, conventional notations, and interpretive function, mathematics is a domain where cognitive effects in bilinguals are likely to occur.

Language proficiency affects mathematical achievement on the levels of instruction and testing (Kempert et al., 2011), hence both oral and written language are central to mathematical teaching and learning, which rely on the discourse structures of description, sequencing, procedural iteration, and justifications (Sigley & Wilkinson, 2015). And furthermore, several studies states that the area of mathematics reasoning is consistent with the threshold hypothesis (J. Cummins, 2000).

Even when students may not be in full command of the mathematics register until they understand the mathematics (Sigley & Wilkinson, 2015), presenting mathematic problems with simplified linguistic instructions (Abedi & Lord, 2001) seemed to help them to overcome their linguistic complexity (Van Rinsveld, Schiltz, Brunner, Landerl, & Ugen, 2016). According to Bialystok a generous interpretation of some studies that is consistent with data is that if language proficiency is at least adequate for understanding the problem bilingualism has no effect on mathematical problem-solving (2001).

Whereas there are specific grammatical patterns to the mathematics register which include dense noun phrases, subordinators, nominalizations, logical connectors, and verbs employed in arguments, justifications and constructions of mathematical ideas (Sigley & Wilkinson, 2015), a simplification of the linguistic structure of word problems presented in L2 increases the mathematical performance of learners of L2 (Abedi & Lord, 2001). Other comprehension problems on a surface level (i.e., an unknown verb or noun) may result in an extra load of memory resources which can lead to the unavailability for carrying out arithmetic calculations (Kempert et al., 2011).

A cognitive modelling process is required to solve mathematics word problems, in which students identify and extract the relevant pieces of information and, at the same time, suppress any misleading or irrelevant linguistic or numerical information (Kempert et al., 2011) that is embedded in the problem context. According to a prominent model of arithmetic word problem solving the whole process takes place within three steps: forming a situational model by structuring its relevant features, extracting a mathematical problem model (translation from linguistic code to mathematical relations) and finally do the calculations, interpret and validate the results (Kempert et al., 2011)

3.5. Adapting word problems strategies

As shown above variations in the linguistic aspect of word problems affect problem representation and problem-solving performance. Rewording the text of word problems in order to make them reflect better the problem structure leads to significant improvements in problem-solving accuracy (A. B. I. Bernardo, 2002).

Bernardo found that Filipino-English bilingual students solved word problems better when they were written in their first language (Filipino) as a result of better comprehension of the text (1999). He also found that rewording the problem texts resulted in smaller gains in accuracy with the problems worded in English compared with the problems worded in Filipino; in other words difficulties in understanding arithmetic word problems might be intensified for bilingual students who have to solve word problems written in their second language (2002). Kempert, Saalbach and Hardy also found that proficiency in the language of testing had the strongest influence on students' mathematical achievement in both L1 and L2. Anyway bilingual students partly compensate their language deficits by displaying an enhanced ability in attentional control (2011).

According to Abedi and Lord these are the features that can be revised to adapt the linguistic register of the word problems to the linguistic level of students (2001):

- Familiarity or frequency of nonmath vocabulary: change of unfamiliar or infrequent words.
- Voice of verb phrase: change passive to active verb forms.
- Length of nominals: shorten long nominals.
- Conditional clauses: separate conditional sentences or change the order of conditional and main clause.
- Relative clauses: remove or recast.
- Question phrases: change complex question phrases to simple question words.
- Abstract or impersonal presentations: make more concrete.

  Some changes could involve more than one feature.

But linguistic adaptations must be taken with care as undesired outcomes may appear in simplification or elaboration processes (Lorenzo, 2008). For this reason no adaptations will be made to original word problems, leaving this aspect for future researches.

3.6. CEFR Classification of students

Kempert, Saalbach and Hardy states that proficiency in the instructional language and arithmetic skills can strongly predict students' ability to solve mathematical word problems (2011). In order to classify students by linguistic proficiency an estimation can be done by using reading comprehension (Schleicher, Zimmer, Evans, & Clements, 2009). For this purpose a standards-based assessment process becomes a fundamental tool to see if differences among

students can be set, while questionnaire can be passed to determine participants' language histories and to obtain the most accurate account of their degree of bilingualism (Jiménez Jiménez, 2015).

3.7. Context

The context of the research includes some background information about the bilingual trajectory and perceptions of students and also some socioeconomic measures. It is not the aim of this paper to deeply study the relationship between the socioeconomic status and the academic performance, but to make an initial approach by means of which some factor could arise to have an impact to be analysed in later studies and to provide a description of the context in which the research has taken place.

There is not an accepted definition of the socioeconomic status (SES henceforward) neither of a SES index that can be applied to the educational context, however it is widely used within education researches and it has proved to make relevant contributions (Caro & Cortés, 2012; Rutkowski & Rutkowski, 2013; Sirin, 2005; White, 1982). White suggests that other labels should be considered in the absence of such a definition while Hattie (2009) states that SES is in direct relation to the home resources and establish a "relative position in the social hierarchy".

The three main indicators of SES to be considered are family income, parental education and parental occupation (Ensminger et al., 2000; Hattie, 2009; Sirin, 2005; White, 1982; Willms & Tramonte, 2015), but usually family income data are difficult to obtain either from students nor from parents, hence home possessions such as books at home can be used as an approximation (OECD, 2016; Willms & Tramonte, 2015). Nevertheless there is a low weight for home possessions items as a part of SES due to the lower variability of these items in wealthier societies (Caro & Cortés, 2012). The fact that parental education is one of the most stable aspects of SES (Sirin, 2005) could be indicative of the extensive use of this variable.

For models like ours White (1982) states that students should be the unit of analysis. In this case the use of at least two indicators is recommendable because missing information can be better substituted by its combination (Ensminger et al., 2000).

The PISA indicator for students' economic, social and cultural status (ESCS henceforth) is set to be as stable as possible across the PISA cycles (OECD, 2016). It includes the highest occupational and educational status among parents and the number of books at home as a part of home possessions variables (Willms & Tramonte, 2015).

The consideration of home atmosphere as the possible variable that correlates with academic achievement (White, 1982), being SES correlated with home atmosphere to some extent, makes relevant the use of frequently used variables as indicators of SES like family's attitude toward education, family stability and aspirations of parents for child. Besides Hattie

(2009) affirms that the strongest relationship with achievement, considering all home variables, are for parental aspirations and expectations for children's educational performance.

I will follow Ensminger et al. criteria to include SES measures: adolescents should know the information and the items can be part of a self-administered questionnaire (2000). Parental occupation may be problematic at some extent because it is difficult for students to classify it, but this can be partially cleared up by an item with the description of the activity. He also found that the likelihood of missing data is less among older adolescents and those with better school achievement. Besides the agreement between adolescents and their mothers regarding SES measures is higher than 70% (Ensminger et al., 2000) with the exception of questions about fathers that are not in the household, however this can be overcome by the use of a composite measure.

Although there is a belief of strong relation between SES and academic achievement White states that it is probably much weaker than it has been assumed (1982). Besides better correlations are provided by aggregated data, in contrast to individual data. Another important factor is the use of two or more indicators combined together, as they provide better correlations than individual variables. The unit of analysis has also an essential role, as SES and academic achievement are weakly correlated where the student is the unit of analysis. Sirin found that there is a decrease in the average correlation throughout time (2005) and that it is stronger for suburban schools than for rural or urban schools.

As shown above there is no consensus about calculating a SES index but Caro and Cortés (2012) calculate an index with six items from PIRLS 2006 data:

$SES = \alpha_1\, momed + \alpha_2\, daded + \alpha_3\, momsei + \alpha_4\, momsei + \alpha_5\, hompos + \alpha_6\, finan$

being α_i the median weight for each item:

momed	mother's education	$\alpha_1 = 0.49$
daded	father's education	$\alpha_2 = 0.48$
momsei	mother's occupational status	$\alpha_3 = 0.45$
dadsei	father's occupational status	$\alpha_4 = 0.44$
hompos	home possessions	$\alpha_5 = 0.19$
finan	financial status	$\alpha_6 = 0.27$

Table 3–1: Items and weights for Caro and Cortés SES index (2012).

Parental education and occupation are very similar in weight, while home possessions is about 41% of those on average and the financial status is around 58%. On the other hand PISA 2012 ESCS index (OECD, 2014) is calculated as:

$$ESCS = \frac{\beta_1\, HISEI + \beta_2\, PARED + \beta_3\, HOMEPOS}{\varepsilon_f}$$

being β_i the median weight for each item and ε_f a measure of variance that serves to standardize the ESCS measure (Rutkowski & Rutkowski, 2013):

HISEI	highest occupational status of parents	$\beta_1 = 0.84$
PARED	highest parental education	$\beta_2 = 0.83$
HOMPOS	home possessions	$\beta_3 = 0.67$

Table 3–2: Items and weights for Spain in PISA tests 2012 ESCS index (OECD, 2014)

Again parental education and occupation are very similar in weight, while home possessions is about 80% of those.

4. Methodology of research

The research takes place with two bilingual groups (of 27 and 28 students respectively for a total of 55) from the fourth year of secondary education who take part in the academic courses (aiming to higher education). Eventually two students were not included in the investigation due to the fact that they dropped out several subjects including Mathematics and English as a Foreign Language. This made impossible to assess any performance nor in English neither in Mathematics (as they did not provide information about their actual development and skills).

From the total 53 participants 2 students where held back by one year and one by two years. The mean age of the students at the day the PISA test was made was 15.55 years old.

4.1. Instruments

4.1.1.B1 Test selection

As explained above (J. Cummins, 2000; Schleicher et al., 2009), to assess the CEFR level in reading comprehension with an standardized-based assessment participants made a B1 test from Cambridge English Preliminary. Reading parts 1 to 5 (for a total of 35 questions) from Reading and Writing Sample Set 6 (Cambridge, 2017a) were provided to students who took the test on May 24th, 2017 (except for two students who did not attend class that day and took the test on May 30th). The total time for the completion of the test was 50 minutes, with 10 minutes for previous explanations about how to complete the answer sheet. A complete example of the test and answer sheet can be consulted in Appendix II: B1 test.

Each correct answer was worth 1 mark, with a maximum of 35 possible marks. The distribution of scores is shown in Table 4–1 (Cambridge, 2017b).

Score	CEFR Level	# students	Score out of 10
7	–	0	2.0
15	A2	5	4.3
25	B1	36	7.1
32	B2	12	9.1

Table 4–1: CEFR Level of students and minimum scores per level. Own elaboration based on data from Cambridge (2017b)

All the information was digitalized in a spreadsheet including the following fields of information: a numeric identifier exclusive of the student, the group he or she is a member of, his or her name, the score and the date of the test. Three more fields where automatically calculated: CEFR Level (A2, B1 or B2) based on the score, a detailed CEFR Level (A2, B1.1 –minimum score of 25–, B1.2 –minimum score of 28– or B2) also based on the score and the score out of 10.

Score	CEFR Level	# students	Score out of 10
7	–	0	2.0
15	A2	5	4.3
25	B1.1	18	7.1
28	B1.2	18	8.0
32	B2	12	9.1

Table 4–2: CEFR Level of students and minimum scores per detailed level. Own elaboration based on data from Cambridge (2017b)

A previous analysis of the data shows that the range of scores varied from 17 to 34, with an average of 28.43 and standard deviation of 3.72. 50% of scores were between 26 and 31 with a median score of 29. The fact that all the scores of the students in the reading comprehension test where between the indicated CEFR levels that the test is intended to could be an indicator of the adaptation of the test for the purpose of this paper.

4.1.2.Context questionnaire.

Based on the theoretical information (see 3.7 above) and different context questionnaires like PISA (OECD, 2016; Willms & Tramonte, 2015) and Andalusian Diagnostic Assessment Tests (Pruebas de Evaluación de Diagnóstico) (AGAEVE, 2017) a basic context questionnaire was created. It has been structured in three parts. The first part (questions 2 to 4) provides information about the English language learning history the participants; the second part (questoins 5 to 8) is about the mathematical-bilingual history and personal perceptions of the content learning process through a second language; finally the last part (questions 9 to 13) is about the familiar structure, home possessions (number of books at home) and parents expectations, education and occupation. All the students completed the questionnaire on May 29th, 2017. To allow a better understanding of questions and a more accurate data collection the

questionnaire is done in Spanish. A complete example of the context questionnaire can be consulted in Appendix III: Context questionnaire.

The context information was digitalized in a spreadsheet including a numeric identifier exclusive of the student, the group he or she is a member of and his or her name. Questions 2 to 5 are measured in years. Some of the data were corrected according to the maximum possible values, i.e. for question 3 *"How many years have you been enrolled in a bilingual school?"* (¿Cuántos años consecutivos lleva en un centro bilingüe (incluido este)?) the maximum possible value is 10, except for those held back by one or two years that could be respectively 11 or 12; for question 5 *"How many consecutive years have you been learning mathematics through English?"* (¿Cuántos años consecutivos lleva aprendiendo matemáticas a través del inglés?) the maximum possible value is 4, except for those held back by one or two years that could be respectively 5 or 6. Only one data was corrected to the maximum of 10 for question 3 and five were corrected to the maximum of 4 for question 5.

Questions 6 and 7 are Likert-type scales (1932) designed to measure opinions about learning mathematics and solving word problems through English. They are coded from 1 (strongly disagree) to 5 (strongly agree). Question 8 measure the main perception of the difficulties that students find when solving word problems in English, hence it has been coded with 1 for each marked option and 0 for unmarked options.

Question 9 has three options therefore it was coded from 1 to 3, whereas question 10, having four options, was coded from 1 to 4. Questions 11 and 12 have five options for father and mother, so the coding was made separately for each of them from 1 to 5. Similarly question 13 has eight options for father and mother, so the coding was made separately for each of them from 1 to 8. In this last question about parent occupation some students were not able to mark one of the available options. For this reason a text field was available to write a descriptive name of the post of each parent in order to match it later with the adequate option. Each answer for question 13 was analysed in the digitalization process to get as much an accurate answer as possible.

Participants have been in the bilingual program for a mean of 5.42 years. 5 of the students enrolled the bilingual program the first year of primary education, 18 entered during primary education, 20 signed up the first year of secondary education and 10 has been with the bilingual program during part of secondary education (see Figure 4–1 below). It means that 18.87% of participants did not start secondary education within the bilingual program (no one dropped out the program once they had started it, although there has been some drop outs that are not in the program any more). As mathematics is only part of the bilingual program in secondary education, participants mean number of years with Mathematics taught through English is 3.57.

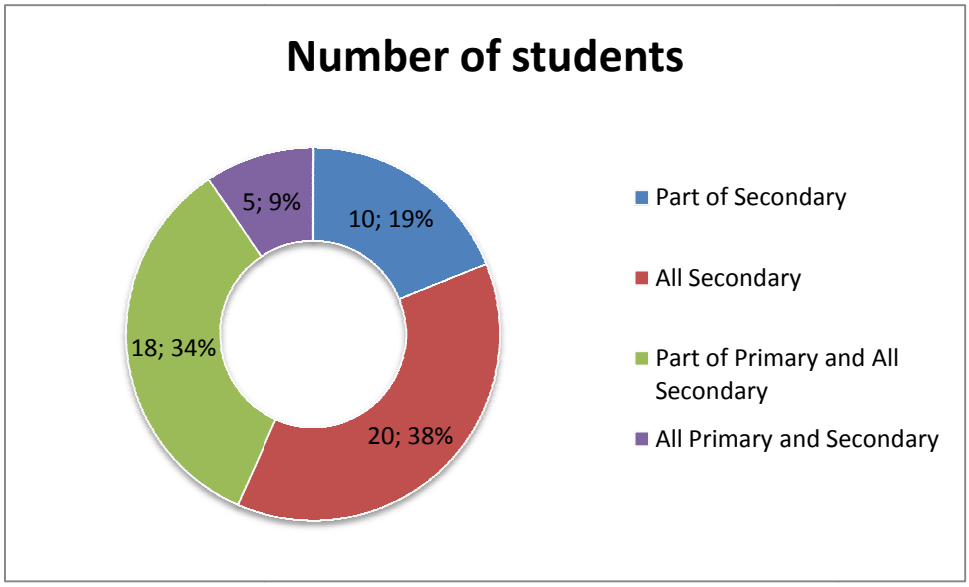

Figure 4–1: Academic bilingual history of students. Own elaboration.

4.1.3. PISA word problems selection and creation of booklets

The mathematical word problem test was made using some PISA released mathematics items (INEE, 2013; OECD, 2006, 2013). Firstly an adequate mathematical content area selection was made. According to the level of the students and the content areas they knew from previous and present years descriptive statistics, probability and combinatorics where discarded as part of the test. Questions should be available in both English and Spanish, and they also should be balanced in terms of general difficulty. This level of difficulty was previously evaluated with the right answer percentage for the word problems in OECD and Spain (INEE, 2013). I made a provisional selection that had three word problems from each content area: arithmetic and algebra, geometry and functions and graphics; for a total of 9 word problems and 18 questions.

Content area	Name	Year	Number of questions	Time for solving (min:s)
Arithmetic and Algebra	Internet Relay Chat	2006	2	7:20
	Cubes	2006	1	0:35
	Exchange Rate	2006	3	2:40
Geometry	Staircase	2006	1	0:30
	Ice-Cream Shop	2012	3	6:56
	Garage	2012	2	2:35
Functions and Graphics	Carpenter	2006	1	1:08
	Growing Up	2006	3	2:33
	The Best Car	2006	2	5:25

Table 4–3: Initial selection of word problems. Own elaboration

I solved myself the word problems to evaluate the time needed and the relative difficulty for my group of students, employing 29 minutes and 42 seconds. Provided that it was important for the purpose of the investigation that all students were able to finish all the word problems in the time given (50 minutes, with 10 minutes for previous explanations) I decided to discard one word problem from each content area, in such a way that the number of questions was also balanced. From my own experience students about the end of secondary education need twice or three times as much time as I need to solve the word problems, hence the time limit should be around 17 minutes.

The final selection (see Table 4–4) had then 6 word problems and 11 questions (4 from arithmetic and algebra, 4 from geometry and 3 from functions and graphics for a total solving time of 17 minutes and 14 seconds).

Content area	Word problem number	Name	Year	Number of questions	Time for solving (min:s)
Arithmetic and Algebra	1	Cubes	2006	1	0:35
	2	Exchange Rate	2006	3	2:40
Geometry	3	Staircase	2006	1	0:30
	4	Ice-Cream Shop	2012	3	6:56
Functions and Graphics	5	Carpenter	2006	1	1:08
	6	The Best Car	2006	2	5:25

Table 4–4: Final selection of word problems. Own elaboration.

To avoid the bias that could be provided by the difficulty, the language and/or the order the word problems were presented to the students, questions were divided in two booklets (paper A and paper B), both with six word problems, three in Spanish and three in English. Both booklets have the same word problems but in different linguistic situations (i.e. one problem in Spanish in paper A is in English in paper B.). The order of the word problems within each booklet was also randomized.

For paper A a random selection of the language of the first word problem was done, resulting English. The rest of the word problems will alternate the language from English to Spanish, to English and so on. Paper B would be the opposite. Then the content areas were also randomly selected, provided that the language has to be in alternating series. The final configuration of the booklets is given in Table 4–5. Besides a complete example of the booklets and answer sheets can be examined in Appendix IV: PISA word problem papers.

Paper A			**Paper B**		
Language	**Word problem number**	**Name**	**Language**	**Word problem number**	**Name**
English	4	Ice-Cream Shop	Spanish	1	Cubos
Spanish	2	El tipo de cambio	English	6	The Best Car
English	1	Cubes	Spanish	5	Carpintero
Spanish	6	El mejor coche	English	3	Staircase
English	5	Carpenter	Spanish	4	Heladería
Spanish	3	Escalera	English	2	Exchange Rate

Table 4–5: Order and Language of word problems. Own elaboration.

To provide each student with a particular paper (A or B) they are grouped according to their CEFR reading comprehension level (see Table 4–1 above). Several random raffles were made per CEFR group, using the RANDBETWEEN function in a spreadsheet, until the number of papers A and B were fair.

	Paper A	**Paper B**	**Total**
A2	3	2	5
B1	18	18	36
B2	6	6	12
Total	27	26	53

Table 4–6: Number of participants solving papers A and B per CEFR reading comprehension level. Own elaboration.

Eventually the PISA word problem paper was done on June 2nd, 2017 except for six students who did not attend class that day. They took the test on June 13th and 14th (3 students each day).

Each question was marked according to the PISA test scoring with a maximum of 1 point each. Only two questions of word problem 4 (Ice-Cream Shop) had codes for intermediate scoring of 0.5 points, while the rest of the questions could be marked only as correct (1 point) or incorrect (0 points). Table 4–7 shows the possible codes and scores for each question.

Word problem number	**Questions**	**Code**	**Score**
1	1	1	1 (full credit)
2	1 and 2	0	0
3	1	9 (missing)	-
4	3		
5	1		
6	1 and 2		

Word problem number	Questions	Code	Score
2	3	11 01 02 99 (missing)	1 (full credit) 0 0 -
4	1 and 2	2 1 0 9 (missing)	1 (full credit) 0.5 (partial credit) 0 -

Table 4–7: Codes and scores for each question. Own elaboration.

The resulting information was digitalized in a spreadsheet containing a numeric identifier exclusive of the student, the group he or she is a member of, his or her name and the type of paper (A or B) solved. A first sheet was used to introduce the code for each word problem number and question number (see Table 4–7 above) and it was automatically converted into score values (0, 0.5, 1 or "-") in another sheet. One column had the score of the questions solved in Spanish and another had the score of the questions solved in English, adding the total out of the 11 maximum score in a third column. As paper A had 6 questions in Spanish and 5 in English and paper B was the other way around, scores were automatically transformed into a 0 to 10 scale rounded to two decimal places to make all of them comparable.

A first analysis of the data (see Figure 4–2 below) shows that 7% of questions were missing (codes 9 or 99) and that the mean total score of the test is 6.472 out of 11. This could indicate that the time given and the difficulty of the questions were adequate for the purpose of this research.

Figure 4–2: Per question and total percentage of each possible score. Own elaboration.

Questions were classified into high, medium and low mathematical difficulty according to the percentage of students with the maximum score and the average score. Word problems 1, 2 and 3 and question 1 of word problem 6 are classified as low difficulty whereas word problems 4 and 5 are classified as high difficulty (see Table 4–8 below). 49% of students has the maximum score in question 2 of word problem 6, hence it has been classified as medium difficulty. The percentage of students with the maximum score in the test, OCDE and Spain is similar except for question 3 in word problem 2 and question 2 in word problem 6, providing a good triangulation of the overall result of the test.

	Word problem and Questions										
	1.1	**2.1**	**2.2**	**2.3**	**3.1**	**4.1**	**4.2**	**4.3**	**5.1**	**6.1**	**6.2**
Test	84%	87%	84%	76%	75%	18%	15%	36%	24%	93%	49%
OECD	69%	80%	74%	40%	78%	*No Data Available*			20%	73%	25%
SPAIN	73%	79%	72%	30%	78%				13%	71%	22%
average	0,85	0,92	0,90	0,88	0,77	0,23	0,22	0,44	0,24	0,93	0,55
DIFFICULTY	Low	Low	Low	Low	Low	High	High	High	High	Low	Med

Table 4–8: Percentage of students with the maximum score in the test, in OECD and in Spain; average score (out of 1) and classification of questions according to the mathematical difficulty. Own elaboration and data from PISA released items (INEE, 2013)

4.2. Research Design

In order to classify the design of the research I take into account *A guide for naming research studies in Psychology* by Montero García-Celay y León (2007). In this section I try to explain the main characteristics of the research methodology and the variables of the study.

In this study we produce our own original data so it can be classified as **empiric with quantitative methodology**. As shown above a part of the study is **descriptive** with the use of **the context questionnaire**, part of which information has also to be considered as an empirical variable.

Within the empiric methodology the study belongs to **ex post facto** because the independent variables, e.g. the language in which word problems are presented or the reading comprehension CEFRL level, are not manipulated.

In this research we try to establish the effect of different factors in the score obtained in a mathematics word problem test solved both in Spanish and English. For this reason our study could be classified as **prospective**. Three of the research questions (A, B and D; see section 2 above) are answered by studying the effect of one independent variable so it can be considered as **prospective, with one independent variable, simple**. The research question C analyse the effect of two independent variables over the dependent variable, so it can be considered as **prospective, with more than one independent variable, factorial**.

To sum up the design is **empiric with quantitative methodology, ex post facto** with a **prospective research** (with one -simple- or two -factorial- independent variables). In Table 4–9 below an analysis of the main variables has been done, including also the statistical test used to answer each research question, i.e. one-way or two-way ANOVA.

Research Question	Independent variables	Dependent Variable	Design methodology*	Statistical test
A	Language	Score	Simple	One-way ANOVA
B	CEFR level (simple and detailed)	English score	Simple	One-way ANOVA
C	Language and Mathematical difficulty	Score	Factorial	Two-way ANOVA
	Language for high difficulty	Score	Simple	One-way ANOVA
	Language for low difficulty	Score	Simple	One-way ANOVA
D	Contextual index	English score	Simple	One-way ANOVA

** empiric with quantitative methodology, ex post facto with a prospective research*

Table 4–9: Variables, design methodology and statistical tests. Own elaboration.

4.3. Reliability and validity

The quality of any research depends on the reliability and validity of data, as they must be accurate and measure what is supposed to be measured. Provided that two different papers are given to students to solve PISA word problems (same word problems but different language) we must be sure that they are statistically similar, which is essential in the answer of all the research questions. An analysis of the context questionnaire is also made to provide triangulation to the findings and to be sure of the internal validity of the Likert-type questions (6 and 7).

Paper A and Paper B analysis

To ensure that paper A and paper B in the PISA word problems test are not statistically different we compared the performance of the students using a one-way ANOVA in which the dependent variable is the total score (out of 11) and the factor is the type of booklet A or B. As shown in Figure 4–3 below the mean score for paper A is 6.33 (SD = 1.71) while paper B mean is 6.62 (SD = 1.83) with a difference of 0.29.

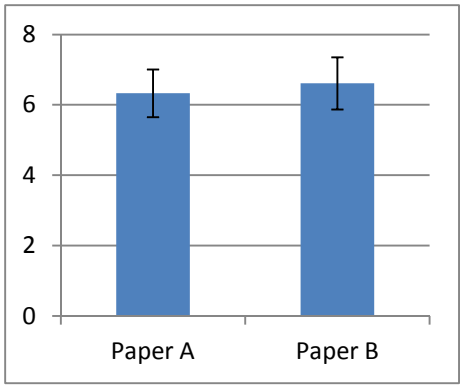

Figure 4–3: Mean and 95% confidence interval of the scores in PISA test's papers A and B. Own elaboration.

The ANOVA test (See Appendix I) indicates that there is not a significant difference between paper A and paper B ($F= 0.335 < F_{1,52,0.05}=4.027$; p-value = 0.556 > 0.05) validating the combined use of both papers.

Context questionnaire analysis

For questions 6 and 7 (Likert-type scale) the calculated Cronbach's $\alpha = 0.751$ is an acceptable value, therefore the scale provided is considered reliable.

In order to provide triangulation of data an analysis of questions 6, 7 and 8 of the questionnaire has been made. The scale for questions 6 and 7 was 1 (strongly disagree) to 5 (strongly agree) whereas Question 7 was a multiple option question, so students could mark those he or she agreed with. The questions are:

Question 6. Is it more difficult for you to learn mathematics through English than through Spanish?

Question 7. Do you think that solving word problems in English is more difficult than solving them if they were in Spanish?

Question 8. What are the difficulties when solving word problems in English in comparison of solving them if they were written in Spanish?

The fact of seen a word problem in English makes me feel anxious

I need more time to understand them

The specific mathematics vocabulary was not seen in classroom

There are unknown grammatical structures

There is unknown non-mathematics vocabulary

For question 6 the majority of students are in the lower part of the scale, with 79% of them choosing 1, 2 or 3 and only 6% choosing 5, with an average of 2.43. This shows that students do not find a great difficulty when learning mathematics through English (see Figure 4–4).

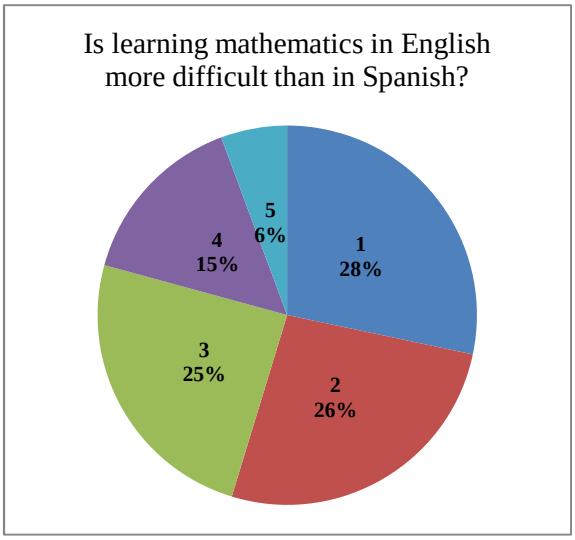

Figure 4–4: Context questionnaire question 6 answers. 1 (strongly disagree) to 5 (strongly agree) scale. Own elaboration.

Regarding word problem solving processes students find more difficulties than with the mere mathematics learning. This is shown in question 7, where 77% of students choose the middle options 2, 3 or 4 whereas only 9% choose 1, with an average of 3.04. The main conclusion is that it seems to be more challenging solving word problems written in English than learning mathematics through English (see Figure 4–5).

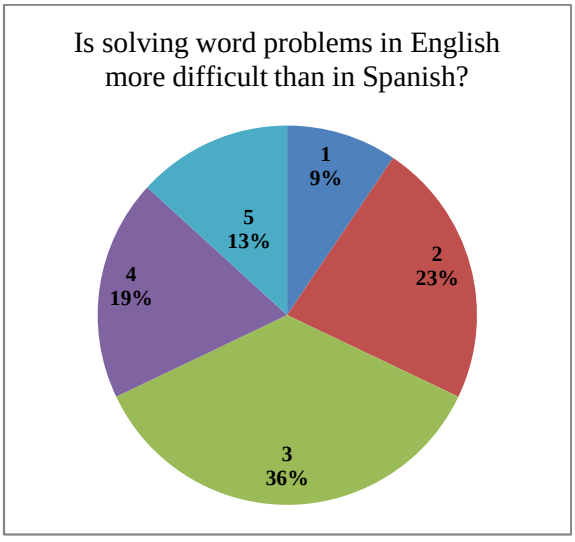

Figure 4–5: Context questionnaire question 7 answers. 1 (strongly disagree) to 5 (strongly agree) scale. Own elaboration.

The answers for question 8 indicates that there are two factors that students perceive as difficulties when solving word problems written in English in comparison to those written in Spanish. The majority of students (77%) consider that they need more time to solve them, and almost half of them (42%) think that non-mathematics vocabulary provides complication (see Figure 4–6).

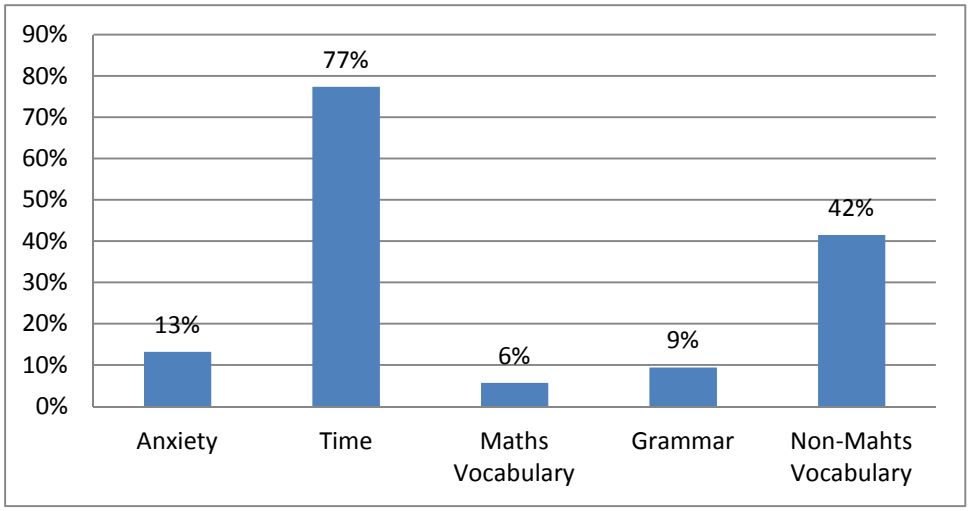

Figure 4–6: Context questionnaire question 8 answers. difficulties when solving word problems in English. Own elaboration.

4.4. Procedure

The research has been carried out during the academic year 2016/2017. During the first months of 2017 all the theoretical background was analysed to provide our instruments a good foundation, to end up with the development of three papers: a reading comprehension level test, a context questionnaire and a word problems test.

A first data collecting calendar was established with the criterion of making it possible the administration of each type of paper within the same day. Another criterion was the lapse of time, it must be as small as possible to avoid any differences in their English or Mathematics proficiency level or in their perception about the use of English as a medium to learn Mathematics. Some students did not attend class the day the papers were given to the class, therefore an alternative date was found. According to these criteria the calendar was set as follows in Table 4–10.

Instrument	General date*	Other dates*
B1 Test selection	May 24th (51)	May 30th (2)
Context questionnaire	May 29th (53)	–
PISA word problems test	June 2nd (47)	June 13th (3); June 14th (3)

** In parenthesis the number of students who did the instrument that day*

Table 4–10: Data collecting calendar. Own elaboration.

B1 Test: it was given to students on May 24th, 2017 during the English classes by their respective English teachers. The group 4th-1 completed it in the 4th period of classes whereas the group 4th-2.3 completed it in the 6th period. There was no brake between those periods and rooms were separated enough to avoid any transference of information. Students were placed in separate rows and columns and a brief explanation of the text and the answer sheet was

provided for the first 10 minutes of the class. They had 50 minutes to complete the test, which was proved to be enough as most of the student finished it in advance. Only two students from the group 4th-1, who did not attend class that day, took the test on May 30th (during the 1st period of classes). In order to check if any information about the test passed to those students their scores where compared to other marks during the academic year resulting in plausible scores. The average age of the students the day each of them took the test was 15.49 years old.

Context questionnaire: it was completed on May 29th by all students during the Mathematics classes. The possible transference of information was not a problem with this paper as only personal data was needed for the questionnaire, that's why the group 4th-1 completed the task during the 1st period and the group 4th-2.3 completed it during the 6th period, having a break in between. The average age of the students the day each of them took the test was 15.53 years old.

Students were placed in separate rows and columns and a brief explanation of the questionnaire was given for the first 10 minutes of the class. Students were told about the importance of the questions, the fact that they were about individual perceptions and experiences, therefore there were no right or wrong answers, and that the utmost sincerity was needed. Then they had 50 minutes to complete it, which was proved to be enough as most of the student finished it in advance. Question 13 about parents occupation was difficult to answer for many of them, therefore some students required some extra explanations. Anyway the descriptive field included in this question provided a good help to check the answers and complete some missing information about the classification given.

PISA word problems test: it was completed on June 2nd during the mathematics classes. To avoid any transference of information the test took place in two consecutive periods, starting with the group 4th-2.3 in the 4th period and then moving to 4th-1 in the 5th period, with no brakes in between.

Students were placed in separate rows and columns and a brief explanation of the PISA word problems test and the sequence of each booklet was given for the first 10 minutes of the class. Then they had 50 minutes to complete it, which was proved to be enough as most of the student finished it in advance. All word problems in English had a glossary adapted to the B1 reading comprehension level that most students had. The most important thing was to evaluate the mathematical performance, therefore questions about the vocabulary were allowed but not about any mathematical contents or processes, although very few were made.

Six students did not attend class that day so the three students of the group 4th-2.3 took the test on the 6th period of June 13th and the three students of the group 4th-1 took the test on the 2nd period of June 14th. Although some transference of information could have happened it was minimal according to their performance in the test in comparison to their performance in

solving word problems during the academic year. The average age of the student the day each of them did the PISA test was 15.55 years old.

5. Results and data analysis

In this section of the paper we will try to answer the four research questions by the use of the statistical techniques that are detailed in 4.2. All data are analysed using the software IBM© SPSS© Statistics 24.

5.1. Research question A

A) Is the word problem solving process affected by the use of L2?

To answer the first research question a one-way ANOVA was performed with language as the independent variable and the total score per language as the dependent variable. Each student has hence two scores, one for the word problems written in English and one for the word problems written in Spanish. As shown in Figure 5–1 descriptive data indicate that the mean for the word problems written in English (M = 5.000; SD = 3.039) is less than the mean for the word problems written in Spanish (M= 6.440; SD = 2.737).

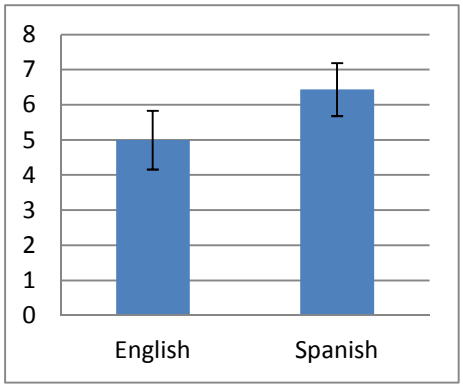

Figure 5–1: Mean and 95% confidence interval of the scores in PISA test's papers in English and Spanish. Own elaboration.

In order to assess if the difference is significant the ANOVA test was conducted (see detailed information in Appendix I: Statistical tables). Homogeneity of variances can be assumed with a p-value = 0.234 for Levene test. The test reveals that the difference of the scores obtained in solving the word problems in English or Spanish is statistically significant ($F = 6.569 > F_{1,105,0.05} = 3.932$). P-value = 0.012 confirms that the scores in English are significantly lower than the scores in Spanish at 0.05 significance level.

The importance of this finding is that the language affects the assessment of the mathematical proficiency, so this has to be taken into consideration when evaluating word problem solving processes in bilingual contexts.

5.2. Research question B

B) Is the reading comprehension level of students in the L2 a key factor in word problem solving processes?

For the second research question we completed two one-way ANOVA tests with the reading comprehension CEFR level (simple or detailed, see 4.1.1 above) as the independent variable and the total score of the word problems written in English as the dependent value. As shown in Figure 5–2 and Figure 5–3 descriptive data illustrate that the mean for the word problems written in English is similar for each CEFR level (see Table 5–1).

CEFR Level	M	SD
A2	5.066	1.092
B1	4.889	3.030
B2	5.306	3.724

Detailed CEFR Level	M	SD
A2	5.066	1.092
B1.1	4.686	3.097
B1.2	5.092	3.037
B2	5.306	3.724

Table 5–1: Mean and standard deviation in English score per CEFR level (simple and detailed). Own elaboration.

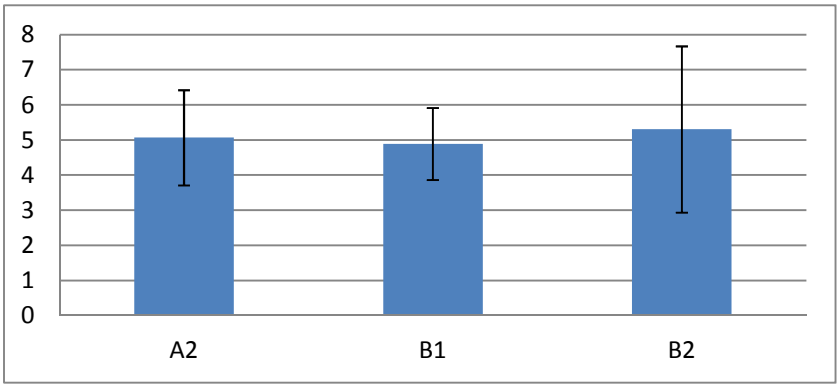

Figure 5–2: Mean and 95% confidence interval of the English scores per CEFR level. Own elaboration.

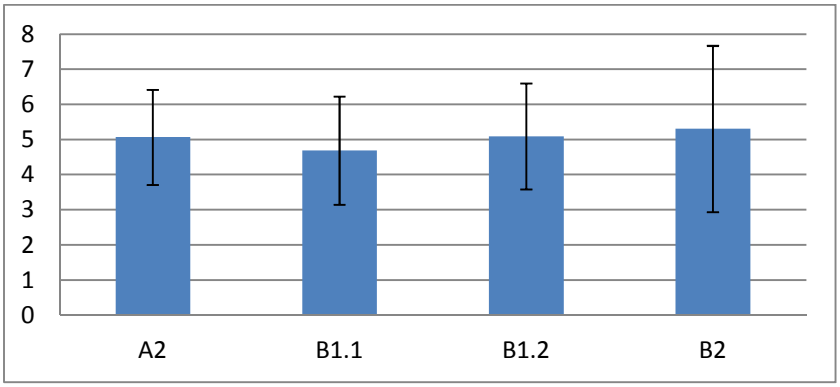

Figure 5–3: Mean and 95% confidence interval of the English scores per detailed CEFR level. Own elaboration.

Two ANOVA tests, one for the simple and another for the detailed CEFR level, were made to establish whether the differences are significant (see detailed information in Appendix I: Statistical tables). Homogeneity of variances cannot be assumed ($p\text{-value}_{simple} = 0.003$; $p\text{-value}_{detailed} = 0.005$ for Levene tests), which implies that other analysis must be done to provide confirmation of the results. The ANOVA tests indicate that the difference of the scores in English obtained in solving the word problems per CEFR level is not statistically significant ($F_{simple} = 0.083$; $F_{detailed} = 0.105$; both less than $F_{3,52,0.05} = 2.783$). $P\text{- value}_{simple} = 0.921$ and $p\text{-value}_{detailed} = 0.957$ confirm that the scores in English do not differ significantly between CEFR levels (simple or detailed) at 0.05 significance level. The robust tests of equality of means (Brown-Forsythe) confirms that the scores are not significantly different with a p-value > 0.898.

Multiple comparisons were made by a post hoc test (Tamhane) to evaluate the effect of each pair of CEFR levels, resulting in no significant differences between any pair of levels, being them simple with a minimum p-value = 0.980, or detailed with a minimum p-value = 0.998.

Although in the first research question we found out that there are differences in solving word problems in English compared to Spanish, it seems that the reading comprehension level does not affect to the final score obtained when solving word problems in English.

5.3. Research question C

C) How the combined action of language and mathematical difficulty affects the word problem solving processes?

Interaction

The first analysis to be performed is a two-way ANOVA test with language and math difficulty as factors and the score obtained in each case as the dependent value. Previously a selection of the word problems that are going to be included must be made. The criteria are that all the questions for each word problems must be classified with the same difficulty and that the maximum number of word problems can be arranged per language at a particular level (see Table 4–8). Word problem 6 is discarded because it has one low and one medium question, whereas word problem 1 is not selected due to the fact that the rest of low difficulty word problems (2 and 3) are written in a different language. Hence the final selection includes word problems 2 and 3 for low mathematical difficulty and word problems 4 and 5 for high mathematical difficulty.

Descriptive data (see Figure 5–4) coincide in the fact that the score is greater in Spanish than in English, although the difference seems to be grater for word problems with higher mathematical difficulty.

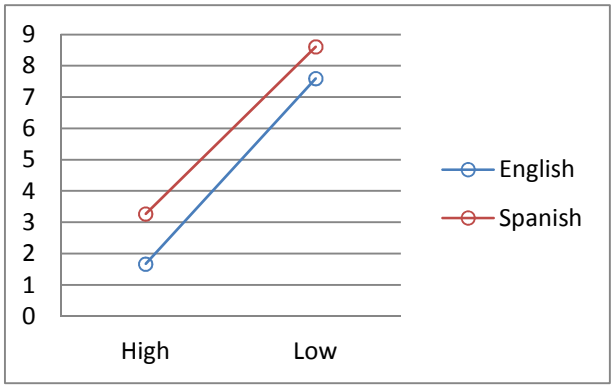

Figure 5–4: Mean score for word problems according to language and mathematical difficulty. Own elaboration

Two-way ANOVA evaluate the importance of the two factors in the score differences (see detailed information in Appendix I: Statistical tables). ANOVA table shows that there are statistically significant differences in the scores regarding the mathematical complexity ($F = 162.178 > F_{1,105,0.05} = 3.932$), which is confirmed by the p-value = $8.3524 \cdot 10^{-23}$. As expected from the findings in the answer of the research question A, there are also statistically significant differences in the scores regarding the language ($F = 8.746 > F_{1,105,0.05} = 3.932$), which is confirmed by the p-value = 0.004. The table also indicates that the interaction of the two factors, difficulty and language, is not statistically significant ($F = 0.441 > F_{1,105,0.05} = 3.932$), which is confirmed by the p-value = 0.508. The analysis of the partial Eta squared tells that the difference is mostly explained by the mathematical difficulty, as the language is responsible for 7.9% of the differences and the interaction for 0.4%.

Separate analysis

The fact that the mathematical difficulty is the main factor affecting the differences we will perform separate one-way ANOVA for high and low difficulty levels. Language is the independent variable and the score is the dependent variable. Again descriptive data (see Figure 5–5) indicate that the difference is grater for word problems with high mathematical difficulty, with a mean value of 1.667 (SD = 1.801) for word problems written in English and a mean of 3.269 (SD = 2.426) for word problems written in Spanish. In contrast the difference is diminished for word problems with low mathematical difficulty, with a mean value of 7.596 (SD = 3.040) for word problems written in English and a mean of 8.611 (SD = 1.601) for word problems written in Spanish.

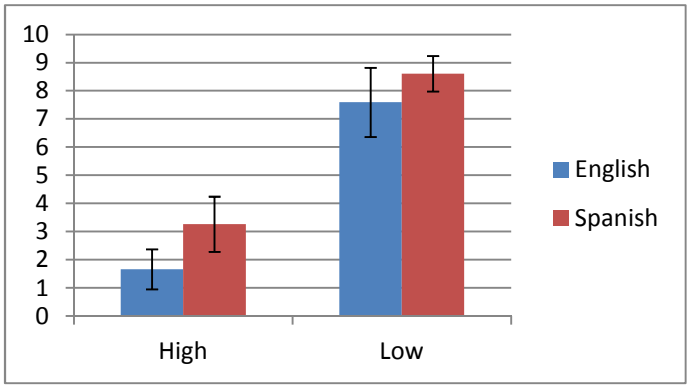

Figure 5–5: Mean and 95% confidence interval of the scores per difficulty level. Own elaboration.

The ANOVA test for high difficulty word problems (see detailed information in Appendix I: Statistical tables) indicates that homogeneity of variances can be assumed with a p-value = 0.127 for Levene test. ANOVA announce that the difference of the scores obtained in solving high difficulty word problems in English or Spanish is statistically significant ($F = 7.494 > F_{1,52,0.05} = 4.027$). P-value = 0.009 confirms that the scores in English are significantly lower than the scores in Spanish at 0.05 significance level.

On the other hand the ANOVA test for low difficulty word problems (see detailed information in Appendix I: Statistical tables) indicates that homogeneity of variances cannot be assumed with a p-value = 0.012 for Levene test. ANOVA points out that the difference of the scores obtained in solving low difficulty word problems in English or Spanish is not statistically significant ($F = 2.338 < F_{1,52,0.05} = 4.027$). P-value = 0.132 confirms that the scores in English and Spanish do not differ significantly at 0.05 significance level.

Albeit there is not a significant interaction of language and mathematical difficulty, the separated analysis reveals that when the mathematical difficulty of the word problems is low there is not a significant difference in the scores, but when the difficulty is high the difference is significant. This has to be considered when assessing word problem solving processes in bilingual contexts.

5.4. Research question D

D) Is there an interaction between contextual factors and the word problem solving processes in the L2?

Foundations about SES indexes can be found in section 3.7 above. As we explained it is not the objective of this research to calculate any SES index but to see if contextual factors could be relevant when solving word problems in English. In addition Sirin concludes that there are much smaller correlations between SES and academic achievement when data are collected from students (2005). For this reasons a contextual index (CI henceforth) has been built following the theoretical background. In any case where questions affected both parents, the

highest possible value has been chosen (questions 11, 12 and 13). The weighs for each item has been selected in accordance to the SES indexes indicated above: parents occupation and education with the same weight and home possessions weight is 50% of those. Some correction is provided by family structure and parents' expectation with a weight of 20% (see Table 5–2).

$$CI = \alpha_1 FAM\_STR + \alpha_2 HOM\_POS + \alpha_3 PAR\_EX + \alpha_4 PAR\_ED + \alpha_5 PAR\_OC$$

FAM_STR	Family structure (Q 9)	$\alpha_1 = 0.2$
HOME_POS	Home possessions (Q 10)	$\alpha_2 = 0.5$
PAR_EX	Highest parents' expectation (Q 11)	$\alpha_3 = 0.2$
PAR_ED	Highest parents' education (Q 12)	$\alpha_4 = 1$
PAR_OC	Highest parents' occupation (Q 13)	$\alpha_5 = 1$

Table 5–2: Items and weights for the contextual index. Own elaboration.

There was one missing data for parents' expectation but it was calculated as 5 because the mean value for this question is 4.9. All answers were re-coded in a 1 (lower contextual status) to 5 (higher contextual status) scale in order to make all the items comparable before applying the respective weights to calculate the CI.

	Original codification							
Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
9	5	3	1	-	-	-	-	-
10	1	2,3	3,6	5	-	-	-	-
11	1	2	3	4	5	-	-	-
12	1	2	3	4	5	-	-	-
13	5	1	3	2	2	1	4	3

Table 5–3: Re-codification of questions 9 to 13 for CI calculation. Own elaboration.

The aim of the contextual index is to establish a hierarchy in the group of students, not to have a numeric value to actually measure such status. Consequently when the calculus of the CI was performed, a cluster analysis using average linkage has been done to form two to four groups. After the study, which dendogram can be seen in Appendix I: Statistical tables, two groups are formed, as three and four cluster options have a group with just two cases (see Table 5–4).

	2 Clusters	**3 Clusters**	**4 Clusters**
1	40	40	20
2	13	11	11
3	-	2	20
4	-	-	2

1 is the maximum state and 4 is the minimum

Table 5–4: Number of cases per cluster for 2, 3 and 4 clusters. Own elaboration

To evaluate if there is a contextual influence when solving word problems in English, a one-way ANOVA was performed with CI as the independent variable and the English score as the dependent variable. As shown in Figure 5–6 descriptive data tell that the mean for the word problems solved by students with high contextual level (M = 5.167; SD = 3.098) is greater than the mean for the word problems solved by students with low contextual level (M= 4.487; SD = 2.907).

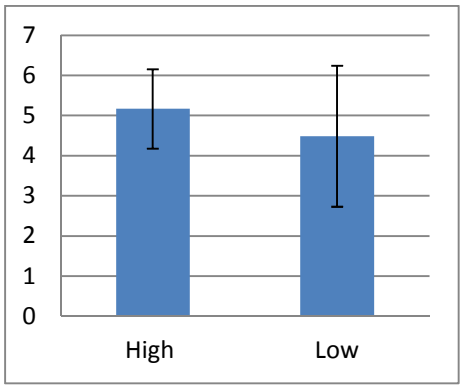

Figure 5–6: Mean and 95% confidence interval of the scores per contextual level. Own elaboration.

With the objective of assessing if the difference is significant the ANOVA test was conducted (see detailed information in Appendix I: Statistical tables). Homogeneity of variances can be assumed with a p-value = 0.675 for Levene test. The test reveals that the difference of the scores obtained in solving the word problems written in English is not statistically significant ($F = 0.486 > F_{1,52,0.05} = 4.027$). P-value = 0.489 confirms that the scores are not significantly different per contextual level at 0.05 significance level. The ANOVA test was repeated for 3 and 4 clusters producing identical results.

When a separated analysis is made for all the contextual variables results show that the F values are always smaller than the critical value, which is confirmed by p-values between 0.227 and 0.945. Consequently there is no statistically significant difference in the scores of the word problems written in English when considering each variable separately.

Therefore contextual factors analysed seems to have no influence in the word problem solving processes in English.

6. Conclusion

6.1. Main conclusions and pedagogical implications

From the data analysis several conclusions can be drawn. Two of them have clear pedagogical implications in the assessment of the mathematical performance regarding word problem solving processes. The first one is that language affects the evaluation, as word

problems written in English have significantly lower scores than in Spanish. This is consistent with the perception of the students that solving word problems in English is more difficult than doing it in Spanish. It also concur with other findings that language proficiency affects mathematical achievement on the level of testing (A. B. Bernardo, 1999; A. B. I. Bernardo, 2002; Kempert et al., 2011) but not with other studies that declare that if language proficiency is adequate for understanding the problem bilingualism has no effect on mathematical problem-solving (Bialystok, 2001). The second one is that this difference appears in word problems with high mathematical difficulty, but not when this difficulty is low. We can conclude that a correct assessment of the mathematical proficiency of the word problem solving processes, in bilingual contexts, should be done choosing those word problems with low mathematical difficulty to be written in the L2 (quadrant 4 in CLIL matrix, see Figure 3–1), complementing them with other word problems written in the L1.

Although the reading comprehension CEFR level does not seem to affect the word problem solving processes, this could be due to fact that only five students were classified as A2 level. According to this conclusion the mathematical register of the word problems may not be necessarily adapted to the linguistic level of the students.

According to the students perceptions the word problem solving processes require more time and the unknown non-mathematical vocabulary is problematic. Studies state that simplified linguistic instructions help students to overcome the linguistic complexity of the word problems (Abedi & Lord, 2001; Van Rinsveld et al., 2016), and known vocabulary unloads memory resources that are needed when comprehension difficulties occur on a surface level, which can lead to the unavailability for carrying out arithmetic calculations (Kempert et al., 2011). This can be partially solved by including glossaries or word and expression banks in tests where word problems in the L2 appear. Besides being generous about the timing of the test can help students to carefully read and understand word problems, keeping the focus on the solution process and not on the clock.

Finally we have found that contextual factors analysed do not influence the performance when solving word problems written in English. Maybe this is because the group is quite homogeneous in this matter, nonetheless there are 40 students classified in the group with highest CI whereas there are only 13 in the other group.

To sum up, a recurrent question that concerns bilingual content teachers is the evaluation of the content through the second language avoiding the extra difficulties that could appear when doing any kind of test in the L2. The main pedagogical implication that this study has is related to the assessment procedures. Any evaluation test contains questions with different grades of complication, but from research questions A and C the judgement about the mathematical skills of the bilingual learners should be based on tests where the word problems presented in English are chosen among those with low mathematical difficulty. More arduous

word problems written in L1 can be also used to completely estimate the mathematical competence level.

Although research question B indicates that the reading comprehension level does not affect the score of the word problems written in English, students think otherwise (see 4.3). Other variables that learners perceive as influencing the word problem solving are the non-mathematical vocabulary and the greater time needed to find out the solution. To avoid the extra weight that these factors could have students should have both, time enough to complete the test and vocabulary help, e.g. in the form of a glossary.

If a mathematics teacher wants to transform an L1 test into a bilingual test, all this factors must be considered, choosing the easiest word problems to be translated into the L2, eliminating some questions to proportionate extra time and including a glossary, consequently diminishing any possible mismatch of the mathematical performance due to linguistic difficulties.

6.2. Weaknesses and future directions

The study took place in only one high school in the city centre of an average city in Andalusia, affecting the external validity that makes the results difficult to extrapolate to other contexts. Nevertheless the participants are formed by two whole groups of students that could be representative of similar high schools in contextual and socio-economic terms. In any case further researches should take this one as an starting point in order to guarantee that the conclusions are valid in general, including schools with different situations (e.g. urban, suburban or rural) and contexts.

Another factor that could affect the external validity is the homogeneity of the group in terms of CEFR reading comprehension level. Hence more studies with students having different reading comprehension grades should be done to confirm if solving word problems in English is truly affected by their reading performance and if the reading performance in combination with the mathematical difficulty of the word problems can be used for the adequate selection of the word problems in tests which main objective is to assess the mathematical performance.

Although it was an initial purpose of the research, language itself has not been studied in this paper due to possible undesired outcomes, but this is a factor that could be of interest in future investigations, as language is the basis of the word problem understanding and leads the students to their resolution.

Finally, the homogeneity also appears within the contextual factors. For this reason a more profound research regarding the context and the mathematical performance in English should be done.

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Appendices

Appendix I: Statistical tables

PISA word problem test. Total score in Paper A and Paper B.

One-way ANOVA. Dependent variable: total score (out of 11)

Factor: type of booklet A or B

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
Paper A	27	6,3333	1,71532	,33011	5,6548	7,0119	2,00	9,00
Paper B	26	6,6154	1,83471	,35982	5,8743	7,3564	2,00	9,00
Total	53	6,4717	1,76345	,24223	5,9856	6,9578	2,00	9,00

Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
,052	1	51	,820

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,054	1	1,054	,335	,566
Within Groups	160,654	51	3,150		
Total	161,708	52			

RQ A: PISA word problem test. Total score in English and Spanish.

One-way ANOVA. Dependent variable: total score for both languages (out of 10)

Factor: language

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
English	53	5,0000	3,03903	,41744	4,1623	5,8377	,00	10,00
Spanish	53	6,4400	2,73744	,37602	5,6855	7,1945	,00	10,00
Total	106	5,7200	2,96788	,28827	5,1484	6,2916	,00	10,00

Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
1,435	1	104	,234

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	54,950	1	54,950	6,569	,012
Within Groups	869,922	104	8,365		
Total	924,872	105			

RQ B: PISA word problem test. English score per CEFR level.

One-way ANOVA. Dependent variable: English Score (out of 10)

Factor: CEFR level (A2, B1, B2)

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
A2	5	5,0660	1,09169	,48822	3,7105	6,4215	3,33	6,00
B1	36	4,8889	3,03011	,50502	3,8636	5,9141	,00	10,00
B2	12	5,3058	3,72393	1,07501	2,9398	7,6719	,00	10,00
Total	53	5,0000	3,03903	,41744	4,1623	5,8377	,00	10,00

Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
6,453	2	50	,003

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,589	2	,794	,083	,921
Within Groups	478,667	50	9,573		
Total	480,256	52			

Robust Tests of Equality of Means

	Statistica	df1	df2	Sig.
Brown-Forsythe	,108	2	19,782	,898

a. Asymptotically F distributed.

Multiple Comparisons

			Mean Difference			95% Confidence Interval	
	(I) CEFR_3	(J) CEFR_3	(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Tamhane	A2	B1	,17711	,70242	,993	-1,7067	2,0609
		B2	-,23983	1,18068	,996	-3,4286	2,9490
	B1	A2	-,17711	,70242	,993	-2,0609	1,7067
		B2	-,41694	1,18772	,980	-3,5786	2,7448
	B2	A2	,23983	1,18068	,996	-2,9490	3,4286
		B1	,41694	1,18772	,980	-2,7448	3,5786

One-way ANOVA. Dependent variable: English Score (out of 10)

Factor: detailed CEFR level (A2, B1.1, B1.2, B2)

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
A2	5	5,0660	1,09169	,48822	3,7105	6,4215	3,33	6,00
B1.1	18	4,6856	3,09731	,73004	3,1453	6,2258	,00	8,33
B1.2	18	5,0922	3,03684	,71579	3,5820	6,6024	,00	10,00
B2	12	5,3058	3,72393	1,07501	2,9398	7,6719	,00	10,00
Total	53	5,0000	3,03903	,41744	4,1623	5,8377	,00	10,00

Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
4,929	3	49	,005

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3,077	3	1,026	,105	,957
Within Groups	477,179	49	9,738		
Total	480,256	52			

Robust Tests of Equality of Means

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	,127	3	38,390	,944

a. Asymptotically F distributed.

Multiple Comparisons

			Mean Difference			95% Confidence Interval	
	(I) CEFR_4	(J) CEFR_4	(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Tamhane	A2	B1.1	,38044	,87825	,999	-2,1928	2,9537
		B1.2	-,02622	,86644	1,000	-2,5684	2,5160
		B2	-,23983	1,18068	1,000	-3,8372	3,3576
	B1.1	A2	-,38044	,87825	,999	-2,9537	2,1928
		B1.2	-,40667	1,02241	,999	-3,2624	2,4490
		B2	-,62028	1,29946	,998	-4,3989	3,1583
	B1.2	A2	,02622	,86644	1,000	-2,5160	2,5684
		B1.1	,40667	1,02241	,999	-2,4490	3,2624
		B2	-,21361	1,29151	1,000	-3,9751	3,5479
	B2	A2	,23983	1,18068	1,000	-3,3576	3,8372
		B1.1	,62028	1,29946	,998	-3,1583	4,3989
		B1.2	,21361	1,29151	1,000	-3,5479	3,9751

RQ C: PISA word problem test. Score per Language and Mathematical difficulty.

Two -way ANOVA. Dependent variable: Score (out of 10)

Factors: Language and Mathematical difficulty

Descriptive Statistics

Dependent Variable: SCORE

1:Alta;2:Baja	1:Eng;2:Spa	Mean	Std. Deviation	N
1	1	1,667	1,8014	27
	2	3,269	2,4258	26
	Total	2,453	2,2596	53
2	1	7,596	3,0398	26
	2	8,611	1,6013	27
	Total	8,113	2,4468	53
Total	1	4,575	3,8756	53
	2	5,991	3,3734	53
	Total	5,283	3,6851	106

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	896,718[a]	3	298,906	57,616	,000	,629
Intercept	2960,541	1	2960,541	570,662	,000	,848
DIF	841,365	1	841,365	162,178	,000	,614
LAN	45,374	1	45,374	8,746	,004	,079
DIF * LAN	2,287	1	2,287	,441	,508	,004
Error	529,167	102	5,188			
Total	4384,375	106				
Corrected Total	1425,884	105				

a. R Squared = ,629 (Adjusted R Squared = ,618)

One-way ANOVA. Dependent variable: Score for high difficulty word problems (out of 10)

Factor: Language

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
English	27	1,667	1,8014	,3467	,954	2,379	,0	5,0
Spanish	26	3,269	2,4258	,4757	2,289	4,249	,0	7,5
Total	53	2,453	2,2596	,3104	1,830	3,076	,0	7,5

Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
2,401	1	51	,127

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	34,017	1	34,017	7,494	,009
Within Groups	231,490	51	4,539		
Total	265,507	52			

One-way ANOVA. Dependent variable: Score for low difficulty word problems (out of 10)

Factor: Language

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
English	26	7,596	3,0398	,5962	6,368	8,824	,0	10,0
Spanish	27	8,611	1,6013	,3082	7,978	9,245	5,0	10,0
Total	53	8,113	2,4468	,3361	7,439	8,788	,0	10,0

Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
6,860	1	51	,012

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13,644	1	13,644	2,338	,132
Within Groups	297,676	51	5,837		
Total	311,321	52			

Robust Tests of Equality of Means

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	2,287	1	37,566	,139

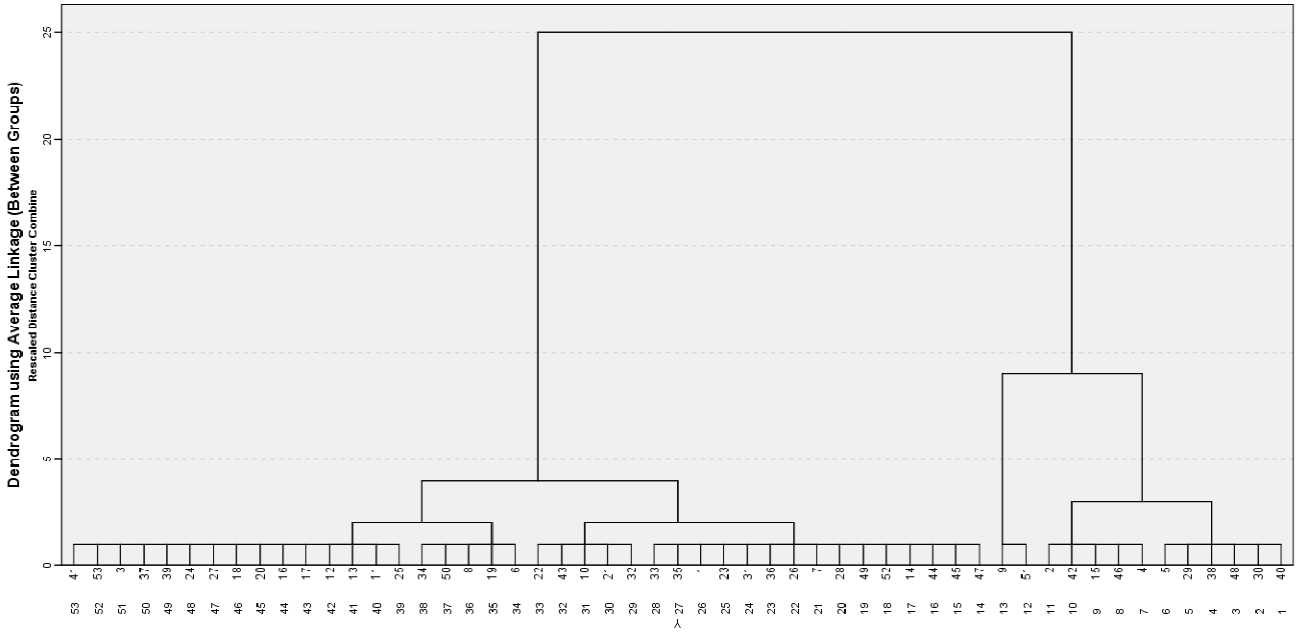
a. Asymptotically F distributed.

RQ D: PISA word problem test. English score per CI level.

Cluster analysis. Factor: CI

Interval: Euclidean Squared distance

Grouping: Average linkage



One-way ANOVA. Dependent variable: English Score (out of 10)

Factor: CI level (High, Low)

2 clusters

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
High	40	5,1668	3,09797	,48983	4,1760	6,1575	,00	10,00
Low	13	4,4869	2,90721	,80631	2,7301	6,2437	1,67	10,00
Total	53	5,0000	3,03903	,41744	4,1623	5,8377	,00	10,00

Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
,178	1	51	,675

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4,534	1	4,534	,486	,489
Within Groups	475,721	51	9,328		
Total	480,256	52			

3 clusters

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (High)	40	5,1668	3,09797	,48983	4,1760	6,1575	,00	10,00
2	11	4,8782	2,99320	,90248	2,8673	6,8890	2,00	10,00
3 (Low)	2	2,3350	,94045	,66500	-6,1146	10,7846	1,67	3,00
Total	53	5,0000	3,03903	,41744	4,1623	5,8377	,00	10,00

Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
1,670	2	50	,199

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15,480	2	7,740	,833	,441
Within Groups	464,776	50	9,296		
Total	480,256	52			

4 clusters

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (High)	20	4,8665	3,38702	,75736	3,2813	6,4517	,00	10,00
2	11	4,8782	2,99320	,90248	2,8673	6,8890	2,00	10,00
3	20	5,4670	2,83519	,63397	4,1401	6,7939	,00	10,00
4 (Low)	2	2,3350	,94045	,66500	-6,1146	10,7846	1,67	3,00
Total	53	5,0000	3,03903	,41744	4,1623	5,8377	,00	10,00

Test of Homogeneity of Variances

Levene Statistic	df1	df2	Sig.
1,656	3	49	,189

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	19,086	3	6,362	,676	,571
Within Groups	461,170	49	9,412		
Total	480,256	52			

Appendix II: B1 test

This test is part of the Reading and Writing test from Preliminary English Test of Cambridge

Time 50 minutes

INSTRUCTIONS TO CANDIDATES

Do not open this question paper until you are told to do so.

Write your name, group and date on this sheet and on your answer sheet.

Read the instructions for each part of the paper carefully.

Answer all the questions.

Read the instructions on the answer sheet.

Write your answers on the answer sheet. Use a pen.

You **must** complete the answer sheet within the time limit.

At the end of the test, hand in both this question paper and your answer sheet.

INFORMATION FOR CANDIDATES

There are 35 questions in this paper.

Questions **1 – 35** carry one mark.

Conversion scale:

Test score	7	15	25	32
CEFR Level	-	A2	B1	B2

NAME: _____

GROUP: _____

DATE: __ / __ / 2017

Part 1 Questions 1 – 5

Look at the text in each question. What does it say?
Mark the correct letter **A**, **B** or **C on your answer sheet**.

There is an example at the beginning (**0**).

Example:

0

A Andy would prefer to go sailing with Julia on Saturday rather than on Sunday.

B Andy can go sailing with Julia on Friday if she's not free on Saturday.

C Andy wants to go sailing with Julia on both Saturday and Sunday if possible.

1

The note tells Sarah she

A can buy new games now at a special price.

B can get new and used games in the current sale.

C can sell her used games to the shop.

2

Wanted:

babysitter for regular work, two evenings per week – generally Monday and Wednesday, but this could change in future.

Own transport essential; call Sue to discuss duties and pay details.

The advertisement says

A the babysitter should call Sue about weekly transport to her house..

B the jobs the babysitter is responsible for will change each week.

C the babysitter might work on different days each week.

3

Due to staff holidays, shop closes early on weekdays during August;

Saturdays as normal.

A The shop is closed during some weekdays in August due to holidays.

B The shop's opening hours are different on Monday to Friday in August.

C The shop is closing at different times at weekends in August.

4

Gym changing rooms

Place personal items in lockers.

Staff will remove anything on floor.

A If staff find items on the floor, they will put them away in a locker.

B You must only leave belongings in the areas provided.

C Lockers are regularly checked by staff.

5

Museum Café

These tables are for customers only.

Follow signs for picnic areas.

A You should take all food to the special picnic area.

B You can eat picnics in this section of the café.

C You may sit here if you buy something from the café.

Part 2 Questions 6 – 9

The people below all enjoy music.
On the following page there are descriptions of eight places where people can have different musical experiences.
Decide which place would be the most suitable for the following people.
For questions **6 – 10**, mark the correct letter **(A – H) on your answer sheet**.

---

6 

Joe's interested in classical music and wants to talk to professional musicians about their work. He'd like to find out more about classical instruments, and actually play some music.

7 

Will wants to learn to play some of his favourite band's songs, and to know how his favourite singers create their own special sound. He'd like to try out some different instruments.

8 

Jess loves watching spectacular concerts with fantastic dancers, and wants to feel some of the atmosphere of a big musical event. She'd like to see performances by famous people she's heard about.

9 

James likes exploring the personal backgrounds of his favourite bands, and also the stories behind their well-known songs. He has his own band, and wants some advice about performing live on stage.

10 

Zoe likes listening to all sorts of pop music, and wants a fun way to learn various dance styles. She'd like to bring something home to show her friends what she's learnt during her visit.

A The Core

This is the place for musical history. You'll learn where your favourite singers and musicians grew up and discover the processes involved in writing famous songs and producing the videos. Find out about their journey to fame, and get some tips on what makes a good concert! There's all you ever wanted to know about famous musicians!

B Rhythm-Studio

Get your body moving in the studio and learn to move to rhythms and sounds from the past to now, including Soul and Disco. Learn your steps from our professional onscreen dance instructor, then watch your performance and become the star in your own video recording which you can take away!

C World Scene

For one month only, experience the amazing sights and sounds of the WorldScene band, a large international group of traditional musicians and dancers. You'll experience music and dance styles never heard or seen before in this country. Book a ticket to meet the musicians, talk about their experiences and get some new ideas!

D Universe of Sound

Create your own musical experience - record yourself making music with a huge orchestra as they play on the video background screen – you can even download it to disc to take home! You can also learn about violins, flutes, trumpets and many more with our computer demonstrations, and meet real musicians who are present every day.

E Archived Images

Want to find out about a new band, or just want more information about an old favourite? Visit our collection to find out facts and figures, or see the actual possessions of famous bands and musicians you are interested in. You can actually get to touch things worn on stage at major rock and pop events, and there are plenty of other concert souvenirs.

F Finale

Imagine being in the crowd for amazing performances from the past. Enjoy 3D life-size videos from the stars of yesterday and today. You can experience the excitement of a massive rock stadium, and the sounds, movement and rhythms that created some of the most exciting music ever known.

G Rave-on!

How about learning new skills on the guitar, drums and keyboard by video? Follow the touch-screen instructions to find lessons on each instrument, or search for a song to practise playing along to. Try our Professional Selection, with video clips of band members who will explain the techniques that make their recordings so individual.

H Show-in-a-day!

Be a star singer or dancer for the day in a one-time-only special performance! Experts in international music and dance styles will train you, and costumes provided for the performance help create a really special, individual show. Get your friends and family to come and see you perform, as no videoing or photography is allowed.

Part 3 Questions 11 – 20

Look at the sentences below about two wildlife filmmakers.
Read the text on the next page to decide if each sentence is **correct** (**A**) or **incorrect** (**B**).
If it is **correct**, mark **A on your answer sheet**.
If it is **not correct**, mark **B on your answer sheet**.

---

11 Richard and Sonia's most recent film compared lions' behaviour in different parts of Africa.

12 It was Richard and Sonia's idea to set up a special project to research the lions in Africa.

13 Meeting each other as students was the start of Sonia developing a new interest.

14 Sonia's parents encouraged her to discover the natural environment around her childhood home.

15 They agree that an uncomfortable working environment is the worst part of their job.

16 They have different ideas about what is the most enjoyable part of their job.

17 They found people with fewer opportunities to use technology have a better understanding of geography.

18 Richard advises students of wildlife to keep up to date with the most recent filmmaking techniques.

19 Sonia suggests that some modern technology can make the type of work they do harder.

20 The couple believe that people must act quickly to prevent wildlife from disappearing.

Wildlife Filmmakers

Richard and Sonia Muller make documentaries about wildlife, particularly dangerous animals, like the big cats found in Africa. Film-making for them is a way to bring the message of the importance of understanding wildlife to international audiences, with their last film, *Staying Alive*, exploring relationships between lions and other wildlife in one African region. When Richard and Sonia were invited to help with a special project run by a wildlife organisation that was providing information about the falling numbers of big cats, especially lions, they immediately agreed to take part.

Richard grew up near a wildlife park and as a child was keen on filming what he saw. The couple were introduced at university in Cape Town, and quickly realised how much they had in common. They were both curious about the natural world and Sonia soon discovered a similar talent for filmmaking. As a child in South Africa Sonia often ran off alone to explore the wild areas surrounding her home, despite her parents' fears.

When asked what they found hardest about their work, Sonia and Richard have the same answer - leaving an area and finishing a project. Sonia adds that the hours required can be hard, and things like the heat, dust, and bugs make it very tiring. The excitement of her work comes from not knowing what will happen, perhaps even discovering something new for science, while Richard takes most interest in spending time with individual animals, getting to know their character.

The pair visit schools around the world, and notice that students with access to lots of information don't always have as much understanding about geography as students in countries where access is limited. "Students without the internet constantly available actually look at maps, they want to find out where they are and often end up with a better idea of place," Richard says. A major part of their work is explaining to students the importance of a fuller understanding of various environments by studying the climate, animals and culture of a specific location.

If you'd like a similar career, Richard suggests studying various different areas of biology, rather than learning about the latest filmmaking technology, as an understanding of the natural world will last forever. The couple also give general advice for those wanting to help protect the environment. Sonia explains that it's important to allow yourself to concentrate. "Turning off personal electronic items gets you closer to the natural world," she says. "You can watch nature, instead of listening for your mobile phone." Most importantly they agree that if urgent action isn't taken, more animals might be lost. However, the fact that more

Part 4 Questions 21 – 25

Read the text and questions below.
For each question, mark the letter next to the correct answer **A, B, C** or **D on your answer sheet**.

My Job at a Summer Camp, by Charlie Rose

Every year I work at a summer camp for kids and I really enjoy seeing the children do things they never thought they could do. Nearly all the kids know how to swim and play table-tennis before they come, but things like rock climbing are new experiences for most. Some of them are very nervous, but after a bit of encouragement, they agree to try and they all get to the top in the end, which makes them feel great.

The kids stay several weeks and some do miss home. You might expect it to be the really young ones who feel like that the most but it's actually the ten- to thirteen-year-olds. We don't let them use their mobile phones all the time. First we tell them they can phone home after lunch. Then when they ask again, usually after dinner, we say it's a bit too late to phone and suggest doing it the next day. Most children are fine in a couple of days and at the end of their stay, it's amazing how many come and thanks us because they have had a great time.

It's not just the children who get lonely. We get parents who are on the phone the whole time, asking how their child is getting on, which is quite unnecessary. Often their son or daughter will be busy, playing games or doing something else, so we have to tell parents to ring back another time.

Some kids arrive dressed in smart, designer, new clothes and they sometimes argue when we tell them to change into something they won't mind getting dirty, but before long they realise what we mean.

21 What is the writer trying to do in this text?

A describe how children make friends at a summer camp
B suggest how parents should choose a summer camp for children
C explain what it is like for children at a summer camp
D advise children how to behave at a summer camp

22 What does the writer say about rock climbing at the camp?

A Some children already know how to do it.
B Some children prefer to swim or play table-tennis.
C Some children refuse to take part.
D Some children find it more enjoyable than they expected to.

23 What surprises the writer about the children who stay at the camp?

A The youngest ones find it hard to be away from home.
B They complain if they cannot phone their parents.
C They miss meal times with their parents.
D They seem grateful for their experience here.

24 What does the writer think about some parents?

A They should visit their children instead of phoning them.

B They don't need to keep on phoning the camp.

C They shouldn't allow their children to bring phones to camp.

D They need to be reminded to phone their children.

25 Which postcard might a child at the camp send home?

A

I was annoyed when they suggested I put on old jeans, but I guess they were right.	

B

It's so unfair that everyone else can use their mobile phone, but they won't let me use mine.	

C

I've made some good friends but we're all bored because there isn't much to do here.	

D

I was really frightened every time we went rock climbing, so they let me do something else instead.	

Part 5 Questions 26 – 35

Read the text below and choose the correct word for each space.
For each question, mark the correct letter **A, B, C** or **D on your answer sheet**.

There is an example at the beginning (**0**).

Example:

0 (A) hope **B** decide **C** want **D** expect

San Francisco

Whatever you **(0)** ..... for from a visit to San Francisco in the USA, you won't be disappointed. The hills are just as steep as you imagined they would be, and the Golden Gate Bridge is just as spectacular. It's no **(26)** ..... then that the city is among the world's **(27)** ..... tourist destinations. **(28)** ..... many people live there, San Francisco **(29)** ..... more like a small town than a city of more than 4 million people. Its **(30)** ..... on the water, its parks, and its hills all **(31)** ..... that you can never see further than a few blocks.

One of the most **(32)** ..... trips is a drive across the Golden Gate Bridge. This is a journey **(33)** ..... should be saved for a sunny day so that you can **(34)** ..... the fantastic view, and Golden Gate Park has wonderful gardens, **(35)** ..... addition to being great for a picnic.

26	**A**	guess	**B**	excuse	**C**	question	**D**	surprise
27	**A**	complete	**B**	top	**C**	proper	**D**	full
28	**A**	Although	**B**	Besides	**C**	Unless	**D**	Despite
29	**A**	shows	**B**	fits	**C**	seems	**D**	makes
30	**A**	location	**B**	point	**C**	landscape	**D**	scene
31	**A**	allow	**B**	mean	**C**	let	**D**	intend
32	**A**	amazed	**B**	popular	**C**	interested	**D**	positive
33	**A**	who	**B**	where	**C**	which	**D**	what
34	**A**	admire	**B**	approve	**C**	accept	**D**	attract
35	**A**	in	**B**	as	**C**	on	**D**	by

ANSWER SHEET

SCORE: _____

NAME:_____GROUP:_____ DATE: __ / __ / 2017

INSTRUCTIONS TO CANDIDATES

Circle the correct option like this: **A** **B** **(C)** **D**

If you make a mistake cross out your answer and circle another one like this: **(A)** **B** **(C)** **D**

If your answer is not clear it will score 0 points.

Each question carry one mark.

Part 1: *Partial score: _____*

1	**A**	**B**	**C**
2	**A**	**B**	**C**
3	**A**	**B**	**C**

4	**A**	**B**	**C**
5	**A**	**B**	**C**

Part 2: *Partial score: _____*

6	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
7	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
8	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
9	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
10	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**

Part 3: *Partial score: _____*

11	**A**	**B**
12	**A**	**B**
13	**A**	**B**
14	**A**	**B**

15	**A**	**B**
16	**A**	**B**
17	**A**	**B**

18	**A**	**B**
19	**A**	**B**
20	**A**	**B**

Part 4: *Partial score: _____*

21	**A**	**B**	**C**	**D**
22	**A**	**B**	**C**	**D**
23	**A**	**B**	**C**	**D**

24	**A**	**B**	**C**	**D**
25	**A**	**B**	**C**	**D**

Part 5: *Partial score: _____*

26	**A**	**B**	**C**	**D**
27	**A**	**B**	**C**	**D**
28	**A**	**B**	**C**	**D**
29	**A**	**B**	**C**	**D**
30	**A**	**B**	**C**	**D**

31	**A**	**B**	**C**	**D**
32	**A**	**B**	**C**	**D**
33	**A**	**B**	**C**	**D**
34	**A**	**B**	**C**	**D**
35	**A**	**B**	**C**	**D**

ANSWERS

PART 1

1	C
2	C
3	B
4	B
5	C

PART 2

6	D
7	G
8	F
9	A
10	B

PART 3

11	B
12	B
13	A
14	B
15	B
16	A
17	A
18	B
19	A
20	A

PART 4

21	C
22	D
23	D
24	B
25	A

PART 5

26	D
27	B
28	A
29	C
30	A
31	B
32	B
33	C
34	A
35	A

Appendix III: Context questionnaire

CUESTIONARIO DE CONTEXTO PARA 4º ESO

No le tomará más de 10 minutos rellenarlo. El objetivo es conocer mejor al grupo para mejorar mi labor docente en años sucesivos.

IDENTIFICACIÓN DEL ALUMNO O DE LA ALUMNA

1. Nombre: _____ Grupo: 4º ESO ___

CONTEXTO DEL APRENDIZAJE DE LA LENGUA INGLESA

Para las preguntas 2 a 4 escriba una respuesta numérica.

2. ¿Cuántos años consecutivos lleva estudiando inglés? _____
3. ¿Cuántos años consecutivos lleva en un centro bilingüe (incluido este)? _____
4. Si recibe clases de inglés fuera del Instituto, ¿durante cuántos años lleva haciéndolo? (0 si no recibe este apoyo) _____

CONTEXTO BILINGÜE-MATEMÁTICO

Para la pregunta 5 escriba una respuesta numérica.

5. ¿Cuántos años consecutivos lleva aprendiendo matemáticas a través del inglés? _____

Para las preguntas 6 y 7 marque su respuesta de acuerdo a una escala del 1 (nada de acuerdo) al 5 (totalmente de acuerdo)

6. ¿Le resulta más difícil aprender las matemáticas a través del inglés que aprenderlas en español?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

7. ¿Cree que resolver los problemas escritos en inglés es más difícil que resolverlos que si estuvieran escritos en español?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Para la pregunta 8 marque todas las opciones con las que esté de acuerdo.

8. ¿Qué dificultad encuentra al resolver los problemas escritos en inglés en comparación con resolverlos si estuvieran escritos en español?
   - ☐ El hecho de ver un problema en inglés me genera ansiedad
   - ☐ Necesito más tiempo para comprenderlos
   - ☐ El vocabulario específico matemático no se ha visto en clase
   - ☐ Aparecen estructuras gramaticales que no conozco
   - ☐ Aparece vocabulario no específico que no conozco

CONTEXTO FAMILIAR

Para las preguntas 9 a 13 marque una sola respuesta de las posibles.

9. La estructura familiar es:
   - ☐ Vivo con ambos padre y madre o tutores legales
   - ☐ Vivo alternativamente con ambos padre y madre o tutores legales
   - ☐ Vivo sólo con el padre o con la madre (o con un sólo tutor/a legal)
10. Aproximadamente, ¿cuántos libros hay en su casa? (Sin contar revistas, periódicos o libros de texto).
    - ☐ De 0 a 50
    - ☐ De 51 a 100
    - ☐ De 101 a 200
    - ☐ Más de 200

11. ¿Hasta qué nivel educativo cree que sus padres esperan que estudie?

	Madre o tutora	Padre o tutor
Hasta terminar los estudios obligatorios (ESO)	☐	☐
Hasta terminar un Ciclo Formativo de Grado Medio	☐	☐
Hasta terminar el Bachillerato	☐	☐
Hasta terminar un Ciclo Formativo de Grado Superior	☐	☐
Hasta terminar una carrera universitaria	☐	☐

12. ¿Cuál es el nivel educativo más alto que han terminado sus padres?

	Madre o tutora	Padre o tutor
Estudios primarios incompletos o no asistió a la escuela	☐	☐
Título de EGB o de ESO	☐	☐
Bachillerato, Formación Profesional de Primer Grado, BUP, COU, Ciclo Formativo de Grado Medio de FP o de Artes	☐	☐
Formación Profesional de Segundo Grado o Ciclo Formativo de Grado Superior de FP o de Artes	☐	☐
Diplomatura, Licenciatura, Grado, Doctorado	☐	☐

13. Según el siguiente cuadro, ¿cuál es la profesión que tienen sus padres?

	Madre o tutora	Padre o tutor
Dirección de empresas	☐	☐
Labores domésticas en el propio hogar	☐	☐
Personal de puestos básicos incluidos los cuerpos de seguridad	☐	☐
Personal de servicios de restauración, de protección, de ventas y otros	☐	☐
Personal especializado en agricultura y pesca, en industrias manufactureras, construcción, minería y artesanía	☐	☐
Población inactiva	☐	☐
Profesiones que requieren titulación universitaria	☐	☐
Técnicas/os profesionales de apoyo. Empleados/as de tipo administrativo. Pequeña empresa.	☐	☐

Escriba a continuación la actividad concreta de cada uno:

Madre o tutora: _____

Padre o tutor: _____

MUCHAS GRACIAS POR SU TIEMPO

Appendix IV: PISA word problem papers

This paper is made using PISA

Released Mathematics Items (years 2006 and 2012)

Time 50 minutes **PAPER A** **Score: ____ / 11**

INSTRUCTIONS TO CANDIDATES

Do not open this question paper until you are told to do so.

Write your name, group and date on this sheet.

Read each word problem carefully.

Answer all the questions.

Use a pen.

You **must** complete the paper within the time limit.

At the end of the test, hand in this question paper.

INFORMATION FOR CANDIDATES

There are 6 word problems with 11 questions in this paper.

Word problems are ordered randomly: (4 Eng; 2 Spa; 1 Eng; 6 Spa; 5 Eng; 3 Spa)

All questions carry up to one mark.

Words with an **asterisk** are shown in a **glossary** at the bottom of each page.

NAME: _____

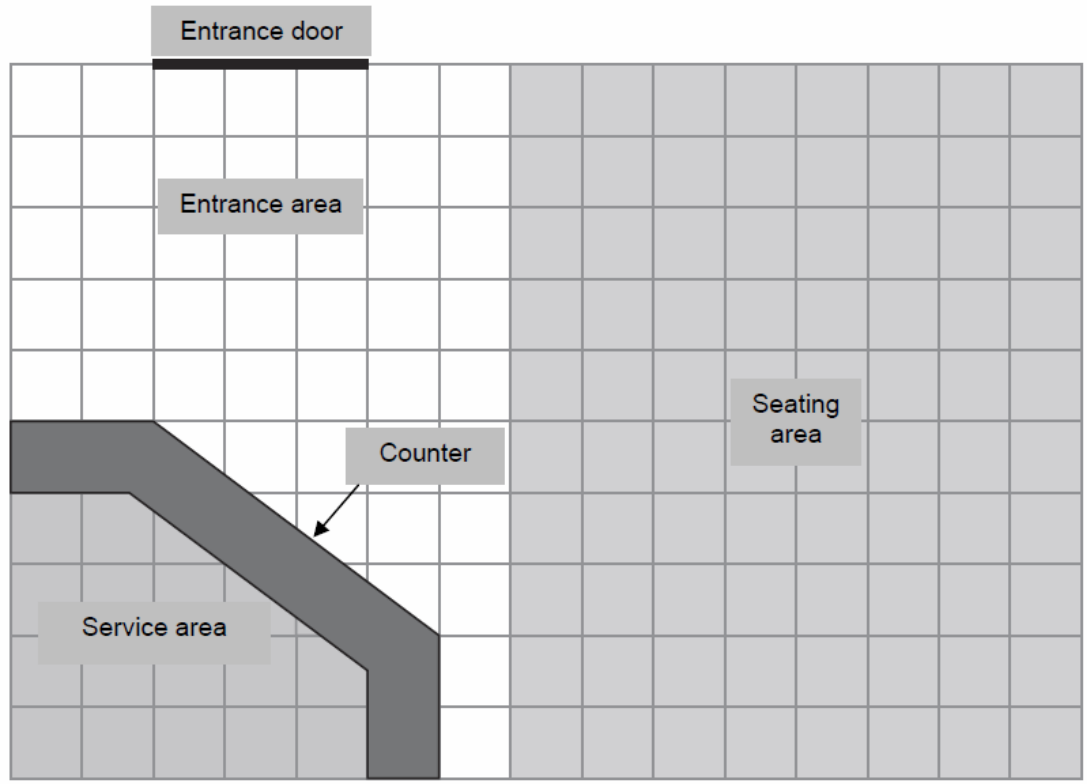
GROUP: _____

DATE: __ / __ / 2017

Word problem 4. ICE-CREAM SHOP

This is the floor plan for Mari's Ice-cream Shop. She is renovating the shop.

The service area is surrounded by the serving counter.



Note: Each square on the grid represents 0.5 metres × 0.5 metres.

Question 4.1 ***2 1 0 9***

Mari wants to put new edging along the outer edge of the counter. What is the total length of edging she needs? Show your work.

GLOSSARY:

serving counter: barra, mostrador

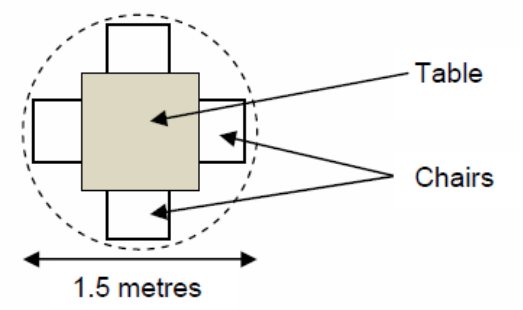
grid: malla, rejilla

edge/edging: borde, plinto, orilla

Question 4.2 ***2 1 0 9***

Mari is also going to put new flooring in the shop. What is the total floor space area of the shop, excluding the service area and counter? Show your work.

Question 4.3 ***1 0 9***



Mari wants to have sets of tables and four chairs like the one shown above in her shop. The circle represents the floor space area needed for each set.

For customers to have enough room when they are seated, each set (as represented by the circle) should be placed according to the following constraints:

- Each set should be placed at least at 0.5 metres away from walls.
- Each set should be placed at least at 0.5 metres from other sets.

What is the maximum number of sets that Mari can fit into the shaded seating area in her shop?

Number of sets: .....

GLOSSARY:
flooring/floor: suelo
to shade: sombrear

Problema 2. EL TIPO DE CAMBIO

Mei-Ling, ciudadana de Singapur, estaba realizando los preparativos para ir a Sudáfrica como estudiante de intercambio durante 3 meses. Necesitaba cambiar algunos dólares de Singapur (SGD) en rands sudafricanos (ZAR).

Pregunta 2.1 ***1 0 9***

Mei-Ling se enteró de que el tipo de cambio entre el dólar de Singapur y el rand sudafricano era de:

1 SGD = 4,2 ZAR

Mei-Ling cambió 3.000 dólares de Singapur en rands sudafricanos con este tipo de cambio.

¿Cuánto dinero recibió Mei-Ling en rands sudafricanos?

Respuesta: .....

Pregunta 2.2 ***1 0 9***

Al volver a Singapur, tres meses después, a Mei-Ling le quedaban 3.900 ZAR. Los cambió en dólares de Singapur, dándose cuenta de que el tipo de cambio había cambiado a:

1 SGD = 4,0 ZAR

¿Cuánto dinero recibió en dólares de Singapur?

Respuesta: .....

Pregunta 2.3 ***11 01 02 99***

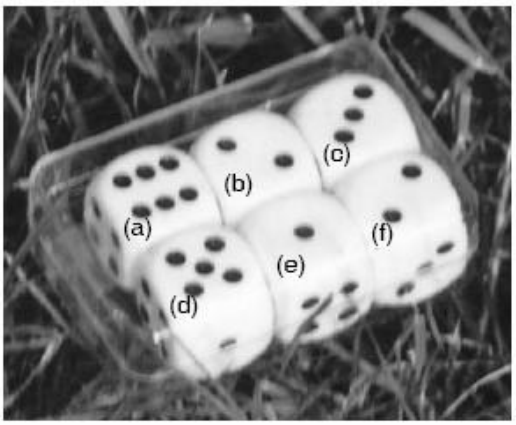
Al cabo de estos 3 meses el tipo de cambio había cambiado de 4,2 a 4,0 ZAR por 1 SGD.

¿Favoreció a Mei-Ling que el tipo de cambio fuese de 4,0 ZAR en lugar de 4,2 ZAR cuando cambió los rands sudafricanos que le quedaban por dólares de Singapur? Da una explicación que justifique tu respuesta.

Word problem 1. CUBES

In this photograph you see six dice, labelled (a) to (f). For all dice there is a rule:

The total number of dots on two opposite faces of each die is always seven.



Question 1.1 ***1 0 9***

Write in each box the number of dots on the **bottom** face of the dice corresponding to the photograph.

(a)	(b)	(c)
(d)	(e)	(f)

GLOSSARY:

die/dice: dado/dados

dot: punto

Problema 6. EL MEJOR COCHE

Una revista de coches utiliza un sistema de puntuaciones para evaluar los nuevos coches y concede el premio de “Coche del Año” al coche con la puntuación total más alta. Se están evaluando cinco coches nuevos. Sus puntuaciones se muestran en la tabla.

Coche	Seguridad (S)	Ahorro de combustible (C)	Diseño Exterior (D)	Habitáculo interior (H)
Ca	3	1	2	3
M2	2	2	2	2
Sp	3	1	3	2
N1	1	3	3	3
XK	3	2	3	2

Las puntuaciones se interpretan de la siguiente manera:

3 puntos = Excelente

2 puntos = Bueno

1 punto = Aceptable

Pregunta 6.1 ***1 0 9***

Para calcular la puntuación total de un coche, la revista utiliza la siguiente regla, que da una suma ponderada de las puntuaciones individuales:

Puntuación total = (3 × S) + C + D + H

Calcula la puntuación total del coche "Ca". Escribe tu contestación en el espacio siguiente.

Puntuación total de "Ca": .....

Pregunta 6.2 ***1 0 9***

El fabricante del coche "Ca" pensó que la regla para obtener la puntuación total no era justa.

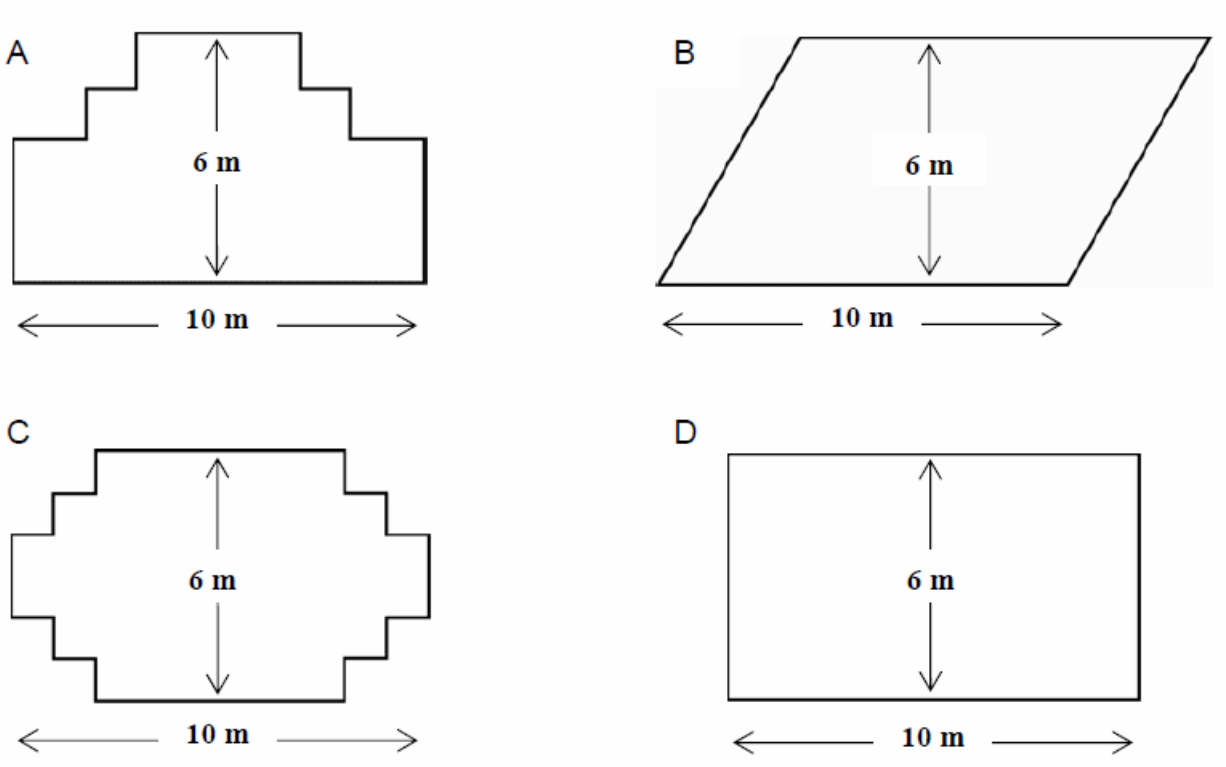
Escribe una regla para calcular la puntuación total de modo que el coche "Ca" sea el ganador.

Tu regla debe incluir las cuatro variables y debes escribir la regla rellenando con números positivos los cuatro espacios de la fórmula siguiente.

Puntuación total = ... × S + ... × C + ... × D + ... × H.

Word problem 5. CARPENTER

A carpenter has 32 metres of timber and wants to make a border around a garden bed. He is considering the following designs for the garden bed.



Question 5.1 ***1 0 9***

Circle either “Yes” or “No” for each design to indicate whether the garden bed can be made with 32 metres of timber.

Garden bed design	Using this design, can the garden bed be made with 32 metres of timber?
Design A	Yes / No
Design B	Yes / No
Design C	Yes / No
Design D	Yes / No

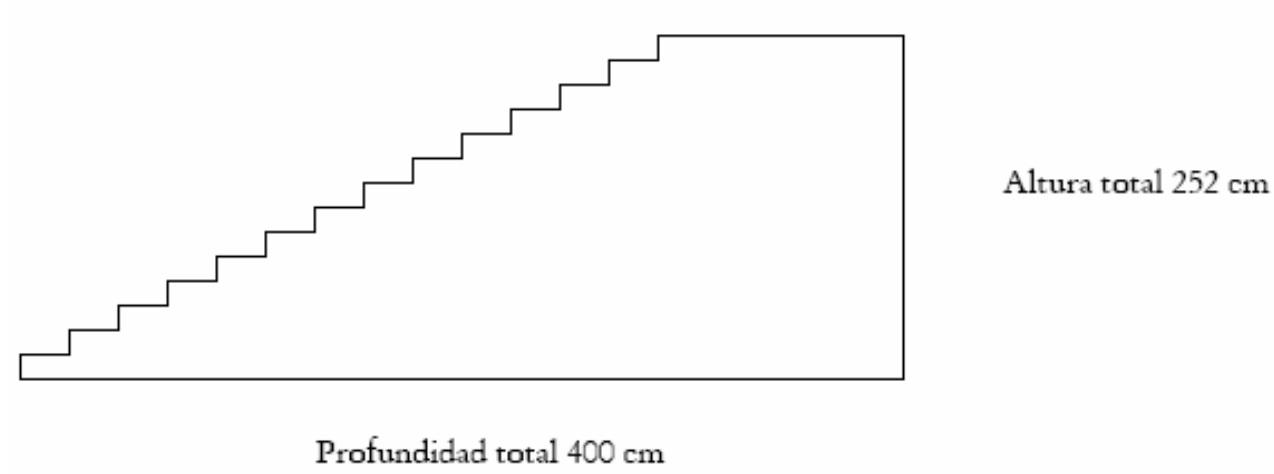
GLOSSARY:

timber: madera

garden bed: lecho del jardín

Problema 3. ESCALERA

El esquema siguiente ilustra una escalera con 14 peldaños y una altura total de 252 cm:



Pregunta 3.1 ***1 0 9***

¿Cuál es altura de cada uno de los 14 peldaños?

Altura: ..... cm.

This paper is made using PISA

Released Mathematics Items (years 2006 and 2012)

Time 50 minutes **PAPER B** **Score: ____ / 11**

INSTRUCTIONS TO CANDIDATES

Do not open this question paper until you are told to do so.

Write your name, group and date on this sheet.

Read each word problem carefully.

Answer all the questions.

Use a pen.

You **must** complete the paper within the time limit.

At the end of the test, hand in this question paper.

INFORMATION FOR CANDIDATES

There are 6 word problems with 11 questions in this paper.

Word problems are ordered randomly: (1 Spa; 6 Eng; 5 Spa; 3 Eng; 4 Spa; 2 Eng)

All questions carry up to one mark.

Words with an **asterisk** are shown in a **glossary** at the bottom of each page.

NAME: _____

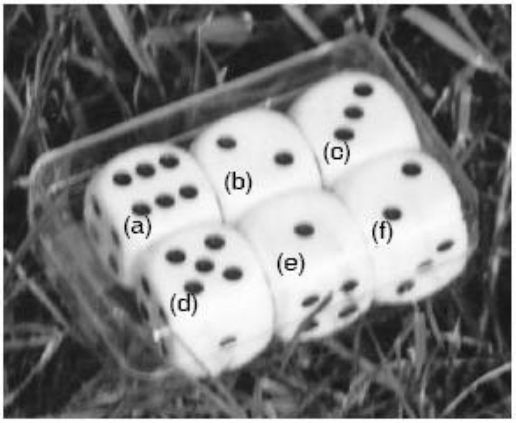
GROUP: _____

DATE: __ / __ / 2017

Problema 1. CUBOS

En esta fotografía puedes ver seis dados, etiquetados desde (a) hasta (f). Hay una regla que es válida para todos los dados:

En todo dado, la suma de los puntos de cada dos caras opuestas es siete.



Pregunta 1.1 ***1 0 9***

Escribe en cada casilla de la tabla siguiente el número de puntos de la cara **inferior** del dado correspondiente al de la foto.

(a)	(b)	(c)
(d)	(e)	(f)

Word problem 6. THE BEST CAR

A car magazine uses a rating system to evaluate new cars, and gives the award of "The Car of the Year" to the car with the highest total score. Five new cars are being evaluated, and their ratings are shown in the table.

Car	Safety Features (S)	Fuel Efficiency (F)	External Appearance (E)	Internal Fittings (T)
Ca	3	1	2	3
M2	2	2	2	2
Sp	3	1	3	2
N1	1	3	3	3
XK	3	2	3	2

The ratings are interpreted as follows:

3 points= Excellent

2 points = Good

1 point = Fair

Question 6.1 ***1 0 9***

To calculate the total score for a car, the car magazine uses the following rule, which is a weighted sum of the individual score points:

Total Score = (3 × S) + F + E + T

Calculate the total score for Car "Ca". Write your answer in the space below.

Total score for "Ca": .....

Question 6.2 ***1 0 9***

The manufacturer of car "Ca" thought the rule for the total score was unfair.

Write down a rule for calculating the total score so that Car "Ca" will be the winner.

Your rule should include all four of the variables, and you should write down your rule by filling in positive numbers in the four spaces in the equation below.

Total score =..... × S + ... × F + ... × E + ... × T.

GLOSSARY:

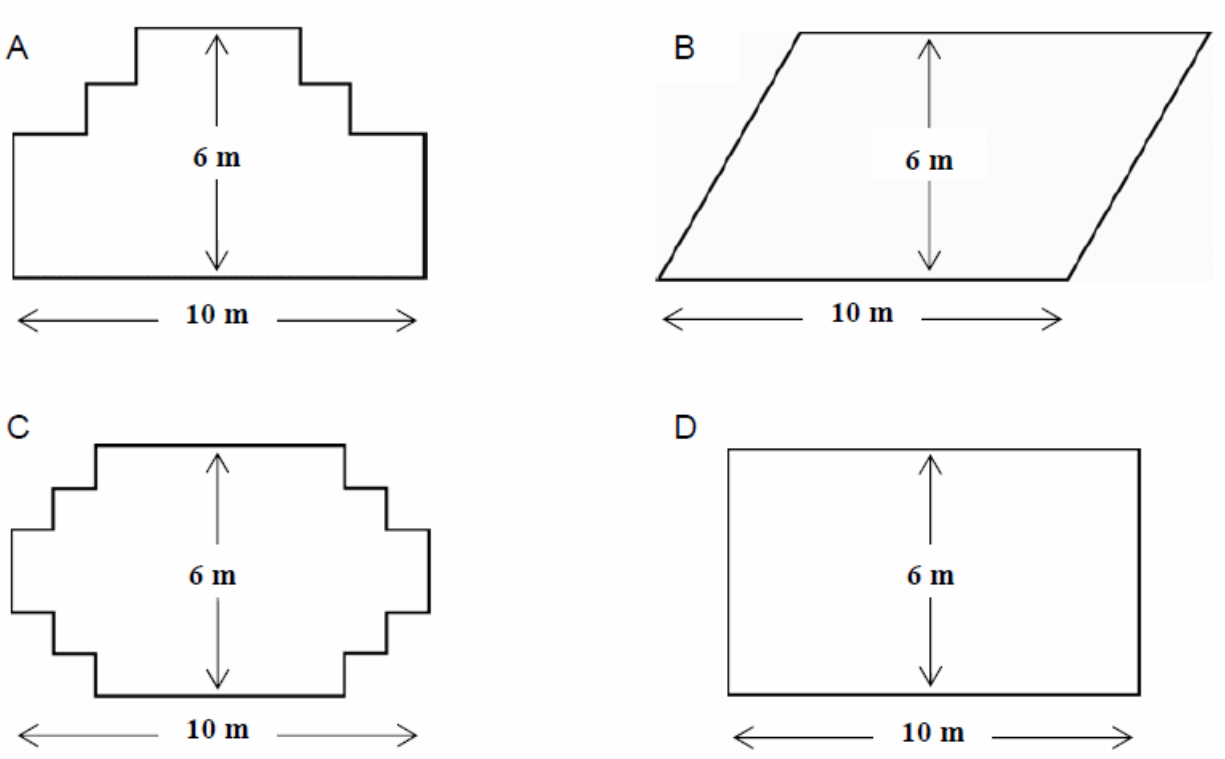
rating system: sistema de puntuación

fair: aceptable

manufacturer: fabricante

Problema 5. CARPINTERO

Un carpintero tiene 32 metros de madera y quiere construir una pequeña valla alrededor de un parterre en el jardín. Está considerando los siguientes diseños para el parterre.



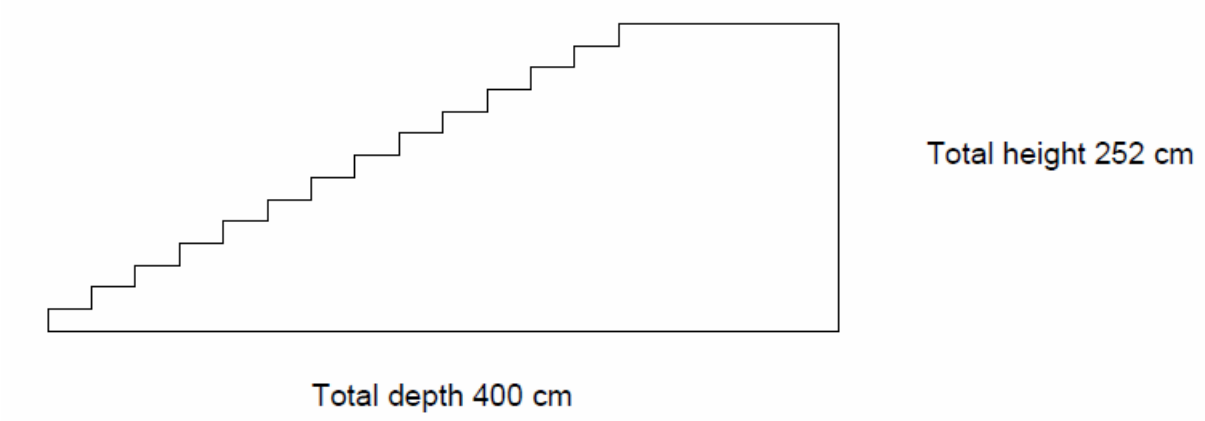
Pregunta 5.1 ***1 0 9***

Rodea con una circunferencia Sí o No para indicar si, para cada diseño, se puede o no construir el parterre con los 32 metros de madera.

Diseño del parterre	**¿Se puede construir el parterre con 32 metros de madera utilizando el diseño?**
Diseño A	Sí / No
Diseño B	Sí / No
Diseño C	Sí / No
Diseño D	Sí / No

Word problem 3. STAIRCASE

The diagram below illustrates a staircase with 14 steps and a total height of 252 cm:



Question 3.1 ***1 0 9***

What is the height of each of the 14 steps?

Height: ..... cm.

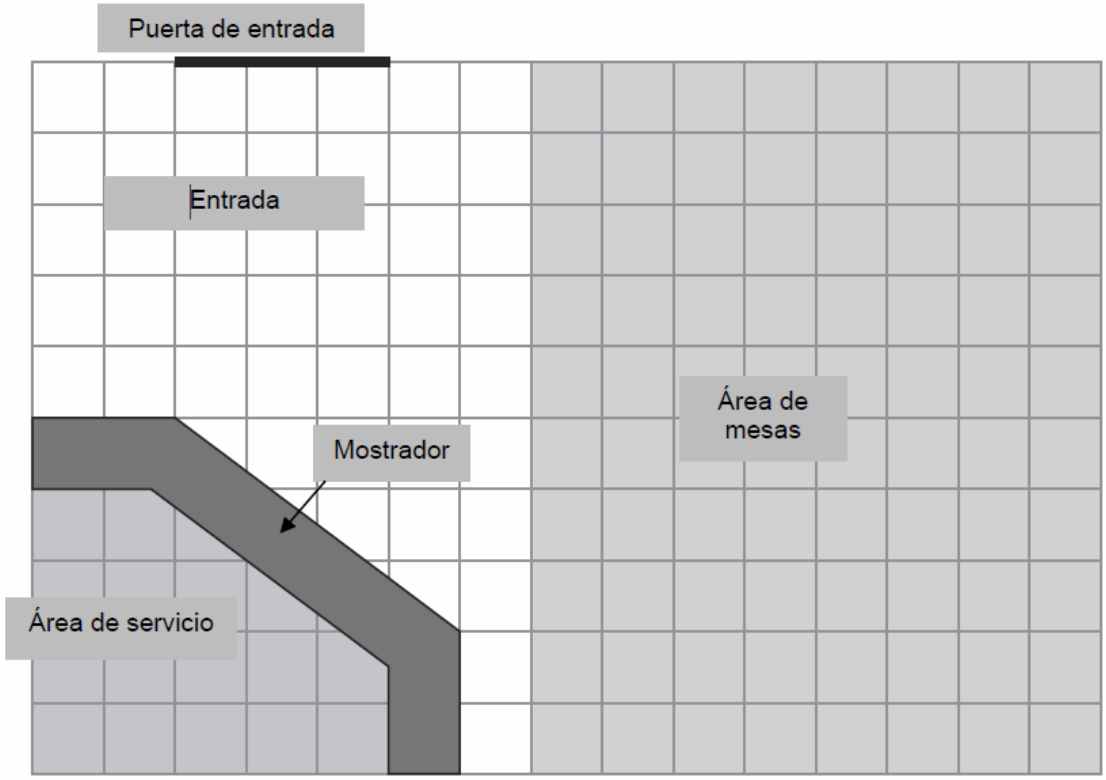
GLOSSARY:

step: escalón

Problema 4. HELADERÍA

Este es el plano de la heladería de María. Está renovando la tienda.

El área de servicio está rodeada por el mostrador.



Nota: Cada cuadrado de la cuadrícula representa 0,5 metros × 0,5 metros.

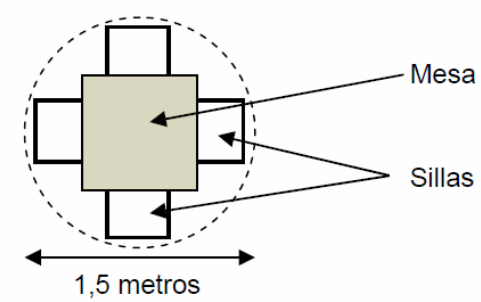
Pregunta 4.1 ***2 1 0 9***

María quiere colocar un nuevo borde a lo largo de la parte externa del mostrador. ¿Cuál es la longitud total del borde que necesita? Escribe tus cálculos.

Pregunta 4.2 ***2 1 0 9***

María también va a poner un nuevo revestimiento para suelo en la tienda. ¿Cuál es la superficie (área) total del suelo de la tienda, excluidos el área de servicio y el mostrador? Escribe tus cálculos.

Pregunta 4.3 ***1 0 9***



María quiere tener en su tienda conjuntos de una mesa y cuatro sillas como el que se muestra más arriba. El círculo representa la superficie de suelo necesaria para cada conjunto.

Para que los clientes tengan suficiente espacio cuando estén sentados, cada conjunto (tal y como representa el círculo) debe estar situado según las siguientes condiciones:

- Cada conjunto debe estar situado, al menos, a 0,5 metros de las paredes.
- Cada conjunto debe estar situado, al menos, a 0,5 metros de los otros conjuntos.

¿Cuál es el número máximo de conjuntos que María puede colocar en la zona de mesas sombreada de su tienda?

Número de conjuntos: .....

Word problem 2. EXCHANGE RATE

Mei-Ling from Singapore was preparing to go to South Africa for 3 months as an exchange student. She needed to change some Singapore dollars (SGD) into South African rand (ZAR).

Question 2.1 ***1 0 9***

Mei-Ling found out that the exchange rate between Singapore dollars and South African rand was:

1 SGD = 4.2 ZAR

Mei-Ling changed 3000 Singapore dollars into South African rand at this exchange rate.

How much money in South African rand did Mei-Ling get?

Answer: .....

Question 2.2 ***1 0 9***

On returning to Singapore after 3 months, Mei-Ling had 3 900 ZAR left. She changed this back to Singapore dollars, noting that the exchange rate had changed to:

1 SGD = 4.0 ZAR

How much money in Singapore dollars did Mei-Ling get?

Answer: .....

Question 2.3 ***11 01 02 99***

During these 3 months the exchange rate had changed from 4.2 to 4.0 ZAR per SGD.

Was it in Mei-Ling's favour that the exchange rate now was 4.0 ZAR instead of 4.2 ZAR, when she changed her South African rand back to Singapore dollars? Give an explanation to support your answer.

GLOSSARY:

exchange rate: tasa de cambio