



MATHS ENGAGEMENT AND REAL-WORLD  
PROBLEM SOLVING THROUGH MATHS TASKS.

## THE LANGUAGE OF **GRAPHS**

{Final Project}

Máster Universitario en Lengua Inglesa para el Aula Bilingüe de Educación Secundaria  
por la Universidad de Oviedo. Curso 2013/2014

by Rocío Yuste Mieres

FINAL PROJECT. Rocio Yuste Mieres

*“Máster Universitario en Lengua Inglesa para el Aula Bilingüe de Educación Secundaria por la Universidad de Oviedo”*

Title: *"Maths engagement and real-world problem solving through maths tasks. The Language of Graphs."*

Academic Year: *2013/2014*

Date: *9<sup>th</sup> June 2014*

Tutor: *Francisco J. Borge López, Titular de Universidad del Departamento de Filología Anglogermánica y francesa. Área de conocimiento, Filología Inglesa*

*“The real role of leadership in education is not and should not be command and control. The real role of leadership is climate control; creating a climate of possibility, and if you do that, people will rise to it and achieve things you did not anticipate and couldn't have expected.”*

Sir Ken Robinson. “How to escape education’s death valley.”

TED Talks Education, April 2013



## Index

<b>1. INTRODUCTION</b> .....	<b>1</b>
<b>2. METHODOLOGIES</b> .....	<b>1</b>
2.1 CONTENT LANGUAGE INTEGRATED LEARNING (CLIL) .....	2
2.1.1 WHAT IS CLIL? .....	2
2.1.2 WHY CLIL? .....	3
2.1.3 CLIL PLANNING .....	4
2.1.4 BENEFITS OF CLIL .....	6
2.2 TASK-BASED LEARNING (TBL) .....	7
2.2.1 WHAT IS TBL? .....	7
2.2.2 TBL PLANNING .....	8
2.2.3 SOME TIPS FOR TBL .....	10
2.2.4 BENEFITS OF TBL .....	10
2.3 PROJECT-BASED LEARNING (PBL) .....	11
2.3.1 WHAT IS PBL? .....	11
2.3.2 PBL PLANNING .....	11
2.3.3 SOME TIPS FOR PBL .....	15
2.3.4 BENEFITS OF PBL .....	16
2.4 DEEPER LEARNING .....	17
2.4.1 WHAT IS DEEPER LEARNING? .....	17
2.4.2 WHY DEEPER LEARNING? .....	17
2.4.3 DEEPER LEARNING FRAMEWORK .....	18
2.4.4 BENEFITS OF DEEPER LEARNING .....	19
2.5 CHANGES IN THE TEACHING METHODOLOGY .....	19
<b>3. STRATEGIES FOR MATHS ENGAGEMENT</b> .....	<b>20</b>
<b>4. THE LANGUAGE OF GRAPHS</b> .....	<b>23</b>
4.1 WHY GRAPHS ARE SO IMPORTANT .....	23
4.2 KEY VOCABULARY .....	23
4.3 AN APPLICATION IN THE CLASSROOM .....	24
4.4 A PROJECT PROPOSAL .....	27
<b>5. CONCLUSION</b> .....	<b>28</b>
<b>6. REFERENCES</b> .....	<b>29</b>

Appendix I. THE LANGUAGE OF GRAPHS. KEY VOCABULARY.

Appendix II. THE LANGUAGE OF GRAPHS. AN APPLICATION IN THE CLASSROOM.

Appendix III. THE LANGUAGE OF GRAPHS. A PROJECT PROPOSAL.



# 1. INTRODUCTION

The present work is the Final Project titled "**Maths engagement and real-world problem solving through Maths tasks. The Language of Graphs.**" related to the Master's degree: "*Máster Universitario en Lengua Inglesa para el Aula Bilingüe de Educación Secundaria por la Universidad de Oviedo*".

As a student, I have suffered from teachers who kept their lesson plan books at the end of the school year and did not take the time and effort to change their lessons. Year after year, new generations were asked to do the same activities using the same methodologies. I could even see their old yellow sheets which were about to fall apart. The teachers sat down in their desk and the students, sitting in rows, waited for their explanations and instructions in order to do these activities.

The children only played a passive role. We were completely in the hands of our teachers, to be molded into a certain pattern set by formal education. We had all too often learnt off by heart facts that were not related to life and, once in a while, some of us were asked to stand up and repeat the lesson "parrot-fashion", without having understood almost anything. The children were made to absorb the contents as a sponge absorbs.

I am aware of the fact that students tend to get bored very easily; I was one of them. I think that the solution has to do with engaging students, and this is one of the main objectives of all the new methodologies in relation to the process of teaching and learning. While a certain store of facts must be learnt for examination purposes and indeed as a background to ordinary living, today such facts are not the main goals of education.

The present Final Project tries to find the ways to engage students, in particular, about the subject of Math and the topic "The Language of Graphs".

After analyzing the following four new methodologies:

- CONTENT LEARNING INTEGRATED LEARNING (CLIL)
- TASK-BASED LEARNING (TBL)
- PROJECT-BASED LEARNING (PBL)
- DEEPER LEARNING

and comparing the old-fashioned and new teaching methodologies, some tips to create a mathematics engaged environment will be established and they will be applied to the topic mentioned before, "The Language of Graphs".

## 2. METHODOLOGIES

Although some teachers continue using the same approaches, most of them are changing and try to use the new ones. In what follows, the main characteristics, objectives, strategies and competencies of the four methodologies mentioned before are going to be analyzed and summarized and, afterwards, the old-fashioned teaching method and the new ones will be compared.

## 2.1 Content Language Integrated Learning (CLIL)

The term CLIL was coined in 1994 by David Marsh and Anne Maljers. It is an approach for learning content through an additional language (foreign or second), thus teaching both the subject and the language (Wikipedia, 2014 a).

### 2.1.1 What is CLIL?

The key is that the target language is used for learning a content, and content is used for learning the target language. The subject matter is what determines the language needed to learn.

CLIL is creative and the world is in need of creativity, problem solving and innovation to face the challenges of the 21<sup>st</sup> Century in a global economy. CLIL breaks the tasks in less difficult parts to construct the knowledge. It works just like scaffolding is used in building. It holds students at the level needed. This approach is holistic, comprehensive and natural, and the result is that what students learn through experience and using real objects they will not ever forget. The process (how and how long) is more important than the end product.

Other CLIL characteristics are that classroom setting changes according to the activities; the approach attends to the different learning styles and follows Gardner's ideas. Different areas and skills can be used to teach a particular content; therefore, there is a cooperative learning among learners and teachers. The task-based learning is used and the assessment methods are different according with the new teaching methodology (García-Sampedro, 2014; CLIL, 2009).

CLIL helps to (BBC, 2006 a):

- Introduce the wider cultural context and prepare for internationalization.
- Access International Certification and enhance the school profile.
- Improve overall and specific language competence.
- Prepare for future studies and / or working life.
- Develop multilingual interests and attitudes.
- Diversify methods & forms of classroom teaching and learning.
- Increase learner motivation.

A typical lesson plan for CLIL consists of stages specially designed to perform the following activities (Lesca, 2012):

- Checking previous knowledge.
- Practicing content language.
- Expanding vocabulary.
- Consolidating knowledge.
- Summarizing skills.
- Applying the new knowledge.
- Checking and correcting mistakes.

In the lesson, all language skills should be combined. The skills are seen thus (BBC, 2006 b):

- Listening is a normal input activity, vital for language learning.
- Reading, using meaningful material, is the major source of input.
- Speaking focuses on fluency. Accuracy is seen as subordinate.
- Writing is a series of lexical activities through which grammar is recycled.



Teachers do not teach a language, only create the conditions under which it might be learned. They do not have to correct students the use of the language; it is better to get fluency and communication making mistakes than trying to have students speak and write perfectly.

Learners take an active part in the process of learning and the teacher becomes a guide, instead of having the main role in the teaching and learning process (García-Sampedro, 2014).

Learners prefer (CLIL, 2009):

- Dealing with questions rather than answers.
- Sharing their opinions.
- Participating in group projects.
- Working with real-world issues and people.
- Having teachers who talk to them as equals rather than as inferiors.

## 2.1.2 Why CLIL?

There are four guiding principles upon which a CLIL lesson can be built and provide reasons to apply CLIL approach (García-Sampedro, 2014; CLIL, 2009).

### - CONTENT

Content refers to the subject or theme of the lesson or course. Learners acquire knowledge of different content areas such as History, Science, Maths, and so on, using the target language as the instrument of communication.

### - COMMUNICATION

Communication refers to students using the target language to communicate their thoughts, opinions, attitudes and discoveries related to the lesson content. Therefore, their language skills and their ability to communicate in the target language improve effectively.

Students produce authentic language and not memorize grammar rules and parrot the teacher. They develop spoken and written language in formal and informal contexts.

### - COGNITION

Cognition refers to the critical thinking skills that students use to engage with and understand course contents, to solve problems, and to reflect on their learning.

Using a target language, students' brains have to work harder and more connections are formed expanding their memory. CLIL fires their brains up because it involves memory, speed, attention, problem solving and flexibility.

### - CULTURE

Effective communication requires so much more than just being able to translate vocabulary. It requires a nuanced understanding of word use, expression and language's cultural context.

Culture refers to the learning of the subject's language and culture, as well as ideas and different ways of life of people from other cultures. If a person can express him/herself in a language that is not the mother tongue, it is already a step towards cross-cultural development.

CLIL materials may contain cultural information about other countries, races, and so on, and CLIL promotes exchanges with other students through email projects, video conferencing, etc. The ultimate goal is to promote international awareness and understanding.

### 2.1.3 CLIL planning

There is not a prescribed model for planning modules and lessons in CLIL. The CLIL approach is flexible in order to take into account a wide range of contexts. However, for CLIL to be effective, certain fundamental principles must be followed (Fandiño, 2011).

#### – STRATEGY 1: RICH INPUT

Meaningful, challenging and authentic. Those should be the main criteria for selecting appropriate classroom materials, in a sense that it focuses on global problems mankind faces while connecting with the daily lives of our students and their areas of interest.

#### – STRATEGY 2: SCAFFOLDING LEARNING

To make sure that students successfully deal with authentic materials and that as much input as possible can become intake, it is essential for students to receive ample support.

They need to be taught how to learn efficiently. Learning skills and strategies, especially study skills like working with maps, diagrams or pictures, must be practiced continually.

#### – STRATEGY 3: RICH INTERACTION AND PUSHED OUTPUT

Languages are acquired most successfully when they are learned for communicative purposes in meaningful and significant social situations. Learners need to be pushed to make use of their resources; they need to have linguistic abilities; they need to reflect on their output and consider ways of modifying it to enhance comprehensibility, appropriateness and accuracy.

#### – STRATEGY 4: ADDING THE INTER-CULTURAL DIMENSION

Looking at various topics from different cultural angles, realizing that other cultures tend to see things differently, have different values and beliefs, is one of the most valuable experiences that CLIL may offer. Cultures differ in many aspects including view of the self, perceptions of time, and verbal and non-verbal communication styles, which also need to be taken into account.

#### – STRATEGY 5: MAKE IT HIGH-ORDER THINKING

Effective teaching means creating environments in which students are engaged, challenged, and saturated with various types of thinking – without being overwhelmed.

Academic discourse functions, the intersection of content, cognition and language, the ability to express complex thought processes appropriately, need systematic instruction, both in native language and second language.

#### – STRATEGY 6: SUSTAINABLE LEARNING

Teachers have to make sure that what they teach in a class is taught in a way that new knowledge becomes deeply rooted in our students' long-term memory. Passive knowledge has to be turned into active knowledge. Competent learners are those who can deliberately retrieve knowledge and apply it to solve problems or complete tasks.

There are different models depending on a range of contextual factors. Two of these models are the 4Cs planning guide and the 3As tool. Whilst the 4Cs provides a useful guide for the overall planning of a unit of work, the 3As tool can be used for more detailed lesson planning. Whilst there is clearly some overlap between the tools, their suggested use is significantly different. The 3As are used with specific content (Fandiño, 2011; Coyle, 2005; Jalberí, 2010).

The 4Cs planning	
CONTENT	<ul style="list-style-type: none"> <li>– What will I teach?</li> <li>– What will they learn?</li> <li>– What are my teaching aims/objectives?</li> <li>– What are the learning outcomes?</li> </ul>
COMMUNICATION	<ul style="list-style-type: none"> <li>– What language do they need to work with the content?</li> <li>– Specialized vocabulary and phrases?</li> <li>– What kind of talk will they engage in?</li> <li>– Will I need to check out key grammatical coverage of a particular tense or feature (e.g. comparatives and superlatives)?</li> <li>– What about the language of tasks and classroom activities?</li> <li>– What about discussion and debate?</li> </ul>
COGNITION	<ul style="list-style-type: none"> <li>– What kind of questions must I ask in order to go beyond ‘display’ questions?</li> <li>– Which tasks will I develop to encourage higher-order thinking - what are the language (communication) as well as the content implications?</li> <li>– Which thinking skills will we concentrate on which are appropriate for the content?</li> </ul>
CULTURE	<ul style="list-style-type: none"> <li>– What are the cultural implications of the topic?</li> <li>– How does the CLIL context allow for ‘value added’?</li> <li>– What about otherness and self?</li> <li>– How does this connect with the all Cs?</li> </ul>

The 3 As tool	
STAGE 1 <b>ANALYSE</b> content for the language <b>of</b> learning	<p>The content focus for a period of teaching, a lesson or a short series of lessons, needs to be defined. Then the content can be analysed for the language needed in order for conceptual learning to take place. This is systematic content analysis to identify key phrases, grammatical functions for concept formation and comprehension. This is not translation. This is the language of learning and this is Stage 1.</p>
STAGE 2 <b>ADD</b> to content language <b>for</b> <b>learning</b>	<p>Stage 2 puts the focus on the learner. Language experiences are added to the lesson plan for specific attention which enable the learner to operate effectively in a CLIL setting. This includes meta-cognitive or learner strategies, classroom talk, discussion, task demands. It also involves the teacher in considering ways in which the learning will be scaffolded. This is the language for learning. This is a crucial stage if the content and the language are to be truly integrated and if the learners are to fully realise the potential of CLIL.</p>

<p>STAGE 3</p> <p>APPLY/ASSURE</p> <p>to content language <b>through</b> learning</p>	<p>Stage 3 is one where the language which emerges through the learning context is built on to assure that there is cognitive and cultural capital. It is at this stage that tasks and opportunities which enable learners to extend their cognitive skills and cultural awareness are made transparent to learners. This will involve exploring how thinking skills have been incorporated into the lesson plan in order to advance learning. This puts task types and learning activities at the core. It uses emergent knowledge and skills to apply thinking skills and high level questioning. It demands cultural awareness. Since language and thinking are explicitly related, this stage is also necessary to assure that a translated transmission model of learning will not evolve. This is language through learning. Attention to this process assures learner progression.</p>
---	---

A variety of tasks should be provided, taking into account the learning purpose and learner styles and preferences. Receptive skill activities are of the 'read/listen and do' genre. A menu of listening activities might be:

- Listen and label a diagram/picture/map/graph/chart.
- Listen and fill in a table.
- Listen and make notes on specific information (dates, figures, times)
- Listen and reorder information.
- Listen and identify location/speakers/places.
- Listen and label the stages of a process/instructions/sequences of a text.
- Listen and fill in the gaps in a text.

Tasks designed for production need to be subject-orientated, so that both content and language are recycled. Since content is to be focused on, more language support may be required. Typical speaking activities include:

- Question loops - questions and answers, terms and definitions, halves of sentences.
- Information gap activities with a question sheet to support.
- Trivia search - 'things you know' and 'things you want to know'.
- Word guessing games.
- Class surveys using questionnaires.
- 20 Questions - provide language support frame for questions.
- Students present information from a visual using a language support handout (BBC, 2006 b; Lesca, 2012).

## 2.1.4 Benefits of CLIL

There are many benefits to integrating content and language. The main benefits, in relation to learners, are the following (García-Sampedro, 2014).

- Learners are motivated as they are developing language skills along with the subject.
- Learners develop cognitively and their brains work harder; therefore, they may be more likely to remember what they have learned, both the language and the content.
- Learners develop communication skills in a variety of situations, formal and informal, specialized and general.

- Learners make new personal meanings in another language linking new information or ideas in the target language to previous content or language knowledge in their first language.
- Learners' language progresses more because in CLIL lessons students hear and read the target language, understand it, use it to speak and write in meaningful interactions, and notice how the language is used in practice.
- Learners receive a lot of input, that is, the language they read and hear. And learners work effectively with that input by means of CLIL activities.
- Learners interact meaningfully. CLIL provides meaningful interaction about the content needed for language acquisition and the language needed for subject development.
- Learners learn to speak and write, that is, they produce the language and become more proficient users of language.
- Learners develop intercultural awareness learning about ideas and communicating with people from other cultures.
- Learners learn about the culture of a subject; teachers are not only teaching information about a subject, but also teaching learners to think, write and speak like subject specialists.
- Learners are prepared to study in another language because, at the end of their school careers, they are confident and fluent in their second language.
- Learners learn in different ways because CLIL teachers give them the opportunity to process and produce information and language in a variety of ways reinforcing the learning of both content and language.

## 2.2 Task-based Learning (TBL)

Communicative Language Teaching (CLT) is the origin of TBL. During the 1970s, there were considerable moves within language teaching to embrace the communicative approach. At that time, the assumption seemed to be that it was not enough in language teaching to focus only on language structure, but that this needed to be accompanied by a concern to develop the capacity to express meanings. TBL could be considered a strong version of CLT (Zhao, 2011).

### 2.2.1 What is TBL?

TBL focuses on the use of authentic language and on asking students to do meaningful tasks using the target language. Assessment is primarily based on task outcome (in other words, the appropriate completion of real world tasks) rather than on accuracy of prescribed language forms. This makes TBL especially popular for developing target language fluency and student confidence (Wikipedia, 2014 b).

Teaching techniques required for TBL are not very different from those of ordinary language teaching. The differences lie in the ordering and weighting of activities and in the fact that there is a greater amount of student activity, and less direct, up-front teaching (Pools-m, 2012).

A task is a goal-oriented activity in which learners use language to achieve a real outcome. Students use whatever target language resources they have in order to solve a problem, do a puzzle, play a game, or share and compare experiences. One topic can give rise to a number of different tasks; and these might be linked in order to provide a thematic unit of study. It is important that in all these activities there is an identifiable outcome (Borge, 2014).

## 2.2.2 TBL planning

The framework of TBL has three components that allow students to get a sense of security by giving them a great variety of activities to do and providing a naturally flowing sequence, each one preparing the ground for the next, adapted to suit students' needs (Borge, 2014).

<b>TBL STEP 1 – THE PRE-TASK PHASE</b>
<p>This phase introduces the topic and the task to the students, activating words and phrases in relation to the topic. There are several important aspects to consider.</p>
<p><b><i>Advance preparation</i></b></p> <p>To plan a task you can use a task from a book or design a new task. In both cases, during the task cycle, the students will do most of the work without much teacher intervention. And, when the lesson is over, teachers have not too much work to do in assessing the students, since they have been helping them during all the task work and to do their written report.</p>
<p><b><i>Introducing the topic</i></b></p> <p>Some topics are easily to understand but for others, it is necessary to spend time discussing with the class the concept and, in some cases, to change the task focus before continuing.</p>
<p><b><i>Identifying topic language</i></b></p> <p>This is the time to help students recall and activate vocabulary that will be useful during the task and outside the classroom, and to introduce new unknown vocabulary about the topic.</p>
<p><b><i>Pre-task language activities</i></b></p> <p>It is necessary to make a selection of pre-task activities which rehearse topic language in a stimulating way, for instance: Classifying words and phrases, Odd one out, Matching phrases to pictures, Memory challenge, Brainstorming and mind-maps, Thinking of questions to ask.</p>
<p><b><i>Giving task instructions</i></b></p> <p>Different kinds of learning opportunities can be provided for students. For instance:</p> <ul style="list-style-type: none"><li>– Students read the instructions by themselves.</li><li>– Teacher demonstrates the task with a good student.</li><li>– Teacher plays audio or video recording of fluent speakers doing the task.</li><li>– Teacher shows the class what previous students have achieved.</li></ul>
<p><b><i>Allowing preparation time</i></b></p> <p>If the teacher wants to give the students the opportunity to practice spontaneous speaking, as they can have in many real-life situations, a preparation time it is not necessary.</p> <p>But, if the teacher wants to get more complexity and variety of syntax, a wide range of vocabulary, and fluency and naturalness, it is necessary to give students a few minutes to prepare individually for the tasks. Two minutes can be enough if the task is short and the topic is familiar. For more complex tax on less familiar topics, students might need up to ten minutes.</p>

## TBL STEP 2 – THE TASK CYCLE

This phase gives the students the opportunity of using language to do the task. It also makes students improve the language guided by the teacher when they are writing up their reports.

### *The task stage. The teacher as monitor*

Students do the task, in pairs or groups. The task helps students to develop fluency in the target language and strategies for communication.

Teachers only monitor and let students get on with the task on their own, observing and encouraging them from a slight distance, suggesting students to speak in the target language. It is also important to give sufficient time to do the task, setting a time limit too short rather than too long, preventing anyone from getting bored. It is useful to give a one-minute warning.

### *The planning stage. The teacher as language adviser*

Students prepare the final report, so it is important that they know the purpose of the report, what kind of information they have to write, what form the report will take, and how long it should be, what resources they have at their disposal, and what they will have to do with that information, oral or written presentations. It is important that they know who is to be the spokesperson or final-draft writer.

The teacher's main role is that of language adviser, helping students to correct, rephrase, rehearse an oral presentation or draft a written report. At the beginning, teachers have to check that all students know what they are supposed to be doing; after that, it is better to wait until you are asked than offer help. It is good to encourage students to help each other and make positive commentaries about good points that they have done.

### *The report stage. The teacher as a chairperson*

This stage is mainly an incentive to the students to improve the use of the target language. It is very important to encourage them rather than to devalue their achievements, in order to increase their motivation, their self-esteem, and spur them on to the greater efforts next time.

The main role of the teacher is that of chairperson and, depending on whether the presentations are oral or written. It is important to make notes to sum up the reports, in order to comment them and give feedback to the students. It is more productive to give positive feedback to the students than to remark only mistakes, and it is important that students feel that you are interested in what they have said or written.

## TBL STEP 3 – THE LANGUAGE FOCUS PHASE

This phase goes into detail about the study of the language used during the task cycle. The aim is to help students explore language, to develop an awareness of aspects of syntax, collocation and lexis, to help systematize what they have observed about certain features of language, to clarify concepts, and to notice new things.

Students focus on form and ask questions about language features, and teachers conduct activities based on the analysis work or examples from different texts.



### 2.2.3 Some tips for TBL

- Use the foreign language as much as possible.
- Use only the mother tongue when necessary for the explanation of exercises.
- The pre-task is meant to help create a good atmosphere for learning without anxiety. It must supply words, phrases, and ideas to support the individual student in the main task. They can be anything; for example: audio text, a video clip, a brainstorm activity, a small exercise (cloze, cross word etc.) photos, webpage... Anything that will promote the foreign language and set the minds of the students into a certain context and atmosphere.
- The main task must facilitate a process where each student can activate and use his/her own strategies. The teacher role in this phase is monitoring the processes of the students working with the main task.
- The teacher must pick up and draw attention to relevant grammatical and semantic points in this last phase of the TBL-cycle. Students repeat their process and their work with the main task must be performed in class; the process will make students realize that language is diverse and that many different structures and words give meaning and can be used for communication (Pools-m, 2012).

### 2.2.4 Benefits of TBL

TBL has some clear advantages (Pools-m, 2012; BBC, 2004; Borge, 2014):

- Students are free of language control. In all three stages they must use all their language resources rather than just practice one pre-selected item.
- TBL does not teach isolated chunks of language; it starts with the whole body of language.
- Gives students a different way of understanding language as a tool instead of as a goal.
- Students will have a much more varied exposure to language. They will be exposed to a whole range of lexical phrases, collocations and patterns as well as language forms.
- Skills are really integrated and there is a real need to communicate and to listen. TBL distinguishes between private (fluency) and public (accuracy + fluency) communication.
- A natural context is developed from the students' experiences with the language that is personalised and relevant to them.
- The language explored arises from the students' needs. These needs dictate what will be covered in the lesson rather than a decision made by the teacher or the course book. It can bring teaching from abstract knowledge to real world application.
- It is a strong communicative approach where students spend a lot of time communicating.
- A Task is helpful in meeting the immediate needs of the learners and it provides a framework for creating classes, which are interesting and able to address the students' needs.
- Is useful for moving the focus of the learning process from the teacher to the student.
- It is enjoyable and motivating. Motivation is provided by the need to meet the objectives of the task and to report back on it. Success in doing this can intensify longer term motivation. Motivation to listen to fluent speakers doing the task is strong too, because, in attempting the task, learners will observe gaps in their own language and will listen cautiously to hear how fluent speakers express themselves.
- Thanks to tasks, teachers provide students with opportunities for interaction, because it is believed that learners learn better through taking part in meaning-oriented interactions.



## 2.3 Project-based Learning (PBL)

PBL is not a new phenomenon. It was popular at the beginning of the 20<sup>th</sup> century and, again, in the 1970s. During the 1970s, it picked up a bad reputation for being unstructured and lacking rigour. However, since then, there have been two key shifts that have reignited teachers' interest in PBL and helped it to shake off its stigma.

Firstly, and most obviously, digital technology makes it easier than ever before for students to conduct serious research, produce high-quality work, keep a record of the entire process, and share their creations with the world.

Secondly, now much more is known about how to do good, rigorous PBL, and its effectiveness can be evaluated (Hamlyn, 2012).

### 2.3.1 What is PBL?

PBL emphasizes learning activities that are long-term, interdisciplinary and student-centered. Unlike traditional, teacher-led classroom activities, students often must organize their own work and manage their own time in a project-based class. PBL instruction differs from traditional inquiry by its emphasis on students' collaborative or individual artefact construction to represent what is being learned (Wikipedia, 2004 c).

PBL asserts that students learn best by experiencing and solving real-world problems and it essentially involves (Vega, 2012 a):

- Students acquire knowledge to tackle realistic problems as they would be solved in the real world.
- Increased student control over his or her own learning.
- Teachers serving as coaches and facilitators of inquiry and reflection.
- Students (usually, but not always) working in pairs or groups.

The difference between PBL and projects is that, with PBL, the project itself is the learning, not the "dessert" at the end. Many teachers think they are doing PBL, but they are doing projects. In PBL, teachers teach through the projects, rather than teach and then do the project (Miller, 2012).

### 2.3.2 PBL planning

The process of a PBL project is based on five main steps (Hamlyn, 2012):

<b>PBL STEP 1 – GET AN IDEA</b>
<p><b><i>Look for project ideas everywhere.</i></b></p> <p>Teachers who do PBL see a world full of projects. This is where the initial spark for a project comes from: from teachers' passions, or from a colleague's passion, or, indeed, from a student's passion. If teachers don't start with something that they feel passionate about, the project won't be much fun, and the quality of the work will suffer.</p> <p>Not all successful projects grow out of a teacher's moment of inspiration. It can be a good idea to try a project that a colleague has done in the past that they find interesting.</p>

***The importance of outcomes.***

The final outcome could be a product (such as a machine or an artwork), a performance (such as a theatre piece or a debate), or a service (such as giving a lesson to younger students). It creates a focus for the project that gives it a feeling of purpose from day one.

It is also important that the outcome be something that can be valued. A good test for this is whether students' work is being kept at the end of a project, or thrown away.

***The curriculum content.***

The project has to be designed in order to allow students to master the content that they are required to learn.

***Looking further afield for project ideas.***

Students can help local businesses, charities, and the government with their projects.

***Being rigorous and honest.***

*Will this project engage my students?* If the place is important to them, the result will be used by others and seem authentic to students. The students are so engaged that they want to take the learning outside the school and school hours and the project taps into students' passion.

*Will this project engage me?* If the outcome of the project does not matter much to the teachers, it probably will not matter much to the students, either.

*Will my students learn something meaningful from this project?* It can be useful to do a list about the things that students are expected to learn.

***Coming up with an "essential question".***

The best projects contain an essential question that inspires and requires students to conduct serious research. This should be a question that people ask in the 'real world', with no easy answer, and that stretches students' intellectual muscles and ignites students' imaginations.

***Talking to colleagues.***

A lot of teachers are interested on PBL and the more teachers talk with each other, the better the project will be.

**PBL STEP 2 – DESIGN THE PROJECT**

***Decide what you want your students to learn.***

It is necessary to establish:

- The learning goals: everything that students are expected to learn from doing this project.
- The plan for assessing students: how you will be able to tell whether or not a student has learned each item on the previous list.
- The exhibition: it is not too soon to start thinking about how and where the work will be exhibited.

***Do the project yourself.***

In order to find if the project is unworkable, to know where students are going to find great difficulties and plan previous solutions, to know how long it will take, to have a model to show students before they begin. If the teacher can do the project before the students do, it is a good idea to identify discrete sections that you can do in advance, and give them a try.

***Make contact with experts outside the school.***

Explain the project, and ask them to help make the project more authentic by providing models, working with students (at school or on a field trip), or offering an exhibition venue.

***Fill out a project plan.***

With everything you've already done. It will be useful for everyone who is involved in your project. It is also useful to do a "Project Sheet" that describes the Project to give them.

***Work out your project's timeline.***

If possible, post your timeline online so that students, parents, and other members of the staff can check it whenever they need to.

***Plan your assessment.***

Assessing your students throughout the project. On your timeline, plan in a series of 'check-ins' to take place throughout the project, to make sure students are on track. These may be short papers, quizzes, journal entries, meetings with the teacher, and critiques. Use multiple drafts in assessment, which means that you can assess a student's improvement, as well as assessing the quality of their final version.

***The final assessment.***

The final assessment will focus on the products that your students have produced, and how they went about producing them (the process).

You may want to have a separate assessment of knowledge, such as an exam. This could come before or after the exhibition. One effective way of doing this is to make an exam that covers information presented by all of the groups during the project. Sources that can be used: Self-assessment, Peer assessment, Teacher assessment, and Outside expert/audience.

***Personalise the project.***

You have to design the project with all your students' needs in mind, so that each student can demonstrate their learning in a way that will be challenging, but not impossible.

***Checklist: What you should have at the end of the design process.***

Once you've finished designing your project, you should have the following:

- A model of the product that students will be creating, made by you.
- A full project plan.
- A project timeline.
- A 'project sheet' that describes the project.

### **PBL STEP 3 – TUNE THE PROJECT**

#### ***Project tuning session.***

This means presenting your plans to a group of colleagues, who will give you constructive feedback, come up with ideas that you haven't thought of, and warn you of potential problems that you may not have anticipated. It is also very helpful to invite students to be part of it.

### **PBL STEP 4 – DO THE PROJECT**

#### ***Engage your students.***

How you introduce a project to your students can have a dramatic effect on how that project progresses. The most important thing is to convey your own passion for the project; it will help to overcome the resistance that can greet the beginning of a project.

#### ***Monitor the process.***

Your plan will start going out-of-date the moment the project starts. This doesn't need to be a bad thing; lots of the adjustments that happen to projects are improvements, but it means you need to have strategies for keeping track of how everyone is doing every step of the way.

### **PBL STEP 5 – EXHIBIT THE PROJECT**

#### ***Promoting the exhibition.***

Plan how your students will advertise the event. Promotion is a part of the project, and students will need to devote time to it if the event is to be well attended.

#### ***Assigning roles for the exhibition day.***

The day of the exhibition the teacher plays a minor role. Exhibitions offer a great opportunity to connect with parents: parents come to exhibitions who don't come to anything else, and they come because their children insist on it.

#### ***Be an archivist of your students' projects.***

Make sure you have digital photographs of all the products, including the drafts. Over time, you will build up a rich 'archive of excellence'.

#### ***Don't give up!***

Like pretty much everything in life, projects get better with practice. And, of course, they get even better with critique – so talk to your students and your colleagues about what went well, what didn't go so well, and what you might want to try in the future.

### 2.3.3 Some tips for PBL

PBL has been criticized in the past for not being rigorous enough. The following features will greatly improve the chances of a project's success (Vega, 2012 b):

#### – A REALISTIC PROBLEM OR PROJECT

PBL projects begin by presenting a driving question that focuses on intended learning objectives, aligns with students' skills, and appeals to students' interests. It is ineffective when:

- a) Skills needed for solving a problem are either above or below the learner's abilities, and/or
- b) The problem asks students to study content that is outside of the content objectives, but required for solving the problem.

Teachers can avoid both common mistakes by following a seven-step procedure that sets up the problem for students:

1. **Define the Content.** Expectations should correspond with students' current research and reasoning skills.
2. **Identify the Context.** Real-life activities in which learners could apply the intended content have to be listed.
3. **List Possible Problems.** Problems or projects that could occur in each context from Step Two have to be listed.
4. **Describe Potential Solutions.** The most viable solution to the problem or project, as well as possible alternative solutions, have to be described. Based on these possible solutions, what researching and reasoning skills learners will need.
5. **Calibrate Your Project.** Using the solutions from Step Four, it has to be checked that the knowledge and skills generated by the most viable solution match the intended knowledge and skills from Step One.
6. **Describe the Task.** If researching or reasoning a critical piece of information is beyond students' problem-solving skills, this information should be presented to the learners rather than have them struggle to learn it.
7. **Reflect on the Learning.** Multiple opportunities to check students' progress have to be included in the initial assignment; for example, they have to know that they need to keep a journal and report to their supervisor on a weekly basis. The final assessment should also be clearly described in the assignment; for example, a final report, presentation, or follow-up question or problem.

#### – STRUCTURED GROUP WORK

Lower ability students tend to work best in mixed groups, medium ability students in homogeneous groups, and for higher-ability students, group ability levels make no difference.

- **Team goals and/or rewards based on individual learning growth.** When the team goal is tied to the learning of each individual, team members care about others' learning and actively help each other.
- **Individual responsibility for outcome.** To increase group-work success, team rewards or goals should depend upon growth in each individual student's skills and knowledge. For example, teams might be awarded points based on each member's meeting or exceeding past performance, based on individual assessments.

## – MULTI-FACETED ASSESSMENT

Criteria for success on PBL tasks need to be clearly defined at the start of the project, and should include multiple opportunities for feedback, reflection, and time for students to revise their work and to provide comments rather than grades during these assessments. Attention must be focused on the quality of work rather than on the worker.

Researchers also recommend end goals that reflect professional practice, such as public exhibitions, portfolios, performances, reports and presentations, which signal the social value and relevance of student work.

The final (summative) assessment should use different criteria that reflect the various skills involved in the task, and these criteria should be communicated openly to students. To ensure that they understand final assessment criteria, teachers can ask them to help define the criteria.

## – PARTICIPATION IN A PROFESSIONAL LEARNING NETWORK

The success of PBL also depends on motivating and supporting teachers in new roles of facilitating inquiry. Teachers learn PBL by collaborating with colleagues, introducing PBL in the classroom, and reflecting on their experiences. Providing teachers with professional development courses in inquiry-based teaching methods is critical for achieving positive PBL results on a district-wide scale.

### 2.3.4 Benefits of PBL

PBL is considered an alternative to paper-based, rote memorization, and teacher-led classrooms. Proponents of PBL cite numerous benefits to the implementation of these strategies in the classroom including:

- A greater depth of understanding of concepts.
- Broader knowledge base.
- Engages students in creating, questioning, and revising knowledge.
- Increases long-term retention of content.
- Improves problem-solving.
- Better understanding of professional environments.
- Improves students' skills in critical thinking, collaboration, communication, reasoning, synthesis, and resilience-enhanced leadership skills, as well as increased creativity and improved writing skills.
- Promotes time on task as well as friendships across diverse groups, such as race, ethnicity, gender, or school cliques.
- Helps students perform as well as or better than traditional learners in high-stakes tests
- Students achieve higher grades.
- Improves students' attitudes towards learning.
- Reduces dropout rates (Wikipedia, 2004 c; Vega, 2012 a; Vega, 2012 b).

Assigning interdependent roles to students has been shown to increase students' learning and engagement through teamwork.

Students who have clear criteria for success spend more time discussing and evaluating content, and these conversations increase student learning.

Frequent feedback enables teachers to adapt their instruction to target students' learning needs, while providing students with information to develop their work. What's more, by emphasizing the process, effort, and strategies involved in accomplishing a task, as opposed to focusing solely on the final product, students come to understand that learning is the result of cumulative effort. This, in turn, improves their resilience and academic achievement.

Although the transition to teaching with PBL can be challenging and time consuming, several studies show that teachers ultimately find the PBL approach to be more rewarding and enjoyable than traditional teaching methods. Longitudinal research also indicates that when teachers create the interactive and engaging classroom environments typical of inquiry-based learning, students are more successful over the long term (Vega, 2012 b).

## 2.4 Deeper Learning

All students have the right to a motivating, challenging education that will prepare them to succeed in college, careers, and life and become engaged citizens. The key to that education is Deeper Learning.

### 2.4.1 What is Deeper Learning?

The knowledge and skills that all students need to succeed in college, career and life are Deeper Learning. It is the delivery of rich core content to students in innovative ways that allows them to learn and then apply what they have learned. Deeper Learning is an instructional method that requires students to use important information repeatedly in complex and meaningful ways such as writing papers or completing projects.

Deeper learning prepares students to

- Know and master core academic content.
- Think critically and solve complex problems.
- Work collaboratively.
- Communicate effectively.
- Be self-directed and able to incorporate feedback.

The assessments are designed not only to find out whether students have mastered a particular curriculum, but also whether they can apply the knowledge they have gained and the skills they have acquired to the new challenges of an increasingly industrialized world (PolicyBrief, 2011; Hewlett, 2013 a).

### 2.4.2 Why Deeper Learning?

We live in a world that is changing quickly. People and goods move around the world with unprecedented ease. The rapid advance of technology means that televisions, computers, and cell phones consume more than seven hours of the average child's day. Signs of our digital connectivity are all around us. Every two years, the amount of digital information more than doubles. What is novel and revolutionary today is quickly outdated.

What does this mean for students? Today's college students can enroll in majors that didn't exist a few short years ago in fields like biomedical engineering or nanotechnology. Experts predict that nearly two-thirds of today's elementary school students will one day hold a job that hasn't been created yet.



These changes pose important questions for education. How well will students be able to use the information and technology at their fingertips, interpret the world around them, and adapt so that they can thrive in such a quickly changing environment? How well are we preparing them for a world that will look dramatically different when they graduate from high school?

Our students need a better education, one that gives them what they need to succeed. The solution is Deeper Learning (Hewlett, 2013 b).

### 2.4.3 Deeper Learning framework

Deeper learning activities should be designed based on the knowledge that students have previously been exposed to or that they will be introduced to in the context of their academic work. Activities have to link the development of academic content knowledge and skills.

In classrooms where Deeper Learning is the focus, you find students who are motivated and challenged, who look forward to their next assignment. They apply what they have learned in one subject area to newly encountered situations in another. They can see how their classwork relates to real life. They are gaining an indispensable set of knowledge, skills, and beliefs, including six competencies that are essential to prepare students to achieve at high levels:

#### 1 – MASTER CORE ACADEMIC CONTENT

Deeper Learning activities require learners to draw information from knowledge they have acquired and then do something meaningful with it. Because the brain must develop the internal wiring necessary to process information efficiently in non-routine ways, Deeper Learning activities should be structured to give students multiple opportunities, over time, to apply knowledge in a range of challenging tasks.

This requires a range of strategies for processing information in sophisticated ways. Those strategies vary somewhat based on the subject area and nature of the activity, but all involve a commitment to systematic thought and analysis.

#### 2 - THINK CRITICALLY AND SOLVE COMPLEX PROBLEMS

Students apply tools and techniques gleaned from core subjects to formulate and solve problems. These tools include data analysis, statistical reasoning, and scientific inquiry as well as creativity, nonlinear thinking, and persistence.

#### 3 - WORK COLLABORATIVELY

Collaborative students work well in teams. They communicate and understand multiple points of view and they know how to cooperate to achieve a shared goal.

#### 4 - COMMUNICATE EFFECTIVELY

Students communicate effectively in writing and in oral presentations. They structure information in meaningful ways, listen to and give feedback, and construct messages for particular audiences. Students clearly organize their data, findings, and thoughts.

#### 5 - LEARN HOW TO LEARN

Students monitor and direct their own learning. They set goals, monitor their own progress, and reflect on their own strengths and areas for improvement. They learn to see setbacks as opportunities for feedback and growth. Students who learn through self-direction are more adaptive than their peers.



## 6 - DEVELOP ACADEMIC MINDSETS

Students with an academic mindset have a strong belief in themselves. They trust their own abilities and believe their hard work will pay off, so they persist to overcome obstacles. They also learn from and support each other. They see the relevance of their schoolwork to the real world and their own future success (Hewlett, 2013 c).

### 2.4.4 Benefits of Deeper Learning

In the short term, Deeper Learning skills help students master core academic content and retain what they learn. Schools are demonstrating that students who are engaged in Deeper Learning are more motivated and take ownership of their education, which results in higher performance. They're gaining knowledge and recalling facts, but they can also apply what they know to real-world situations.

In the long term, Deeper Learning skills are the keys to a student's future success. Employers are, in so many words, telling us they need talent with Deeper Learning skill sets. They report that the strongest applicants work well in teams, communicate effectively, solve problems, manage their own priorities and goals, and believe in hard work.

Deeper learning skills also enable students to become more active, engaged members of their communities (Hewlett, 2013 d).

International studies dramatically demonstrate that Deeper Learning produces high academic performance, thus supporting the effectiveness of Deeper Learning (PolicyBrief, 2011).

## 2.5 Changes in the teaching methodology

There are many differences between the old-fashioned method of teaching and the new ones in general. The main ones are:

New methodologies are focused on the quality of students' learning. The learning experience is more important than the subject matter and there is a big effort to establish a climate in which students can learn best. They are focused on acquiring a range of skills and strategies to locate, document and retrieve information, using it to achieve a purpose, solve problems, or to re-think their position. Students are in control of their own learning, having a degree of flexibility and choice about the circumstances; they are generally more motivated and, therefore, rehearse more, practice more, do more, more often.

Old methods were focused on teaching. The subject to be learned was the most important thing and the biggest emphasis was on what to learn. Students were focused on skill development, acquiring knowledge and committing it to memory. They depended upon the teacher for what, when, how, how much and, where to learn. Norm was to do only as much as required.

New teachers teach by demonstration, with children actively involved in the doing (hands-on experience), and encouraging risk taking, exploration, experimentation, and self-assessment. Since teachers know what outcomes are required, they involve students in planning to achieve those outcomes, beginning from their current knowledge base. Teachers involve students in setting up their own classroom rules and guidelines for behavior, including rewards and consequences. They are responsible to the group for their behavior. Students work in an atmosphere of co-operation and collaboration, knowing that appropriate consequences for their

behavior are already established, agreed upon, and displayed. All students are motivated to participate and learn because there is an acceptance of risk taking and learning from mistakes

Old-fashioned teachers taught by lecturing, telling, copying, rote learning, and lots of testing. They decided content prior to meeting the learners, regardless of their individual abilities or interests. They held the power, and maintained strict discipline over students, teaching them to be quiet and obedient. Students worked in an atmosphere of fear, with punishment decided by the teacher. Many students avoided learning because of fear of embarrassment or failure.

Nowadays, students are motivated to work both individually and collaboratively with others to achieve their learning goals, and are rewarded for their participation, their effort, and their results. Teachers are aware of the fact that all students want to learn, and that they are motivated by recognition, or obtaining 'feedback' for their effort (appropriate feedback sounds like: 'You worked so hard on this, and I can see that you are working on improving your spelling, handwriting, math, etc.'). This is 'intrinsic' feedback, which is natural or internal, as it recognizes the abilities within every individual to maintain control over, and extend their own learning.

Previously, students were motivated by competing successfully on tests and were rewarded for high scores. It was believed that children must be motivated to learn by using punishment for not succeeding; or rewards such as ticks, stars, praise, etc. for what they know or do. These were external rewards and they were always won by the same children. Not receiving these rewards was also seen as negative, compared to what others receive.

In the present, all students have the opportunity to achieve to their potential, with many extending their learning beyond the basic requirements, and no student is made to feel like a failure at any time. Learning experiences are structured for different learning styles. Learning tasks are open-ended and allow the child to work at their own level, with appropriate outcomes negotiated for individuals. Learning experiences are set up in more open-ended ways so that every student experiences success, every time.

In the past, some children really succeeded, most children coped, but a few totally underperformed and knew that they were failures. The argument was, "Life is tough". All children were taught the same things at the same time and in the same way.

New students use Technology to acquire information, enhance their learning, and expand their ability to learn anything, independently.

Years ago, the students only used technology to enhance the presentation of their work.

### 3. STRATEGIES FOR MATHS ENGAGEMENT

Since we are born we are learning and applying Maths. The learning of this subject is a long-term process that can be divided into three school stages (IC, 2014):

1. As children, we develop 'number sense', an intuitive understanding of foundation number concepts and relationships among numbers. A central part of number sense is the student's ability to internalize the number line as a precursor to performing mental arithmetic.
2. As students progress through elementary school, we must next master common Maths operations (addition, subtraction, multiplication, and division) and develop fluency in basic arithmetic combinations ('Maths facts').

3. In later grades, students transition to applied, or ‘word’, problems that relate Maths operations and concepts to real-world situations.

A teacher whose goal is to engage their students and to provide a meaningful learning of Maths should take into account the following tips:

#### – CREATE AN ENCOURAGING AND EMOTIONALLY SAFE CLASSROOM

Try to propose activities that most of your students can do in order to avoid any sense of frustration, and, on the other hand, create rich and complex tasks so that various students have a chance to excel and take on the role of helping others.

As a teacher, you cannot put students down and you can consider teaching this rule to your students, because most people will not take risks in an emotionally unsafe environment.

Recognize a work well done, even if it seems to be so easy to do right. Use words to motivate your students such as: “well done”, “excellent”, “you are improving very much”, and so on.

Do not use the word “wrong” a lot. Try to understand your students’ mistakes as a process of learning; we all make mistakes. Allow your students to help each other with their mistakes.

Do not let your students struggle with any issue of the subject even if it looks very simple. Before intervening, try to motivate your students to solve the problem, tell them the merit that their effort has and reward them as much as possible.

Let them participate and be involved in their own learning.

#### – DESIGN MOTIVATING AND ENGAGING TASKS

Since there is not a single way for students to learn, provide them with a great diversity of visual, auditory, and tactile learning materials.

Be sure that tasks have a rich and engaging content that emanates from a problem that has meaning and is relevant to students’ life experiences, reflecting students’ culture and is also related to their daily life and news of our world.

Use a real-world context and characters that are known and interesting for students.

Propose scaffolding activities that allow students to draw information from knowledge they have acquired and then do something meaningful with it, in order to be able to choose what known tools or techniques they have to apply in order to solve the task.

Let them choose what tool they can use in order to solve the task, allowing them to use tools that they usually use, such as computers, tablets, and so on.

Propose activities that provide opportunities for students to discuss the result, in order to develop thinking skills while exploring their own beliefs and the meaning of being a global citizen.

#### – PROMOTE COLLABORATIVE WORK

Design tasks to be solved individually, in pairs or in groups.

Promote respect between good students and lower students who can be helped by the first ones.

Contribute to build up friendship among the students through the tasks, learning to listen to their classmates, to discuss opinions and to evaluate their classmates’ works.

## – FACILITATE THE LEARNING OF THE TARGET LANGUAGE

Maths is a sort of language, so students in a bilingual program have to combine new target language understanding with new language of Maths understanding. Teachers have to use strategies to support the full participation and engagement of those students (Kersaint, 2014).

- Simplify and elaborate language to provide access and opportunities to learn.

Use terms that are likely familiar to students and provide additional clarifications to help them make sense of the information, because, without the knowledge of these words, it will be difficult for students to solve problems. Every problem can be paraphrased depending on the knowledge of the students.

- Express mathematical information in multiple ways.

Express information in multiple ways to ensure that students can make connections among the various synonyms that are used in the target language and in Maths. Review the various words that have the same meaning by allowing the students to make connections to words that are familiar, while at the same time expanding their vocabulary to include new expressions.

- Use drawings and illustrations to support communication.

They can help students visualize and make sense of vocabulary used in the classroom. Visual aids need not be sophisticated. They can be images from the Internet, lines used to make connections between ideas, or simple drawings to convey the intended meaning. Using and allowing students to use them provides a means for communicating understanding, especially when students cannot articulate their understanding verbally in English.

- Eliminate or address linguistic complexities inherent in the target language.

Eliminate or clarify language features that cause difficulty for students, such as the use of articles, pronouns and synonyms. When they are eliminated or clarified, students are able to focus on the intent of the message being conveyed.

- Assess students in ways that are equitable.

Consider approaches to enable students to demonstrate their Maths knowledge, without underestimating their ability due to difficulties they may have with the English language.

Use glossaries that translate text into their home language taking into account that they might not be familiar with the Maths vocabulary in their home language. Or allow students to use a personal dictionary created by them to make meaning of words they have learned.

Eliminate potential linguistic complexities, as suggested in previous strategies, and find ways to address such complexities so that they do not cause difficulty for students while taking a test.

Provide more time to complete exams or reduce the number of assessment questions. Read up the exam in their home language before starting to answer it.

- Engage students in classroom discourse.

Provide many opportunities for students to use their new language and Maths skills. Find opportunities for students to speak in small and large groups. Provide opportunities for them to rehearse what they will say, to correct the vocabulary they will use, and to gain confidence prior to sharing their ideas with peers. In addition, students can be encouraged to use multiple means (e.g., concrete materials, drawings) to convey their ideas.

- Provide students with a good pronunciation of specific terms.

Although Maths teachers are not language teachers, it is important that they teach students how to pronounce properly new Maths terms that they are using in the subject, allowing them to realize that they are actually enriching their target language vocabulary.

## 4. THE LANGUAGE OF GRAPHS

### 4.1 Why Graphs are so important

When people carry out an investigation, they usually gather a great amount of data that is easier to understand and draw conclusions from if those data are organized and represented in graphs. Graphs can make it easy for students to record and show information about any kind of work that they had done.

All of us have, at some time, read a magazine or a newspaper and seen all kinds of graphs about different studies that we have had to interpret in order to understand what they were showing. Information in graphs and tables is often found in newspapers and pamphlets, so it is necessary that students know how to interpret this kind of information in order to be a global citizen.

Graphs are also useful to make predictions about things like the weather, interest rates, and the future cost of our home electricity usage.

But students not only learn how to read and interpret graphs in Maths; this is something very useful in many other subjects.

Starting to study graphs at an early age can help children to understand huge Maths concepts such as gathering data, sorting, organizing, counting, comparing, and analyzing.

After collecting and organizing data, and before drawing conclusions, the next step is to display them in a manner that makes it easy to read, highlighting similarities, disparities, trends, and other relationships, or the lack of, in the data set. When students decide how to display data and go through the steps to create that display, they learn which type of graphs are useful in displaying the different types of data, and the advantages and disadvantages of each display. It is important for teachers to highlight ways in which different representations of the same data can convey different information and to emphasize the importance of selecting representations suited to the particular Maths tasks.

### 4.2 Key Vocabulary

Maths is a powerful language for describing and analyzing many aspects of our economic, physical, and social phenomena in the world around us so, as a language, it is necessary to learn new words and expressions.

As it was said before, one of the strategies to facilitate the learning of the target English is to use glossaries that translate key words into students' language. It is a good idea to have this glossary made by the students themselves. Thanks to the new technologies, it is possible to have a blog where different matters are uploaded in relation to the subject. Each classroom can have its own blog. Glossaries can be developed in the blog by the students. All the students have the

responsibility of uploading different specific words and their definitions, always guided by the teacher.

Regarding graphs, there are different specific terms to define. The most useful words can be consulted in Appendix I “The Language of Graphs. Key Vocabulary”.

There are also several phrases to be used to present visuals, to comment trends and to explain conclusions. The most useful expressions can also be consulted in Appendix I.

Some tips about new vocabulary and how to explain a graph are the following (Writefix, 2014):

- Don not repeat verbs.
- Before you start to write, make a list of synonyms (words with the same meaning).
- See how many ways you can rephrase the title of the graph. Use one in the introduction and another in the conclusion with the same meaning.
- Be careful with prepositions. They can make a big difference in meaning. For example, “*rose by*” is very different from “*rose to.*” Learn your verbs with the preposition that goes with them.

## 4.3 An application in the classroom

I had the opportunity to give a lesson, about the language of graphs, to students of the First Year of Secondary Education during my internship for the Master’s degree: “*Máster Universitario en Lengua Inglesa para el Aula Bilingüe de Educación Secundaria por la Universidad de Oviedo*” in the *Calderón de la Barca* High School, in *Gijón*.

As it was said before, there are different kind of graphs. One of these are the scatter graphs, used to represent and compare two sets of data to see whether there is any connection (correlation) between them. In this case, accuracy is not so important as just to show information. I had the opportunity to design my own lesson about this topic and I tried to have students learn the language through the subject, fulfilling the leading role and being only a guide, according to what I have learned about CLIL during my Master’s degree. The lesson plan, the PowerPoint presentation used in the classroom, the exercises, and the key can be consulted in Appendix II “The Language of Graphs. An application in the classroom”.

Reviewing about what they had learned before, I started the lesson with an example designed on my own using known characters, current drivers of Formula 1, with the purpose of engaging and motivating students. They took part in the explanations, reasoning and discovering the content before giving them explanations or just answering my questions.

After this brief introduction, the students started doing the exercises in pairs in order to promote collaborative work and speaking skills. I encouraged them to speak English, and I reminded them of useful expressions such as: “*In my opinion...*”, “*I think that...*”, “*What do you think?*”, “*I agree with you*”, “*You are right*”, “*I’m afraid you are wrong*”...

The goal of the first exercise, “The Bus Stop Queue”, was to put into practice the specific Maths content but, in addition, to revise comparatives and superlatives in English. It was a fill-in-the-gaps exercise with sentences written by me.

The purpose of the second exercise, “Planes”, with characters from the films “Planes” and “Cars Two”, was to have students choose the right among three different graphs in order to find the information to decide if different sentences where true or false. In this case, they were



developing the basic skills of “Information processing and digital skills”, practicing their speaking skills and, again, comparatives and superlatives in English.

The objective of the third exercise was to obtain a deeper understanding of the topic and to use the specific vocabulary. They had to interpret three different graphs, choose one that represented a specific matter (the 100-metre race of Usain Bolt), and provide the explanation of the graph in English.

Finally, they watched a video, two minutes long, about the 100-metre runners who participate in the Athens Olympic Games in 1896 to London 2012. They could develop their listening skills and, about the content, they could see how information can be represented in many different kinds of supports (in this case on an athletics track), and how many different conclusions can be drawn from a graph because a great amount of information can be contained in it.

This video, from “The New York Times” (Quealy and Roberts, 2012), gave students more information about Usain Bolt and about the history of the Olympic Games and the 100-metre race. I thought it was interesting as regards Maths content, as well as to develop basic skills, because the information transmits values of self-improvement, sports, and a healthy lifestyle.

The design of the exercises was made on my own, some of them based on the book “The Language of Functions and Graphs” (Nottingham, 1985).

As many teachers believe, I also think that students have to practice at home, so I gave them some exercises to practice and to check if they had understood the content. They had to hand them in the day after. The results of this homework were the following:

25 STUDENTS	100% OK	50% OK	WRONG	No answer
Exercise 2c)	16	8	1	0
Exercise 4a)	16	4	3	2
Exercise 4b)	15	4	3	3

TABLE 1. HOMEWORK RESULTS

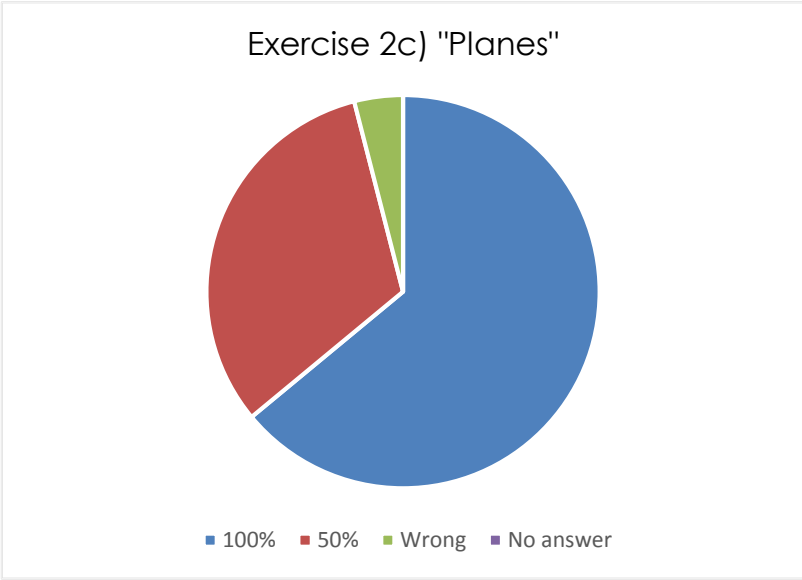


CHART 1. RESULTS OF EXERCISE 2C)

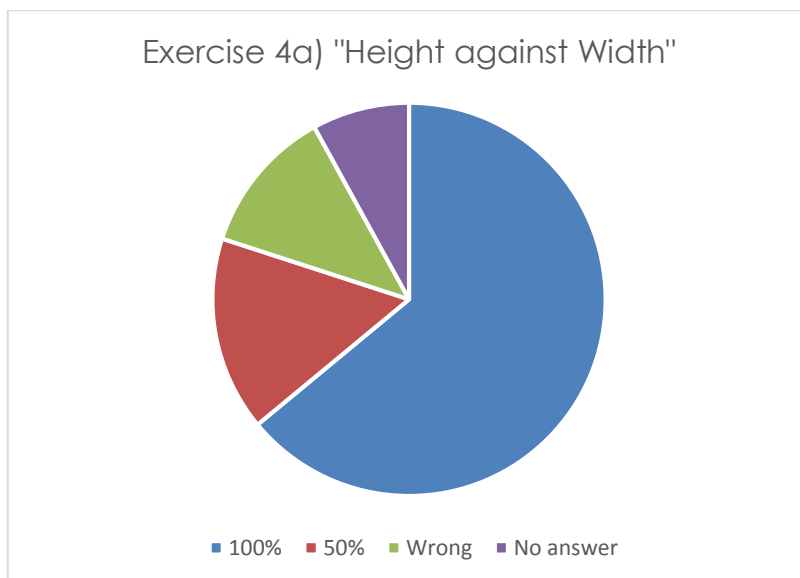


CHART 2. RESULTS OF EXERCISE 4A)

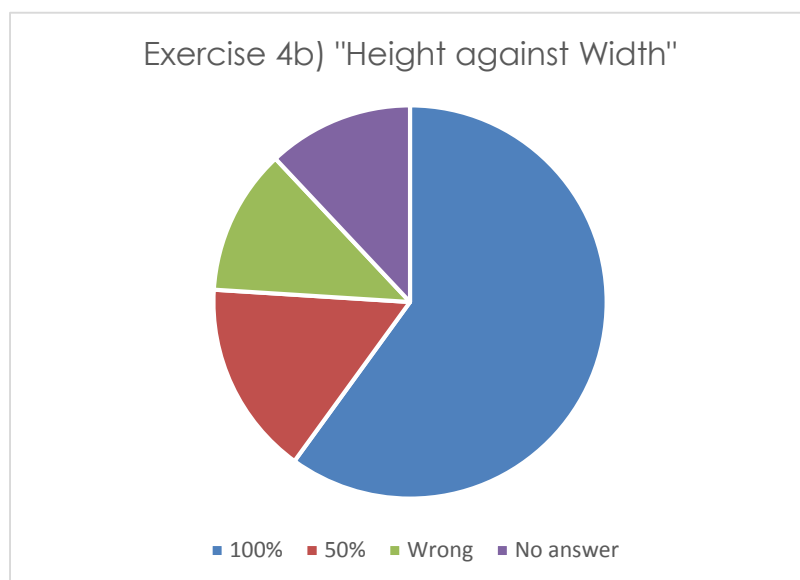


CHART 3. RESULTS OF EXERCISE 4B)

As it can be seen, easily thanks to pie charts, more than a half of the classroom did the exercises completely right, and three quarters of the classroom would have passed the exam, if these exercises were for an exam. The result of the lesson, thus can be considered a success.

In order to create and deliver the lesson, I took into account the four principles of the CLIL approach: content, communication, cognition and culture.

On the other hand, although I did not know Deeper Learning at that moment I have realized that, thanks to CLIL, I was actually developing the six competences of Deeper Learning:

1 – MASTER CORE ACADEMIC CONTENT: students drew information from knowledge they had acquired and then did something meaningful with it.

2 - THINK CRITICALLY AND SOLVE COMPLEX PROBLEMS: students applied tools and techniques gleaned from core subjects to formulate and solve problems (data analysis, statistical reasoning, and scientific inquiry as well as creativity, nonlinear thinking, and persistence).



3 - WORK COLLABORATIVELY: students worked in pairs and the whole group. They communicated and understood multiple points of view and they knew how to cooperate to achieve a shared goal.

4 - COMMUNICATE EFFECTIVELY: students listened to and gave feedback, and constructed messages for their classmates and the teacher. They clearly organized their data, findings, and thoughts.

5 - LEARN HOW TO LEARN: students monitored and directed their own learning.

6 - DEVELOP ACADEMIC MINDSETS: students learned from and supported each other. They saw the relevance of their schoolwork to the real world and their own future success.

## 4.4 A project proposal

The project titled “How good is my High School?” has been designed based on PBL.

The language of graphs is very useful when dealing with statistical studies. Taking advantage of this matter, it could be a good idea to propose a long-term project in relation to this Learning Unit.

In order to have enough time to do this project, this Learning Unit has to be planned to start at the beginning of the academic year. Therefore, the Mathematics Department has to take this into account when they develop their year planning of the subject.

Students of the Third Year of Secondary Education have enough knowledge about Statistics to carry out this kind of investigation. In addition, they are mature enough to communicate with others and to feel responsible for their own High School. Since next year they are going to come back to the school, they will have the opportunity to see the real results of their work, which is another reason to be motivated in its realization.

The teacher has to guide students during all the project and adjust the timing of the others Learning Units to facilitate the achievement of this goal. The teacher has to take into account what is planned in the “Project Timeline” in order to send or not homework and for the dates of other final exams.

As this is a project for the bilingual program, several language learning outcomes have been planned in addition to the learning outcomes related to the content.

This is a real-world problem solving case that can engage the students, as well as help them develop deeper learning turning previous knowledge in something meaningful, applying statistical techniques and tools to carry out the investigations, working collaboratively in groups of five students and the whole group, effectively communicating information gathered and conclusions drawn from their work, monitoring and directing their learning by themselves, and realizing the relevance of their project, done in the school, to the real world.

The idea, design and timeline of the project are included in Appendix III: “The Language of Graphs. A project proposal”.

## 5. CONCLUSION

After finishing this project, I feel that there are a lot of things to change about education, and many teachers to convince that we are living in the 21st century and that our students need to be taught in a very different way from that of the educational system that was conceived and designed in the circumstances created by the Industrial Revolution, two centuries ago! The Educational system should be adapted to the new generations of students and not to each new political party that reaches the country government.

Nowadays, our students have grown with the new technologies, they are digital natives. They send msn daily, play with tablets and computers, surf on their PSP, listen to music in their iPods, post stories online... we cannot expect them to go to school and, well seated on a chair, focus on a teacher telling them things beside a blackboard in an hourly simple and repetitive situation, during six hours!

Students need to see the reason to go to school. Teachers should engage students and encourage them to participate in their own learning, having moments in which something fun happens, doing activities full of purpose and goals, being aware of their achievements, and turning the school into something enjoyable.

Since students are born, they start imitating their parents, siblings, grandparents, and any people around them. They also learn experimenting by themselves but, when they join school, they start being taught by experiences written by others, so they need to imagine the situation and try to memorize it. However, it is easier to remember an activity that you have done with your body and experimented directly than the page that you have read in a book. Why do we change the natural way of learning?

We are living in a period in which to have a degree is not enough to find a job; our society needs our students to receive an integral education and not only pursue academic success. It is most important what people are able to do more than the number of degrees they have managed to obtain; teachers should be more worried about how students learn, the process, than about what they learn, the curriculum that has to be taught in an academic year.

Many people complain that our children play too much time alone so, why do they not complain because they also do too many activities alone at school? If great achievements throughout the history have happened in groups and our students, after school, need to live and, in the future, work in groups, teachers should promote collaborative activities in which our students can socialise and develop their communicative skills.

The bilingual program has facilitated this change in educational methodologies. These new approaches (CLIL and Task-based Learning) encourage students to participate, to work collaboratively, to support each other, to direct their own learning, to communicate effectively in both directions (listening and speaking), to think critically, and to realize that what they are learning will be useful for their own future success. In addition, there is something inherent to in these approaches: learning a second language means to be a citizen of the global world, so thanks to the bilingual program students are receiving an integral education.

Although PBL is not a specific approach to learn a second language, it shares all of these principles and, in addition, CLIL, Task-based Learning, and PBL develop Deeper Learning.

It is a pity that our government is thinking about cutting down resources for the bilingual program. I agree with one of the teachers where I did my practice who told me, “If something works, why do we need change it?” Anyway, even if the bilingual program is cancelled, I believe that it is still a good choice to teach any subject following the principles of all of these approaches.

## 6. REFERENCES

- BBC (2004) British Council. Teaching English. A Task-based approach. *The advantages of TBL*. Searched on the Internet:

<http://www.teachingenglish.org.uk/article/a-task-based-approach>

- BBC (2006 a) British Council. Teaching English. Content and Language Integrated Learning. *The advantages of CLIL*. Searched on the Internet:

<http://www.teachingenglish.org.uk/article/content-language-integrated-learning>

- BBC (2006 b) British Council. Teaching English. CLIL: A lesson framework. *Classroom principles*. Searched on the Internet:

<https://www.teachingenglish.org.uk/article/clil-a-lesson-framework>

- Borge, Francisco J. (2014) A framework for the task-based learning. Notes from the subject: “*Metodología para el desarrollo de las destrezas lingüísticas en el aula bilingüe*” from “*Máster Universitario en Lengua Inglesa para el Aula Bilingüe de Educación Secundaria por la Universidad de Oviedo*” Academic Year 2013 – 2014.
- CLIL (2009) CLIL for Success. *Why CLIL?* Searched on the Internet:

<http://clilforsuccess.blogspot.com.es/>

- Coyle, Do (2005) The University of Nottingham. School of Education. *CLIL. Planning tools for teachers*. Searched on the Internet:

[http://www.unifg.it/sites/default/files/allegatiparagrafo/20-01-2014/coyle\\_clil\\_planningtool\\_kit.pdf](http://www.unifg.it/sites/default/files/allegatiparagrafo/20-01-2014/coyle_clil_planningtool_kit.pdf)

- Fandiño, Yamith José (2011) Universidad de La Salle. *CLIL lesson planning*. Searched on the Internet:

<http://www.slideshare.net/teacheryamith/clil-lesson-planning-9599653>

- García-Sampedro, Marta (2014) Notes from the subject: “*Metodología AICLE/CLIL*” from “*Máster Universitario en Lengua Inglesa para el Aula Bilingüe de Educación Secundaria por la Universidad de Oviedo*” Academic Year 2013 – 2014.
- Hamlyn, Paul Foundation (2012) *Work that matters. The teacher’s guide to project-based learning* ISBN: 978-1-905500-07-9
- Hewlett, Foundation (2013 a) *Deeper Learning Defined. Deeper Learning Competencies*. Searched on the Internet:

[http://www.hewlett.org/uploads/documents/Deeper\\_Learning\\_Defined\\_April\\_2013.pdf](http://www.hewlett.org/uploads/documents/Deeper_Learning_Defined_April_2013.pdf)

- Hewlett, Foundation (2013 b) Deeper Learning Defined. Why is Deeper Learning Important? Searched on the Internet:

<http://www.hewlett.org/programs/education/deeper-learning/why-deeper-learning-important>

- Hewlett, Foundation (2013 c) Deeper Learning Defined. What is Deeper Learning? Searched on the Internet:

<http://www.hewlett.org/programs/education/deeper-learning/what-deeper-learning>

- Hewlett, Foundation (2013 d) Deeper Learning Defined. How does Deeper Learning prepare students? Searched on the Internet:

<http://www.hewlett.org/programs/education/deeper-learning/how-does-deeper-learning-prepare-students>

- IC (2014) Intervention Central. School-Wide Strategies for managing Mathematics. Searched on the Internet:

<http://www.interventioncentral.org/academic-interventions/math/school-wide-strategies-managing-mathematics>

- Jalberi2 (2010) *CLIL Theory*. Searched on the Internet:

<http://www.slideshare.net/jalberi2/clil-theory>

- Kersaing, Gladis (2014) STEM. Strategies to Teach and Engage English Language Learners in Mathematics Classrooms. Searched on the Internet:

[https://www.mheonline.com/mhmymath/pdf/ell\\_strategies\\_in\\_math\\_classroom.pdf](https://www.mheonline.com/mhmymath/pdf/ell_strategies_in_math_classroom.pdf)

- Lesca, Umberto (2012) *An introduction to CLIL*. Searched on the Internet:

[http://www.itis.biella.it/europa/pdf-europa/CLIL\\_Report.pdf](http://www.itis.biella.it/europa/pdf-europa/CLIL_Report.pdf)

- Miller, Andrew (2012) Getting Started with Project-Based Learning (Hint: Don't Go Crazy) Searched on the Internet:

<http://www.edutopia.org/blog/project-based-learning-getting-started-basics-andrew-miller>

- Nottingham (1985) Shell Centre for Mathematical Education. University of Nottingham NG7 2RD The language of Functions and Graphs (ISBN 0 901628 43 3).

- PolicyBrief (2011) Alliance for Excellent Education. A time for Deeper Learning: Preparing students for a Changing World. Searched on the Internet:

<http://all4ed.org/wp-content/uploads/2013/06/DeeperLearning.pdf>

- Pools-m (2012) Tools, Methods and Pools-3. Task Based Learning. Searched on the Internet:

<http://languages.dk/archive/pools-m/manuals/final/taskuk.pdf>

- Quealy, Kevin and Roberts, Graham (2012) The New York Times. One Race, Every Medalist Ever. Searched on the Internet:

[http://www.nytimes.com/interactive/2012/08/05/sports/olympics/the-100-meter-dash-one-race-every-medalist-ever.html?\\_r=0](http://www.nytimes.com/interactive/2012/08/05/sports/olympics/the-100-meter-dash-one-race-every-medalist-ever.html?_r=0)

- Vega, Vanesa (2012 a) EDUTOPIA. Project-Based Learning Research Review. Searched on the Internet:

<http://www.edutopia.org/pbl-research-learning-outcomes>

- Vega, Vanesa (2012 b) EDUTOPIA. Project-Based Learning Research Review: Evidence-Based Components of Success. Searched on the Internet:

<http://www.edutopia.org/pbl-research-evidence-based-components>

- Wikipedia (2014 a) *Content and language integrated learning*. Searched on the Internet:

[http://en.wikipedia.org/wiki/Content\\_and\\_language\\_integrated\\_learning](http://en.wikipedia.org/wiki/Content_and_language_integrated_learning)

- Wikipedia (2014 b) Task-based language learning. Searched on the Internet:

[http://en.wikipedia.org/wiki/Task-based\\_language\\_learning](http://en.wikipedia.org/wiki/Task-based_language_learning)

- Wikipedia (2014 c) Project-based learning. Searched on the Internet:

[http://en.wikipedia.org/wiki/Project-based\\_learning](http://en.wikipedia.org/wiki/Project-based_learning)

- Zhao, Dr. Huajing (2011) Journal of Cambridge Studies. How Far Do the Theories of Task-Based Learning Succeed in Combining Communicative and from-Focused Approaches to L2 Research. Searched on the Internet:

<http://journal.acs-cam.org.uk/data/archive/2011/201101-article4.pdf>



MATHS ENGAGEMENT AND REAL-WORLD  
PROBLEM SOLVING THROUGH MATHS TASKS.

THE LANGUAGE OF **GRAPHS**

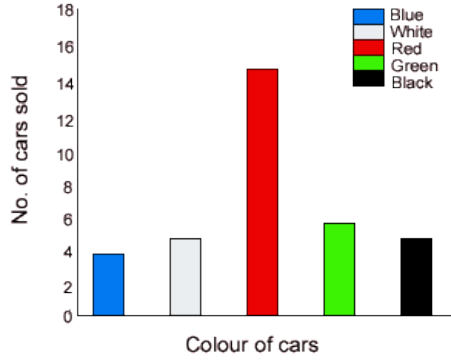
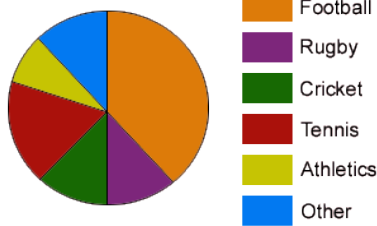
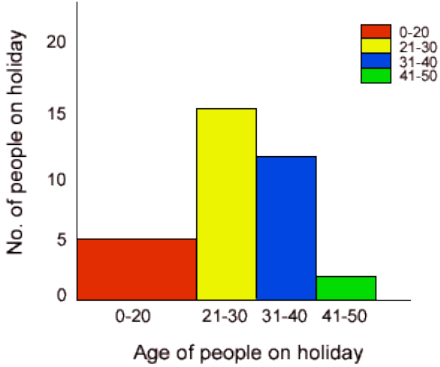
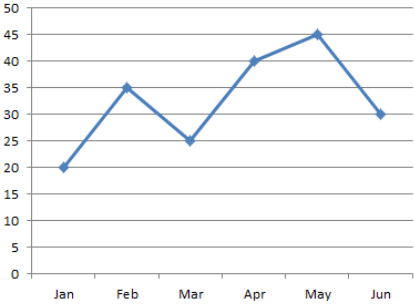
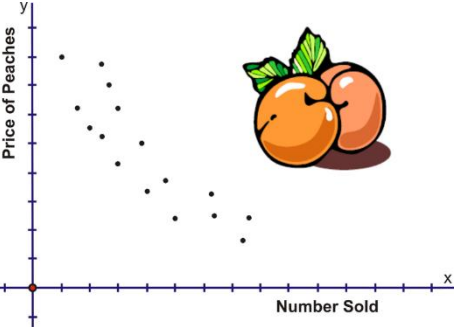
{Appendix I. Key Vocabulary}

Máster Universitario en Lengua Inglesa para el Aula Bilingüe de Educación Secundaria  
por la Universidad de Oviedo. Curso 2013/2014

by Rocío Yuste Mieres





Four Common Graphs in Statistics															
<p><b>Bar Chart:</b> A bar graph is a chart that uses either horizontal or vertical bars to show comparisons among categories. One axis of the chart shows the specific categories being compared, and the other axis represents a discrete value.</p> <p>e.g. Number of cars sold in a week according to their colour.</p>	 <table border="1"> <caption>Data for Bar Chart: No. of cars sold by colour</caption> <thead> <tr> <th>Colour</th> <th>No. of cars sold</th> </tr> </thead> <tbody> <tr> <td>Blue</td> <td>4</td> </tr> <tr> <td>White</td> <td>5</td> </tr> <tr> <td>Red</td> <td>15</td> </tr> <tr> <td>Green</td> <td>6</td> </tr> <tr> <td>Black</td> <td>5</td> </tr> </tbody> </table>	Colour	No. of cars sold	Blue	4	White	5	Red	15	Green	6	Black	5		
Colour	No. of cars sold														
Blue	4														
White	5														
Red	15														
Green	6														
Black	5														
<p><b>Pie Chart or Circle Graph:</b> Used to show parts or percentages of a whole. A pie chart displays qualitative data in the form of a pie. Each slice of pie represents a different category.</p> <p>e.g. Favorite Sport of First Year Students.</p>	 <table border="1"> <caption>Data for Pie Chart: Favorite Sport of First Year Students</caption> <thead> <tr> <th>Sport</th> <th>Relative Frequency</th> </tr> </thead> <tbody> <tr> <td>Football</td> <td>40%</td> </tr> <tr> <td>Rugby</td> <td>15%</td> </tr> <tr> <td>Cricket</td> <td>10%</td> </tr> <tr> <td>Tennis</td> <td>10%</td> </tr> <tr> <td>Athletics</td> <td>10%</td> </tr> <tr> <td>Other</td> <td>5%</td> </tr> </tbody> </table>	Sport	Relative Frequency	Football	40%	Rugby	15%	Cricket	10%	Tennis	10%	Athletics	10%	Other	5%
Sport	Relative Frequency														
Football	40%														
Rugby	15%														
Cricket	10%														
Tennis	10%														
Athletics	10%														
Other	5%														
<p><b>Histogram:</b> Another kind of graph that uses bars in its display. This type of graph is used with quantitative data. Ranges of values, called classes, are listed at the bottom, and the classes with greater frequencies have taller bars.</p> <p>e.g. Number of people staying in a hotel according to their age.</p>	 <table border="1"> <caption>Data for Histogram: No. of people on holiday by age</caption> <thead> <tr> <th>Age Group</th> <th>No. of people on holiday</th> </tr> </thead> <tbody> <tr> <td>0-20</td> <td>5</td> </tr> <tr> <td>21-30</td> <td>15</td> </tr> <tr> <td>31-40</td> <td>12</td> </tr> <tr> <td>41-50</td> <td>2</td> </tr> </tbody> </table>	Age Group	No. of people on holiday	0-20	5	21-30	15	31-40	12	41-50	2				
Age Group	No. of people on holiday														
0-20	5														
21-30	15														
31-40	12														
41-50	2														
<p><b>Line Graph:</b> Used to show specific trends in data, often on a time line. The horizontal axis shows the time and the vertical axis is for the data values.</p> <p>e.g. Number of cars sold first six months.</p>	 <table border="1"> <caption>Data for Line Graph: Number of cars sold by month</caption> <thead> <tr> <th>Month</th> <th>Number of cars sold</th> </tr> </thead> <tbody> <tr> <td>Jan</td> <td>20</td> </tr> <tr> <td>Feb</td> <td>35</td> </tr> <tr> <td>Mar</td> <td>25</td> </tr> <tr> <td>Apr</td> <td>40</td> </tr> <tr> <td>May</td> <td>45</td> </tr> <tr> <td>Jun</td> <td>30</td> </tr> </tbody> </table>	Month	Number of cars sold	Jan	20	Feb	35	Mar	25	Apr	40	May	45	Jun	30
Month	Number of cars sold														
Jan	20														
Feb	35														
Mar	25														
Apr	40														
May	45														
Jun	30														
<p><b>Scatter Graph:</b> Used to determine if a correlation exists between two data sets, and how strong it is, also used to calculate line or curve of best fit.</p> <p>e.g. Number of peaches sold according to their price.</p>															

<b>Vocabulary</b>			
GOING UP		GOING DOWN	
VERB	NOUN	VERB	NOUN
(to) soar		(to) plummet	
(to) rocket		(to) plunge	(a) plunge
(to) leap	(a) leap	(to) sink	
(to) jump	(a) jump	(to) slump	(a) slump
(to) climb		(to) go down	(a) downswing
(to) ascend	(an) ascent	(to) worsen	
(to) surge	(a) surge	(to) slip back	
(to) shoot up		(to) deteriorate	
(to) grow	(a) growth	(to) dip	(a) dip
(to) recovery	(a) recovery	(to) decline	(a) decline
(to) improve	(an) improvement	(to) drop	(a) drop
(to) increase	(an) increase	(to) decrease	(a) decrease
(to) go up	(an) upswing	(to) fall	(a) fall
(to) rise	(a) rise		
<b>NO CHANGE</b>	(to) stabilize (a stability), (to) level out, (to) level off (a levelling of), (to) keep ... stable, (to) hold ... constant, (to) remain stable/constant/steady, (to) stay constant/the same, (to) be unchanged, not (to) change, (to) plateau (a plateau)		
<b>UP AND DOWN</b>	(to) fluctuate (a fluctuation), (to) zigzag, (to) flutter, (to) undulate		
<b>AT THE TOP</b>	(to) reach a peak, (to) peak, (to) reach its/their highest point		
<b>AT THE BOTTOM</b>	(to) reach/hit a low point/a bottom, (to) reach/hit its/their lowest point, (to) bottom out, (to) fall to a low, (to) sink to a trough		
<b>PREDICTING future movement:</b>	(to) project (a projection), (to) forecast (a forecast), (to) predict (a prediction)		
<b>ADJECTIVES large changes</b>	dramatic, spectacular, substantial, abrupt, considerable, noticeable, sharp, significant, sudden, rapid		
<b>ADVERBS large changes</b>	dramatically, spectacularly, substantially, abruptly, considerably, noticeably, sharply, significantly, suddenly, rapidly, steeply, a lot		

<p>ADJECTIVES small changes</p>	<p>moderate, slight, marginal, steady, gradual, slow, modest, calm</p>
<p>ADVERBS small changes</p>	<p>moderately, slightly, marginally, steadily, gradually, slowly, modestly, calmly, gently, a little</p>
<p>Other ADJECTIVES and ADVERBS</p>	<ul style="list-style-type: none"> <li>– “overall” can be used to describe changes in trend over the whole period: very useful in introductions and conclusions.</li> <li>– “upward” and “downward” are adjectives: the adverbs are “upwards” and “downwards”.</li> <li>– “steady”, “steadily”: without change.</li> </ul>
<p>Expressions of TIME</p>	<ul style="list-style-type: none"> <li>– in 2012 / recent years</li> <li>– over the year / period</li> <li>– between 1980 and 2012</li> <li>– from 1980 until 2012</li> <li>– since (point of time) May / 2011</li> <li>– for (period of time) the period / five months</li> </ul>
<p>PREPOSITIONS, examples using noun and verb forms</p>	<ul style="list-style-type: none"> <li>– an increase in ... / a rise in ... / a decrease in (something)</li> <li>– an increase of ... / a rise of ... / a drop of (the quantity)</li> <li>– increased by ... / fell by ... / decreased by (the quantity)</li> <li>– rose to... / dropped to ... / decreased to (number)</li> <li>– fell by (quantity) to (number) / increased by (quantity) to (number)</li> <li>– rose from (number) to (number) / dropped from (number) to (number)</li> <li>– (just) over / (just) under</li> </ul> <p><i>Examples:</i></p> <ul style="list-style-type: none"> <li>– <i>Sales rose from \$50 to \$140 / There was a rise in sales of \$90</i></li> <li>– <i>Sales fell to 25 million dollars in 1998 / There was a fall in sales of 25 million dollars in 1998</i></li> <li>– <i>Sales fell by 2% / There was a slight fall in sales of 2%</i></li> <li>– <i>It peaked at 23% / It reached a peak of 23%</i></li> <li>– <i>It fluctuated between 5 and 8 %, there was a fluctuation of 3%</i></li> <li>– <i>Numbers studying rose to over 35 men and just under 20 women</i></li> </ul>
<p>PERCENTAGES</p>	<ul style="list-style-type: none"> <li>– 70 % (of) = seven in ten</li> <li>– 90% (of) = nine out of ten</li> <li>– 5 % (of) = one in twenty</li> <li>– 10 % (of) = 0.1 = one in ten = a tenth (of)</li> <li>– 25 % (of) = a quarter (of)</li> <li>– 64 % (of) = nearly two-thirds (of)</li> <li>– 47 % (of) = almost half (of)</li> </ul>

**Presenting Graphs - useful phrases:**

- As you will see from this graph ...
- I'd like to show you ...
- Let me draw your attention to this part of the graph.
- Let's look more closely at this month's figures.
- As you can see ...
- Here you can see a comparison between ...
- This figure refers to the ...
- This pie chart shows ...
- The pie chart is about ...
- The bar chart represents ...
- The bar chart deals with ...
- The line graph (clearly) shows ...
- The slices of the pie chart compare the ...
- The chart is divided into ... parts.
- It highlights ...
- On the line graph you will note :
  - a strong upward trend in the ...
    - o despite occasional fluctuations ...
    - o with a slight drop during ...
    - o with occasional variations due to ...
  - the overall performance of ... is good.
    - o The initial surge in ... was followed by a period of slower growth in the second half of the year.
    - o The instant success of the ... was followed by a period of stabilization in the level of ...

**Commenting trends - useful phrases:**

**INCREASES**

- a slight/constant/marked/substantial/increase in ...
- an increase of about/roughly/approximately/in the region of ... %
- a little over/above what we predicted
- the recovery/upturn began in (month)
- an overall increase in ...
- an upward trend in the demand for ...
- ... reached record levels / reached a peak in (month)
- a strong surge in ...
- by (month), the figure had risen to ...
- we predict that ... will soar in the coming year / over the next ... months

## DECREASES

- just under our target
- way below our expectations
- a slight / notable / significant decrease in ...
- the downturn began in (month)
- the situation began to deteriorate in (month)
- the number has continued to fall

## FLUCTUATIONS

- a slow start developed into steady progress in ...
- an initial upward trend was followed by ...
- we note slight fluctuations through the year
- normal seasonal variations are the cause of occasional downward trends
- ... have been (rather) irregular
- the level / the rate has been unstable since ...
- you will note a certain instability in the rate of ...

### Conclusions - useful phrases :

- We must focus our attention on ...
- What I suggest is ...
- There is a necessity for ...
- We need more ...
- We have no choice but to ...
- Appropriate measures must be taken.
- The only option we have is to ...
- These changes are inevitable.
- We will have to revise our estimation.
- The result / outcome will be ...
- I strongly recommend ...
- To conclude, I am happy...
- I regret to announce that ...
- I was really surprised/shocked by the ...
- So we can say ...

### Use of Tenses

Mind the correct use of tenses when describing a chart. If the charts deals with facts in the present, use the Simple Present, if the facts are the past, then use the Simple Past. If there is a connection between the past and the present, use the Present Perfect.

## REFERENCES

- About.com. English as 2<sup>nd</sup> Language. Language of Graphs and Charts. Searched on the Internet:

<http://esl.about.com/od/businessmeetings/a/Language-Of-Graphs-And-Charts.htm>

- About.com. Statistics. 7 Common Graphs in Statistics. Searched on the Internet:

<http://statistics.about.com/od/HelpandTutorials/a/7-Common-Graphs-In-Statistics.htm>

- DC IELTS. Your guide to exam success and better English. Some more advanced trend vocabulary. Searched on the Internet:

<http://www.dcielts.com/task-1-2/trend-vocabulary-ielts/>

- Describing Charts and Graphs. Searched on the Internet:

[http://oppematerjal.sisekaitse.ee/eppleibur/describing\\_graphs/](http://oppematerjal.sisekaitse.ee/eppleibur/describing_graphs/)

- Englishch-hilfen.de. How to describe charts in English. Searched on the Internet:

<http://www.english-hilfen.de/en/words/charts.htm>

- IELTS Online. IELTS Vocabulary for Graphs. Searched on the Internet:

<http://www.english-studyguide.com/2012/08/ielts-vocabulary-for-graphs.html>

- Learn English. Describing Graphs. Searched on the Internet:

<http://www.ecenglish.com/learnenglish/lessons/describing-graphs>

- Learn English Today. Free English resources and materials for ESL-EFL learners of all levels. BUSINESS ENGLISH VOCABULARY. Graphs – Charts. Searched on the Internet:

<http://www.learn-english-today.com/business-english/graphs-charts.html>

- Notes from the subject: “Inglés II” from “Máster Universitario en Lengua Inglesa para el Aula Bilingüe de Educación Secundaria por la Universidad de Oviedo” Academic Year 2013 – 2014.

- Writefix. Graphs: Vocabulary. Searched on the Internet:

[http://writefix.com/?page\\_id=692](http://writefix.com/?page_id=692)

MATHS ENGAGEMENT AND REAL-WORLD  
PROBLEM SOLVING THROUGH MATHS TASKS.

THE LANGUAGE OF **GRAPHS**

{Appendix II. An application in the classroom}

Máster Universitario en Lengua Inglesa para el Aula Bilingüe de Educación Secundaria  
por la Universidad de Oviedo. Curso 2013/2014

by Rocío Yuste Mieres





## CONTENTS

### General

- Interpretation of quantitative or qualitative information or spatial relationships.
- To have confidence in their own abilities to cope with problems, understand the mathematical relationships and make decisions from them.

### Functions and Graphs

- Understanding local and global phenomena presented in graphical form.
- Interpretation of graphs as a relationship between two magnitudes. Observation and experimentation in practical cases.

### Use of the language

- Level of English according to CEF **A1 A2**
- Use of comparatives and superlatives forms.
- Use of expressions to give their opinions, such as, “In my opinion...”, “I think that...”, “What do you think?”, “I agree with you”, “You are right”, “I’m afraid you are wrong”...

## EVALUATION CRITERIA

- Analyze the relationship between two variables from a graph, showing increase and decrease, continuity and discontinuity, cutoff points with axes and maximums and minimums. Relate the results of that analysis with the meaning of the variables represented.
- Solve, with tables, graphs and simple algebraic relationships, problems that set out the dependence between two magnitudes

## KEY COMPETENCES

- Mathematics contribute to language communication competency that is designed as an area of expression that uses continuously spoken and written form in the formulation and expression of ideas.
- The contribution to social and civic responsibility competency from the consideration of the use of mathematics to describe social phenomena. Mathematics, primarily through functional analysis and statistics, provide scientific basis for predicting and making decisions.
- Interpretation of messages that contain information on quantities and sizes or on elements or spatial relationships.

## ASSESSMENT

- Student will be assessed by checking and correcting the worksheets they do.
- Teacher observation (participation and quality of production) and oral questions.

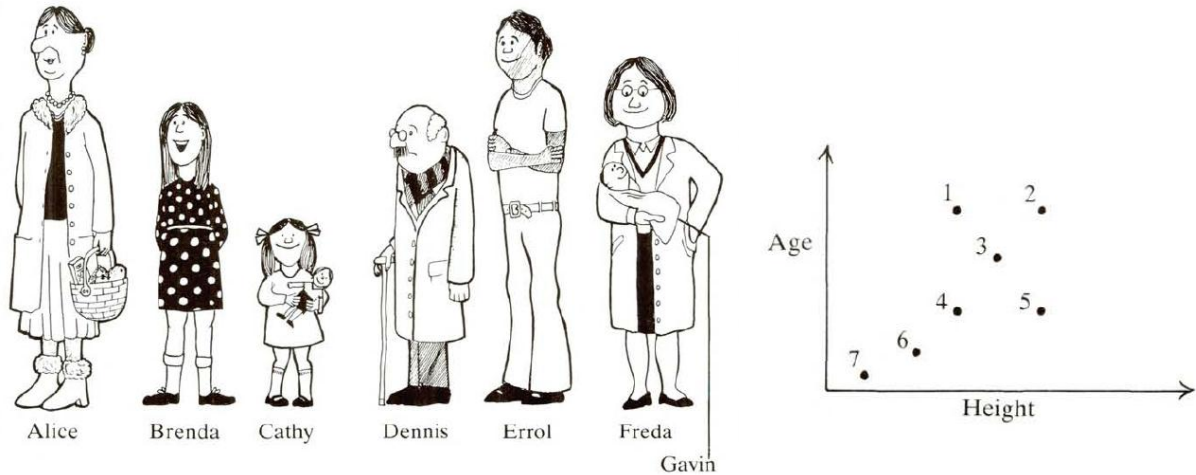
TIMING	LESSON DEVELOPMENT	STUDENT'S ACTIVITY	RESOURCES
2'	Revision of the concepts students have learnt and used before this lesson: Cartesian coordinate system, axes, origin, ordered pairs, plotting points, plotting the graph of a function...	Listen to the explanation of the teacher and answer several questions to maintain their attention.	Power Point Presentation <b>“The language of graphs”</b>
8'	Explanation about what is a sketch graph and how can we use it to show the relationship between two set of data.		Example <b>“Podiums and World Championships”</b>
15'	Looking at a graph to interpret points on a graph.	In pairs, students have to understand what is represented by different points from a sketch graph.  They have to fill in the gaps to complete the exercise.  They have to use comparatives and superlatives.	Exercise 1 <b>“The Bus Stop Queue”</b>
15'	Looking at several graphs to find the information that allows them to answer different questions.	In pairs, students interpret information from different graphs.  They have to decide if several statements are true or false searching information from the appropriate graph among several ones.	Exercise 2 <b>“Planes”</b>  (a and b)
5'	Looking at several graphs to decide which one represents a particular issue.	In pairs, students interpret information from different graphs.  They have to decide which graph represents the issue that is mentioned in the exercise and explain why they have chosen their graph.	Exercise 3 <b>“Which Graph”</b>

5'	Watching a video about a graph and how information is taken away from it.	Individually, students watch a video and the whole group talk about them and what have they understood in relation with the lesson.	Video <b>“One Race, Every Medalist Ever”</b> from The New York Times
5'	Sum up and homework.	Students listen to the teacher and take note of homework.	Exercise 2 <b>“Planes”</b> (c)  Exercise 4 <b>“Height against Width”</b>



### 1. The Bus Stop Queue

Who is represented by each point on the Scatter Graph, below? **Fill in the gaps.**



**Point 7** represents : “He is the shortest and  person”

**Point 6** represents : “She is taller than Gavin but  than the rest of the people”

**Points 2 and 5** represent Alice or : “They are the ”

**Point 2** represents : “She is one of the tallest and  than Errol”

So **point 5** represents : “He is one of the tallest and younger than ”

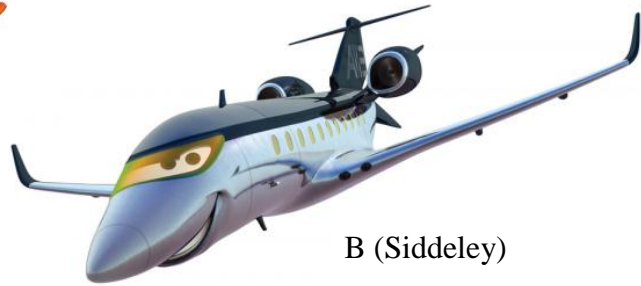
**Point 3** represents : “She is shorter than Alice and Errol but  than the rest of the people”

**Points 1 and 4** represent  or Dennis: “They have the same ”

**Point 1** represents : “He is older than Brenda”

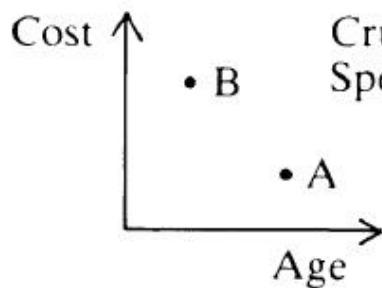
So **point 4** represents : “She is  than Dennis”

## 2. Planes

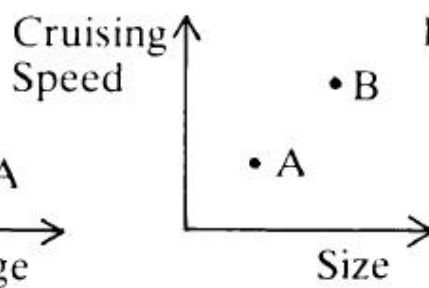


The following quick sketch graphs describe two airplanes, A (Dusty) and B (Siddeley).

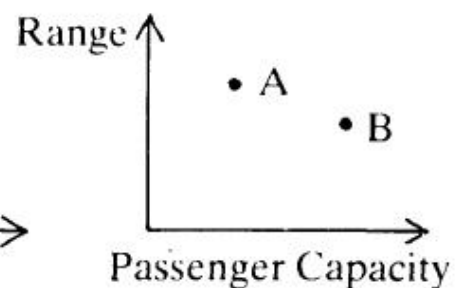
*Note that graphs have not been drawn accurately.*



GRAPH 1



GRAPH 2



GRAPH 3

a) GRAPH 1 shows that airplane A is older than airplane B. What else does it say?

b) Are the following statements TRUE or FALSE?

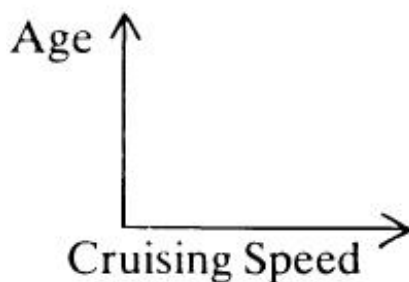
“The older airplane is cheaper”

“The faster airplane is smaller”

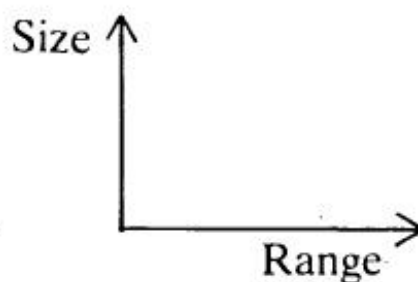
“The larger airplane is older”

“The cheaper airplane carries fewer passengers”

c) On GRAPH 4 and GRAPH 5 mark and label two points to represent airplanes A and B.



GRAPH 4



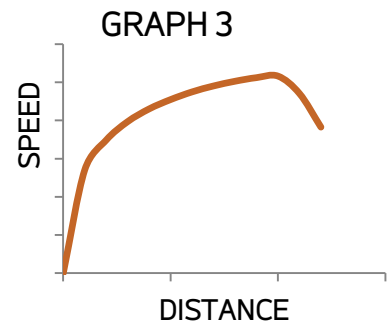
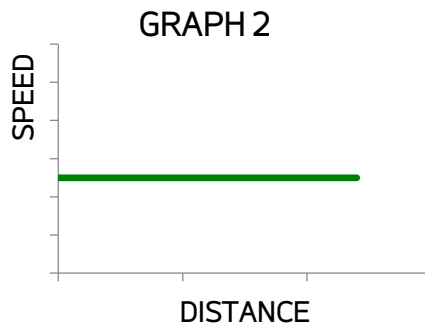
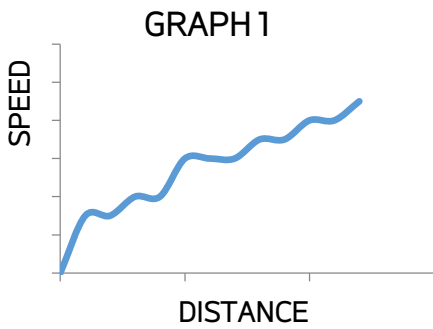
GRAPH 5

### 3. Which Graph?

Usain Bolt is the world's fastest man with a World Record in 9.58 seconds over the 100 m race.

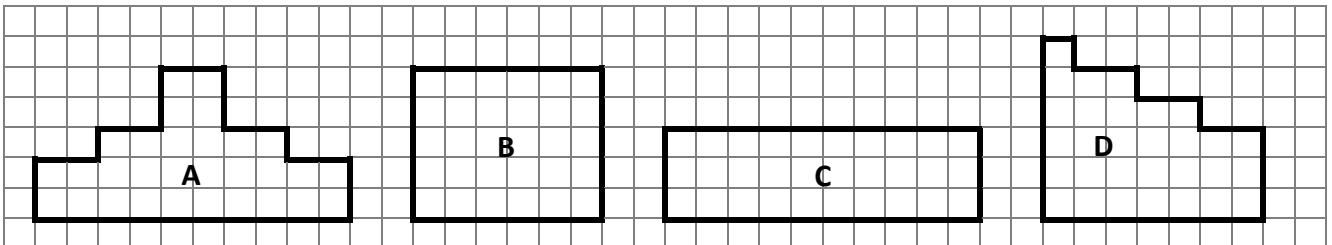
One of the following graphs represents the 100 m race of Usain Bolt.

Which one do you think it is?

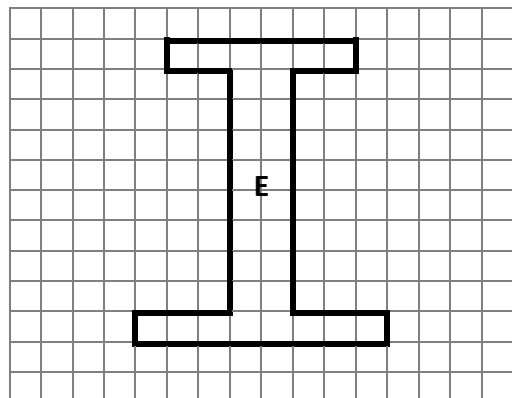
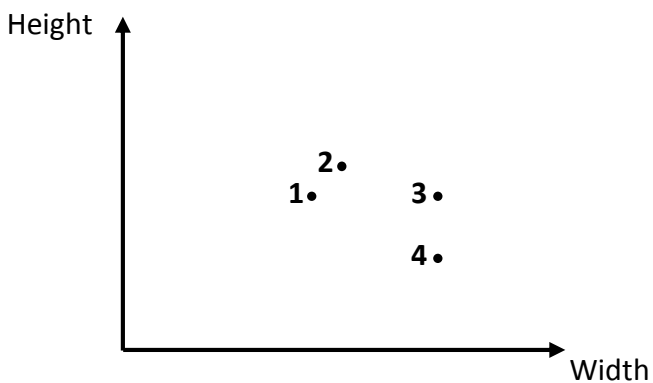


### 4. Height against Width

Mary has 30 square tiles and places them making the following shapes.



- a) Look at the graph below where each point represents one of these shapes. Which shape is represented by each point?



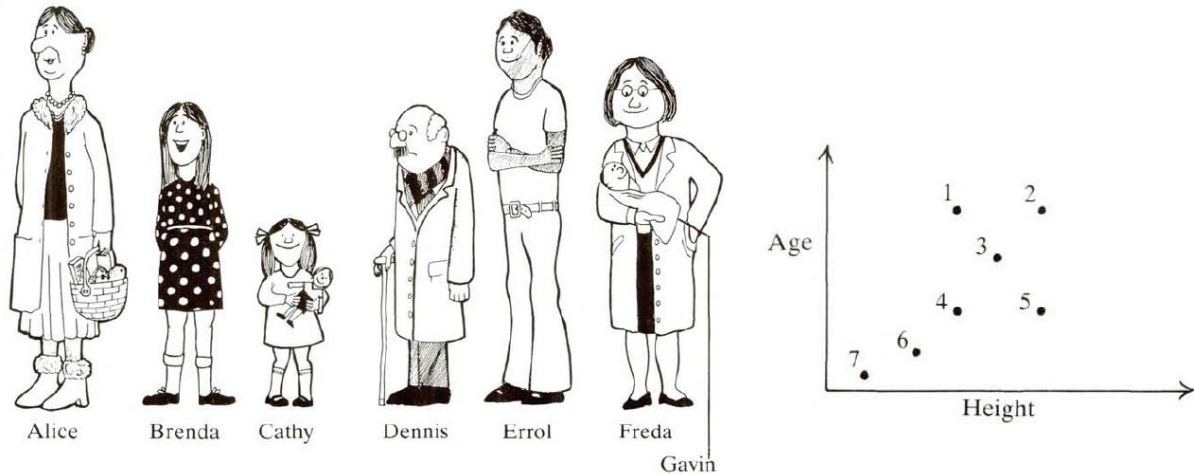
- b) Plot the point on the graph that represents the shape "E".





## 1. The Bus Stop Queue

Who is represented by each point on the Scatter Graph, below? **Fill in the gaps.**



**Point 7** represents **Gavin**: “He is the shortest and **youngest** person”

**Point 6** represents **Cathy**: “She is taller than Gavin but **shorter** than the rest of the people”

**Points 2 and 5** represent Alice or **Errol**: “They are the **tallest**”

**Point 2** represents **Alice**: “She is one of the tallest and **older** than Errol”

So **point 5** represents **Errol**: “He is one of the tallest and younger than **Alice**”

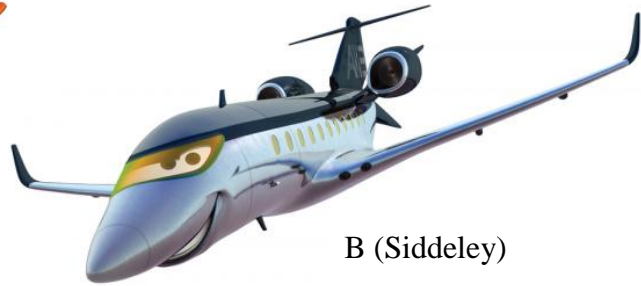
**Point 3** represents **Freda**: “She is shorter than Alice and Errol but **taller** than the rest of the people”

**Points 1 and 4** represent **Brenda** or Dennis: “They have the same **height**”

**Point 1** represents **Dennis**: “He is older than Brenda”

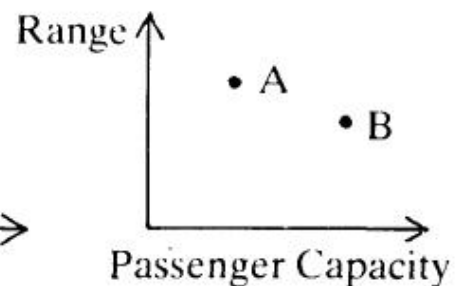
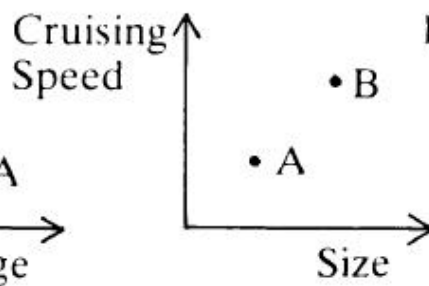
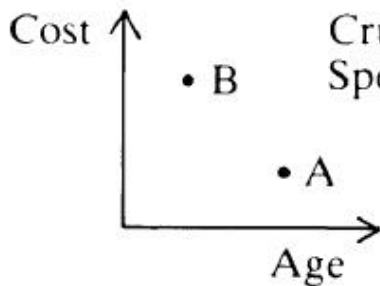
So **point 4** represents **Brenda**: “She is **younger** than Dennis”

## 2. Planes



The following quick sketch graphs describe two airplanes, A (Dusty) and B (Siddeley).

*Note that graphs have not been drawn accurately.*



a) GRAPH 1 shows that airplane A is older than airplane B. What else does it say?

**B IS MORE EXPENSIVE THAN A**

**A IS CHEAPER THAN B**

b) Are the following statements TRUE or FALSE?

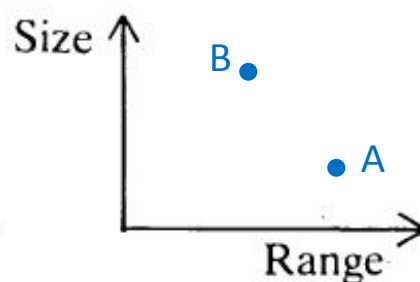
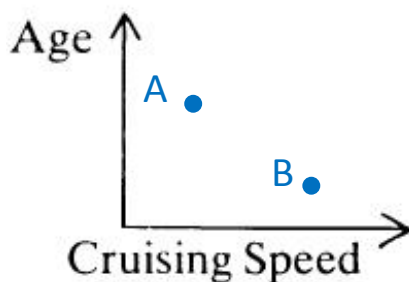
“The older airplane is cheaper”      **TRUE**

“The faster airplane is smaller”      **FALSE**

“The larger airplane is older”      **FALSE**

“The cheaper airplane carries fewer passengers”      **TRUE**

c) On GRAPH 4 and GRAPH 5 mark and label two points to represent airplanes A and B.



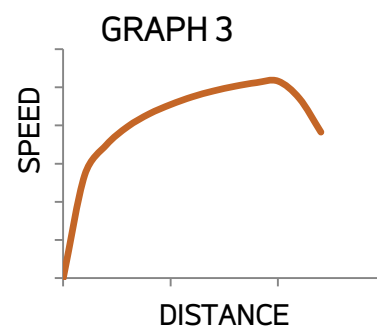
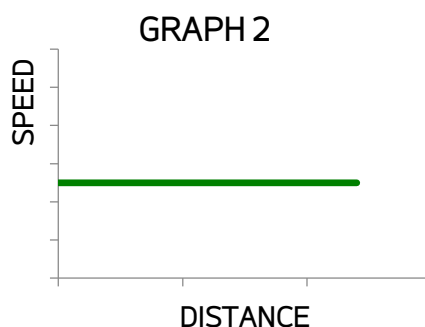
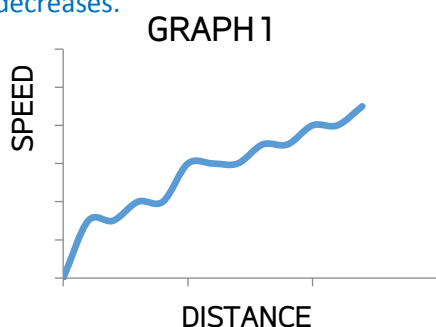
### 3. Which Graph?

Usain Bolt is the world's fastest man with a World Record in 9.58 seconds over the 100 m race.

One of the following graphs represents the 100 m race of Usain Bolt.

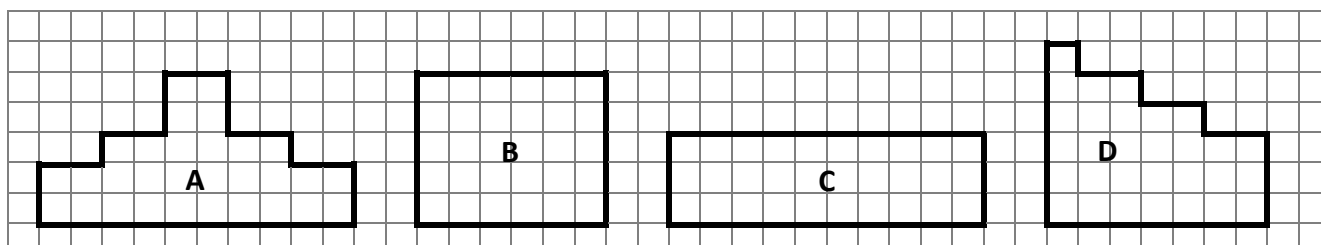
Which one do you think it is?

GRAPH 3: At the start line Usain is still, then he starts run and increases his speed, he picks a maximum at the finish line, and then he starts to stop, his speed decreases.

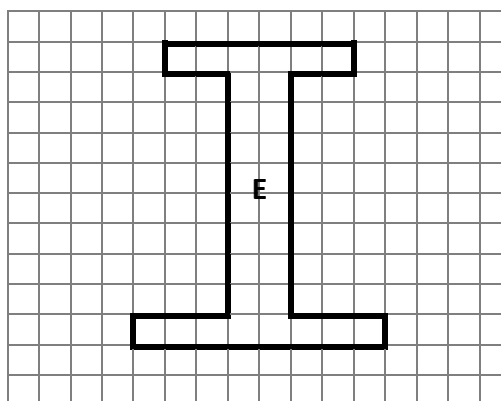
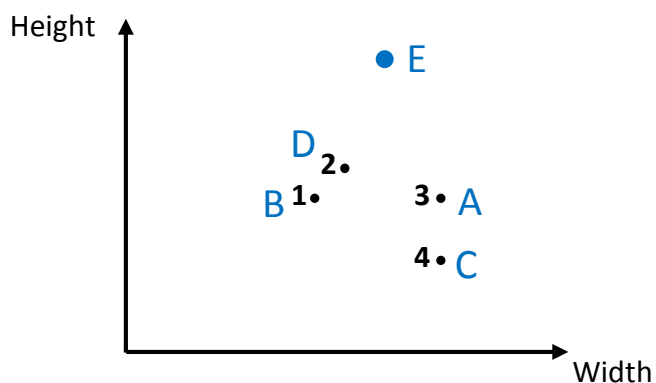


### 4. Height against Width

Mary has 30 square tiles and places them making the following shapes.



- a) Look at the graph below where each point represents one of these shapes. Which shape is represented by each point?



- b) Plot the point on the graph that represents the shape "E".



MATHS ENGAGEMENT AND REAL-WORLD  
PROBLEM SOLVING THROUGH MATHS TASKS.

THE LANGUAGE OF **GRAPHS**

{Appendix III. A project proposal}

Máster Universitario en Lengua Inglesa para el Aula Bilingüe de Educación Secundaria  
por la Universidad de Oviedo. Curso 2013/2014

by Rocío Yuste Mieres



PROJECT NAME: **HOW GOOD IS MY HIGH SCHOOL?**

SUBJECT: **MATHEMATICS**

YEAR: **THIRD YEAR OF SECONDARY EDUCATION**

**PBL STEP 1 – GET AN IDEA**

***Look for project ideas everywhere.***

I feel passionate about education and I am worried about the quality of our High Schools.

I think that there is not much information about High Schools in our city so, thinking about it, an idea came into my mind. Why not do a report about the quality of each High School? This report will be done by the students, so I think that it will reflect the state of each High School from the point of view of the actual users of the centre.

***The importance of outcomes.***

The final outcome will be a report about the quality of High School. Different issues of the centre will be measured and analyzed, and possibilities of improvement will be proposed.

***The curriculum content.***

This is a project for students of the Third Year of Secondary Education; subject: Maths and Learning Unit of Statistics. The minimum contents (mC) of this Learning Unit belong to the *Bloque 6. Estadística y probabilidad* of the autonomous decree of the *Principado de Asturias*:

*Decreto 74/2007, de 14 de junio, por el que se regula la ordenación y establece el currículo de la Educación secundaria obligatoria en el Principado de Asturias (BOPA N° 162 - Jueves, 12 de julio de 2007).*

These mC, regarding Statistics, are the following (Decree 74/2007, p.434):

***mC\_6.1\_Necesidad, conveniencia y representatividad de una muestra. Métodos de selección aleatoria y aplicaciones en situaciones reales.***

***mC\_6.2\_Variables cualitativas y variables discretas y continuas.***

***mC\_6.3\_Agrupación de datos en intervalos. Histogramas y polígonos de frecuencias.***

***mC\_6.4\_Construcción de la gráfica adecuada a la naturaleza de los datos y al objetivo deseado.***

***mC\_6.5\_Significado, cálculo y aplicaciones de la media, moda, cuartiles y mediana.***

***mC\_6.6\_Análisis de la dispersión: rango y desviación típica. Interpretación conjunta de la media y la desviación típica.***

***mC\_6.7\_Utilización de las medidas de centralización y dispersión para realizar comparaciones y valoraciones. Actitud crítica ante la información de índole estadística.***

***mC\_6.8\_Utilización de la calculadora y la hoja de cálculo para organizar los datos, realizar cálculos y generar las gráficas más adecuadas.***

The Decree also establishes the Evaluation Criteria (EC) that are the basis to assess the achievement of the Secondary Education Objectives and the Maths Objectives for the whole Secondary Education, and the acquisition of the Basic Skills. At the same time, the EC indicates the minimum objectives (mO) that teachers have to require to their students; they are the basic skills of the subject that the students have to develop. The Evaluation Procedures and Evaluation Instruments are based on this EC, as well as the Assessment Criteria.

In particular, the EC for the Third Year of Secondary Education, subject Maths and this Learning Unit Statistics, and the mO can be read in the appendix: *Anexo II. Matemáticas. Criterios de evaluación (Decreto 74/2007: p.437)*

***EC\_6\_Elaborar e interpretar informaciones estadísticas teniendo en cuenta la adecuación de las tablas y gráficas empleadas y analizar si los parámetros son más o menos significativos.***

*El estudio de determinados aspectos de una población en ámbitos tan diversos como el entorno social, natural, el consumo y otros, se puede realizar mediante técnicas elementales de estadística, con ayuda, siempre que sea posible, de sistemas tecnológicos. En este sentido la realización de trabajos estadísticos sencillos en los que se han de recoger datos y tratarlos estadísticamente para informar sobre una población permitirá evaluar si el alumno o la alumna es capaz de:*

***mO\_6.1\_aplicar técnicas sencillas de muestreo por sistemas aleatorios en situaciones reales con el fin de obtener información sobre algún aspecto de una población;***

***mO\_6.2\_organizar, en tablas de frecuencias y gráficas, información de naturaleza estadística, atendiendo a sus aspectos técnicos, funcionales y estéticos (elección de la tabla o gráfica que mejor presenta la información);***

***mO\_6.3\_calcular, utilizando si es necesario la calculadora o la hoja de cálculo, los parámetros centrales (media, mediana y moda) y de dispersión (recorrido y desviación típica) de una distribución;***

***mO\_6.4\_interpretar información estadística dada en forma de tablas y gráficas y obtener conclusiones pertinentes de una población a partir del conocimiento de sus parámetros más representativos;***

***mO\_6.5\_mostrar una actitud crítica ante la información estadística facilitada a través de medios de comunicación.***

### ***Looking further afield for project ideas.***

At the beginning of this project, it is necessary to talk with the management of the High School, first of all to ask for permission in order to do the project, because all the centre is going to be involved and asked to collaborate.

And, secondly, because they can give useful ideas for the planning of the project.

Students and other teachers can be also informed and asked for ideas at the beginning of the academic year. Some advertisement can be posted in the hallway and uploaded to the web site of the High School.



It is also very important to ask the families. It would be interesting to tell them about the project and to ask them what they want to know about the centre. The project can be presented to the families in the ordinary meetings that the management of the High School schedules every year before starting the academic year, and families can give their ideas by email or using the suggestions box of the school.

***Being rigorous and honest.***

The goal of the project can engage the students because it is referred to the place where they study and spend most of their time. It can be an opportunity to improve their High School and the results can be interesting for them, the management of the High School, other teachers, families, and the community.

The report can help the management of the High School to know how their students see the quality of the centre and, in addition, can help them to find chances of improvement.

The report can help other teachers who can give their opinions and have the opportunity to listen to students' desires.

The report can help the families of the students to know the "health" of the High School and where their sons and daughters are studying.

The report can help the people from the city to know about the High School, and, may be to decide or not sending their sons or daughters to that High School.

I am very interested in the results of the report, because I really want to know about High School and its chances of improvement. Students are going to learn something very useful, how to do a statistical research from the beginning, collecting data, to the end, extracting conclusions from Graphs. This is a kind of work with a high possibility to be developed when they start their studies at University and at any job.

***Coming up with an "essential question".***

The important question that this project contains and that both inspires and requires students to conduct serious research is:

**"Is my High School good enough?" and, "Can I help to improve it?"**

***Talking to colleagues.***

As it was said before, the management of the High School and teachers can be asked for ideas and, if they do not know how Project-based Learning works, now they are going to know it. At the beginning of the academic year, they are going to be invited to a meeting in order to discuss ideas such as:

- How could I make the project more rigorous, or connect it to the community?
- Could the final output be presented in a different format?
- Between us, can we think of other teachers, friends, parents, or anyone else who we could approach about getting involved in this project? What roles might they play?
- Are there any organizations that might be able to help, such as businesses, museums, social enterprises, universities, clubs, or other schools?
- What are our initial venue ideas for the exhibition?

## PBL STEP 2 – DESIGN THE PROJECT

### *Decide what you want your students to learn.*

During the development of this project, students are going to learn contents that will allow them to achieve the following Learning Outcomes (LO). These LO establish not only contents that students have to learn, but also abilities that they have to improve in each content.

The learning objectives that the students have to achieve while doing this project are:

**LO\_01\_**To recall, apply and interpret Maths knowledge in the context of everyday situations.

**LO\_02\_**To decide characteristics that are relevant for statistical research.

**LO\_03\_**To measure characteristics in statistical research.

**LO\_04\_**To decide the size of the set of individuals to study (population or just a sample)

**LO\_05\_**To apply techniques of collecting data in real world situations in order to obtain information about any issue related to the High School and produce a useful survey.

**LO\_06\_**To distinguish qualitative, discrete quantitative, and continue quantitative data.

**LO\_07\_**To analyze critically data from a survey.

**LO\_08\_**To organize data in a Frequency Table.

**LO\_09\_**To visualize data in graphs (Bar charts, Pie Charts, Histograms, and Line Graphs)

**LO\_10\_**To work out statistical parameters: Mode, Median, Mean, Range, Standard Deviation and Variance.

**LO\_11\_**To draw conclusions about the population (sample), from the information collected.

**LO\_12\_**To do self-assessment during the process of their work in order to avoid any deviation from the original goal.

**LO\_13\_**To propose improvements from the result of a statistical research.

**LO\_14\_**To use a calculator or a spreadsheet in order to work out statistical parameters.

Since this is a project for students in the bilingual program, several Language Learning Outcomes (LLO) are planned for them to achieve:

**LLO\_01\_**To interpret and make appropriate use of Maths statements in the target language.

**LLO\_02\_**To read and understand information in the target language about Statistics.

**LLO\_03\_**To define specific vocabulary about Statistics in the target language.

**LLO\_04\_**To interact orally and express statistical information in the target language.

**LLO\_05\_**To respond questions about Maths in the target language (orally and in writing).

**LLO\_06\_**To discuss (listening to and speaking) Mathematical ideas in the target language.

**LLO\_07\_**To use the basic phonetic, lexical, structural and functional components of the target language in real contexts.

**LLO\_08\_**To develop self-confidence in the use of the target language, regarding the four skills: listening, speaking, reading, and writing.

***Do the project yourself.***

This is not a project that can be done beforehand, because it is necessary to have current information. However, the project is believed to be workable although the great difficulty could be to decide what characteristics should be measured and how and when to measure them. In order to get information about how to start and organize a statistical research, it is possible to invite a company that develops this kind of studies in order to give a presentation and some pieces of advice to the students.

***Make contact with experts outside the school.***

At the beginning of the project, a company that carries out statistical investigation will be invited to give a talk about their work to the students. Thanks to this talk, students are going to be able to start their project and they are going to realize that this kind of work is very usual and useful in real life.

***Fill out a Project Plan.***

The present table is the “Project Plan” but, in order to explain it to everyone who is involved, a “Project Sheet” is going to be designed by the whole group, guided by the teacher, showing what information they want to share with all of these people. Some of this information has to be given by the teacher, but other can be decided by the students in order to motivate other students of the High School, teachers, and families to participate in the project.

***Work out your Project Timeline.***

The “Project Timeline” shows how the project has to be developed in order to achieve the final objectives in time. Different check-ins have been planned in order to find out how the project is going and to make adjustments, if they were necessary.

Other items, such as the exhibition, have also been planned in the same timeline.

The “Project Timeline” is annexed at the end of this “Project Plan”.

***Plan your assessment.***

Students are assessed throughout the project by means of the following assessment instruments:

**Attendance, motivation, and participation:** the roll call, the implication of the students during the project, an active and positive participation in the classroom, the participation during the exhibition, and the respect for other classmates and the teacher, are assessed at this point.

**Regular check-ins:** different check-ins (meetings with the teacher and revision of drafts) have been planned in order to make sure that students are on track.

**Final report:** following the methodology based on PBL, students have to do a final report. This report will be assessed by the teacher and handed in to the management of the High School before the day of the exhibition for its approbation.

**Exhibition:** the result of the project will be presented in public to teachers from the centre, the management of the High School, the families, and students.

Exhibitions are a great opportunity to get people from outside the school involved with assessment; this brings fresh perspectives to the project, and means that students aren't just getting feedback from you and their classmates. A few people will be asked to be panellists, and they will be given a rubric to help them structure their response to what they see.

This final exhibition has an important relevance for students' final mark.

**Final exam:** the last instrument used to establish a final mark is a written examination about the topic. This written exam consists of different questions with different difficulty levels which check if the students have achieved at least the minimum objectives and, hopefully, all the learning outcomes.

All of these assessment instruments have been planned in the "Project Timeline".

### ***Final assessment.***

The criteria that is followed in order to work out the final mark for each student is the following. As it can be seen, all the assessment instruments have their own percentage out of the final mark. The addition of all of these percentages is the final mark of each student, who can get a mark from zero to ten out of ten.

- **Attendance, motivation, and participation:** 20 %
- **Regular check-ins:** 5 %
- **Final report:** 25 %
- **Exhibition:** 30 %
- **Final exam:** 20 %

### ***Personalise the project.***

The whole group is going to be divided in groups of five students.

Each student will fulfill a different role, so that each student can demonstrate their learning in a way that will be challenging, but not impossible.

One of them will be the director of the project, the one who organizes the tasks and checks the development of the work. Other different roles are the field researcher, the analyst of the data, the graphs drawer, the writer of the report, and the designer of the presentation.

All of them have to contribute in all the tasks, but each one has to be the top responsible for their development. The director will share out these roles among the members of the group at the beginning of the project.

There are five check-ins throughout the project and each student has to be the responsible for presenting the information to the teacher at least once.

Each group is going to study one aspect of the High School: Installations and services – Teachers – Families – Students – Subjects. The teacher will share out each aspect among the different groups asking, firstly, if they have any predilection.

The design of the written report and the presentation in the exhibition are free, but the presentation will last about 10-15 minutes per group.

<b>HOW GOOD IS MY HIGHSCHOOL? – PROJECT TIMELINE</b>			
<b>WEEK</b>	<b>TASK</b>	<b>RESPONSIBLE</b>	<b>INVOLVED</b>
1	Presentation of the project to the management of the High School for their approbation and to collect new ideas for the project.	The teacher	The management
2	Meeting with other teachers to present and collect new ideas for the project.	The teacher	Teachers from the High School
	Organize and communicate a meeting to the families to inform them about the project.	The teacher	The teacher
	Organize and invite a company that carries out statistical investigation to give a presentation to the students.	The teacher	Statistical Company
1 - 2	Adjustment of the Project Plan and Project Timeline according to new ideas given by the management of the High School and other teachers from the centre.	The teacher	The teacher
3	Explanation of the project to the students and general explanation of Statistics.	The teacher	The class
	Organization of the groups and distribution of roles and aspects of the High School to study.	The teacher	The class
	A statistical company's presentation to the students.	The Teacher	Statistical Company The management The class
	Design a "Project Sheet" for all the people involved in the project.	The teacher	The class
	Design an advertisement to inform other students of the High School.	The class	The teacher

MATHEMATICS: The language of graphs. A project proposal

4	Presentation of the project to the families to hand in the “Project Sheet” to them.	The teacher	The management The families
	Collect and analyze ideas from email and the suggestion box of the school.	The class	The teacher
	Adjustment of the Project Plan and Project Timeline according to new ideas given by the management of the High School and other teachers from the centre.	The teacher	The teacher
5	Design of statistical indicators.	Each Group	The teacher
	Approbation of the statistical indicators.	The teacher	Each Group
6 - 9	Collect data for the statistical indicators.	Each Group	All the centre
9	Work out statistical indicators (analyze, organize, draw graphs, and work out statistical parameters)	Each Group	The teacher
10	First Check-in.	The teacher	Each Group
10 - 13	Collect data for the statistical indicators.	Each Group	All the centre
13	Work out statistical indicators (analyze, organize, draw graphs, and work out statistical parameters)	Each Group	The teacher
14	Second Check-in.	The teacher	Each Group
14 - 17	Collect data for the statistical indicators.	Each Group	All the centre
17	Work out statistical indicators (analyze, organize, draw graphs, and work out statistical parameters)	Each Group	The teacher

MATHEMATICS: The language of graphs. A project proposal

18	Third Check-in.	The teacher	Each Group
18 - 21	Collect data for the statistical indicators.	Each Group	All the centre
21	Work out statistical indicators (analyze, organize, draw graphs, and work out statistical parameters)	Each Group	The teacher
22	Fourth Check-in.	The teacher	Each Group
22 - 25	Collect data for the statistical indicators.	Each Group	All the centre
25	Work out statistical indicators (analyze, organize, draw graphs, and work out statistical parameters)	Each Group	The teacher
26	Fifth Check-in.	The teacher	Each Group
27 - 29	Writing the final report.	Each Group	The teacher
30	Hand in the final report to the teacher.	Each Group	The teacher
	Assessment of the final report.	The teacher	Each Group
31	Revision of the final reports and hand in to the teacher for their approbation.	Each Group	The teacher
32	Hand in final reports to the management of the High School.	The teacher	The management
31 - 32	Design the presentation for the Exhibition.	Each Group	The teacher
	Design rubrics for the panellists.	The teacher	The teacher

MATHEMATICS: The language of graphs. A project proposal

	Inform about the Exhibition and invite the management, teachers, families, students, and newspapers agencies of the city.	The teacher	The management Teachers Families Students Newspaper agencies
33	Rehearse the presentation for the Exhibition.	The teacher	Each Group
34	The Exhibition (presentation and collecting rubrics from the panellists)	The teacher Each group	The management Teachers Families Students Newspaper agencies
36	Final Exam	The teacher	The class
	Communicate the final mark to each student.	The teacher	The class

Next Year	<p><i>It is expected that the management of the High School will consider all the proposals resulting from each statistical study and that they take advantage of this project to improve the High School.</i></p> <p><i>It would be very motivating that the students could see how their work has a real result.</i></p>	<i>The management</i>	<i>The management</i>
-----------	--	-----------------------	-----------------------