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Peio Goñi Navarlaz

PRACTICAL METHODOLOGIES IN THE SCIENCE CLASS

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Trabajo Fin de Grado
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Preámbulo

El Real Decreto 1393/2007, de 29 de octubre, modificado por el Real Decreto 861/2010, establece en el Capítulo III, dedicado a las enseñanzas oficiales de Grado, que "estas enseñanzas concluirán con la elaboración y defensa de un Trabajo Fin de Grado […] El Trabajo Fin de Grado tendrá entre 6 y 30 créditos, deberá realizarse en la fase final del plan de estudios y estar orientado a la evaluación de competencias asociadas al título".

El Grado en Maestro en Educación Primaria por la Universidad Pública de Navarra tiene una extensión de 12 ECTS, según la memoria del título verificada por la ANECA. El título está regido por la *Orden ECI/3857/2007, de 27 de diciembre, por la que se establecen los requisitos para la verificación de los títulos universitarios oficiales que habiliten para el ejercicio de la profesión de Maestro en Educación Primaria*; con la aplicación, con carácter subsidiario, del reglamento de Trabajos Fin de Grado, aprobado por el Consejo de Gobierno de la Universidad el 12 de marzo de 2013.

Todos los planes de estudios de Maestro en Educación Primaria se estructuran, según la Orden ECI/3857/2007, en tres grandes módulos: uno, *de formación básica*, donde se desarrollan los contenidos socio-psico-pedagógicos; otro, *didáctico y disciplinar*, que recoge los contenidos de las disciplinares y su didáctica; y, por último, *Practicum*, donde se describen las competencias que tendrán que adquirir los estudiantes del Grado en las prácticas escolares. En este último módulo, se enmarca el Trabajo Fin de Grado, que debe reflejar la formación adquirida a lo largo de todas las enseñanzas. Finalmente, dado que la Orden ECI/3857/2007 no concreta la distribución de los 240 ECTS necesarios para la obtención del Grado, las universidades tienen la facultad de determinar un número de créditos, estableciendo, en general, asignaturas de carácter optativo.

Así, en cumplimiento de la Orden ECI/3857/2007, es requisito necesario que en el Trabajo Fin de Grado el estudiante demuestre competencias relativas a los módulos de formación básica, didáctico-disciplinar y practicum, exigidas para todos los títulos universitarios oficiales que habiliten para el ejercicio de la profesión de Maestro en Educación Primaria.

En este trabajo, el módulo *de formación básica* nos ha permitido construir el marco teórico a partir de conceptos estudiados a lo largo del grado como el aprendizaje por descubrimiento o la taxonomía de Bloom.

El módulo *didáctico y disciplinar* se concreta en la programación de los contenidos en las distintas actividades y la elaboración de las mismas.

Asimismo, el módulo *practicum* permite la puesta en práctica de este trabajo para la obtención de resultados además de otorgar realismo y un contexto real al propio trabajo.

Por otro lado, la Orden ECI/3857/2007 establece que al finalizar el Grado, los estudiantes deben haber adquirido el nivel C1 en lengua castellana. Por ello, para demostrar esta competencia lingüística, se redactan también en esta lengua los apartados “situations”, “conclusiones” y la prueba final, así como el preceptivo resumen que aparece en el siguiente apartado.

Resumen

En este proyecto se mostrará que una metodología práctica es más útil para los estudiantes de primaria para adquirir la competencia científica a partir de la asignatura de conocimiento del medio que una metodología teórica, que es factible y que mediante su uso los niños recordarán más y serán capaces de utilizar lo que han aprendido en mayores niveles que cuando lo han aprendido teóricamente.

Para mostrar esto, se observarán los efectos de un aprendizaje mayormente teórico y otro mayormente práctico que se utilizarán simultáneamente en dos temas, las energías renovables, donde mostraré el aprendizaje práctico y climas de Europa, donde usaré una metodología teórica.

Después de algunas pruebas, teniendo en cuenta los niveles de la taxonomía de Bloom, comprobaremos que lo anterior es cierto.

Palabras clave: *Ciencia; Investigación; Metodologías prácticas; Resolución de problemas; taxonomía de Bloom.*

Abstract

In this project I will show that a practical methodology is more useful for primary students in order to develop the scientific competence in the sciences subject than a theoretical methodology, its feasibility and that by using a practical methodology the children will remember more and will be able to use the learning they have acquired in a higher level than when done in a theoretical aspect.

In order to show this, I am going to see the effects of a more theoretical methodology and a more practical methodology using them simultaneously in two different topics: renewable energies, where I will show a practical approach and Europe’s climate and geography, where I will use a theoretical approach.

After some tests taking into account the Bloom’s taxonomy levels, we will find out that a practical methodology is better.

Keywords: *Science; Research; Practical methodologies; Problem Solving; Bloom's taxonomy.*

Índice

1 – Theoretical Work

1.1- Background

The Science subject in the Spanish education has never been the favorite subject for children or teachers. When I studied in primary school I was one of the few children interested in Science and some of the teachers were engaging and tried to make their subject useful and interesting for children, but, on the other side, I do not recall experimenting or doing practical exercises in any moment in class. This issue has kept me interested since I went to the university, where we have been told about the new methodologies and the need of innovation in sciences class.

So, so far my conclusions about the subject of Science in primary are really negative. Many of my classmates had a negative attitude towards science and were not really interested on it since primary education's degree has always been considered as a non-scientific degree, as the teachers are not specialized in a specific science, or as the general understanding of science in general is not one of the main aspects of this degree, where any subjects related to sciences have harvested nothing but complaints from the students and the teachers whose efforts have not been enough to change the student's mentality. Or at least that is what I get from my personal experience.

Also, on my internship period some of the teachers who were in charge of the Science subject told me when I asked them that they did not know a lot about science and that all they knew was from the textbooks, and that they even did not like this subject as much as the other subjects they imparted.

Even tough, experts have always considered sciences as an important part of the primary education. For example, in the PISA tests it is mentioned that the students must be able to extract conclusions based on evidence and provided information and to discriminate, basing in data given by others an opinion and evidence based in facts (OCDE, 2000). And this is how science works, extracting conclusions from evidence and facts. In other words, the children need to understand in order to act.

These facts have led me to think that maybe we are not using a correct way to teach sciences, or at least, that teachers do not give the importance it should have to the subject of Science. Due to this, in most of the cases the students will probably not be able to acquire what they are expected to. As a result, in the PISA tests which measures a different set of competences, as in this case, the scientific competence, the students from Spain do not have good results (OCDE, 2012).

The main cause of this problem may be that science is still really apart from the classrooms. Nevertheless, in the last few years, schools have drastically changed. The behaviorist approach is starting to fade away and the cognitive approach is starting to enter into the classrooms, changing the way teachers and students learn (APA, 2013). In this background I would like to take into consideration one of the branches that is provided to teachers: the discovery learning approach.

The discovery learning approach, originated by *Jerome Bruner* (1967), which receives influences from the cognitive approach states that learning takes place in problem solving situations where the learner draws on their past experience and existing knowledge to discover facts, relationships and new truths to be learned.

Students interact with the world by exploring and manipulating objects, trying to answer questions, or performing experiments. As a result, students may be likely to remember concepts and knowledge discovered on their own (in contrast to a transmissive model). Models that are based upon discovery learning model include: guided discovery, problem-based learning, simulation-based learning, case-based learning, incidental learning, among others.

This method offers us a series of advantages (Cañal, 2007):

- It encourages active engagement
- It promotes motivation
- It promotes autonomy, responsibility, independence
- The development of creativity and problem solving skills.
- It is a tailored learning experience

According to this information provided, a discovery learning approach, including meaningful activities, would be beneficial for the acquisition of scientific competence established in the PISA's objectives, but as it is visible in the PISA's results in Spain, the Spanish students do not obtain these competences. Therefore, it would be interesting to use this approach in the classrooms, comparing the results afterwards.

But, in order to do that, there are still things we need to know, and this starts with the first concept, the scientific competence.

1.2- THE SCIENTIFIC COMPETENCE. The capacity of making science.

In a first sight, one may think that the scientific competence is part of the eight basic competences that appear in the Spanish education curriculum, as there are some competences that may appear similar, as the competence in knowledge and interaction with the physical world, but… are they really the same?

Let's take a look:

In the Spanish curriculum, the competence in knowledge and interaction with the physical world appears as "The ability to interact with the physical world, in both the natural aspects as the ones generated by the action of mankind, in order to make possible the comprehension of events, the prediction of consequences and the activity directed to de improvement and preservation of conditions in their own life and the rest of the people and life being's one." (DF 24/2007) It also declares that this competence incorporates the abilities to correctly be able to act in very different fields of knowledge, as sciences.

Also inside this competence I would like to highlight that it incorporates some practical aspects of the knowledge that as I have said before when I was talking about my previous experience in Science class, are not as used as this document tells.

This can be found in these sentences: “It also includes the application of some notions, scientific concepts and basic scientific theories previously comprehended. This implies the progressive ability to put into practice the processes and attitudes useful for the systematic analysis and the scientific research: to identify and plan relevant problems, make direct and indirect observations being conscious about the theoretical framework that contains them, make questions and evaluate different solutions or hypothesis…” (DF 24, 2007)

This competence also includes the abilities to find the solutions and communicate them.

On the other hand the OCDE (2006) defines the scientific competence as:

> *“The capacity to use the scientific knowledge to identify problems, acquire new knowledge, explain scientific phenomena and extract conclusions based in evidence in issues related to science. It also takes into addition de comprehension of the characteristic aspects of science, understanding it as a mean of human knowledge and research, the perception of the mean in which science and technology conform our material, intellectual and cultural environment and the disposition to imply oneself in issues and ideas related to science as a reflexive citizen.”*

So, summing up, the competence in knowledge and interaction with the physical world includes part of the scientific competence, as the scientific process and the analysis of data or the different hypothesis and it is a very detailed competence inside the curriculum, still not being the same as the scientific competence defined by the OCDE (2006).

But, even if this competence has been in the documents for years this do not means that the scientific knowledge has increased among the students or that the results are going to improve, as this is only worthy if the teachers had changed their methods and were able to create the necessary activities for the students in order to develop this competence. And my previous experience as a student and a practitioner shows this is not happening.

Then, the scientific competence is something more complex than what we see in a first sight. First of all, one of the multiple and accepted definitions for the word *competence*, stated in the oxford dictionary is this: "*the ability to do something successfully or efficiently*"(Oxford, 2014, http://www.oxforddictionaries.com/) although, there are some doubts and some ambiguity about this term and some other authors use different definitions as this "a person can be considered competent for a determined job when he is able to do it in an adequate and creative way" (Cockenill, 1989).

This notion of competence has also been changing since its beginning to the notion we have today and use, so nowadays, the acquisition of a competence includes not only the use of the cognitive functions, but also the use of strategies, emotion, motivation and even ethical and social values. (Crujeiras y Jimenez, 2012)

So, for the OCDE, the scientific competence includes both the scientific comprehension, as students will need to be able to understand theories and facts as the capacity to use a scientific perspective, with a basis in evidence.

In this way the scientific competence must be seen as a transversal competence that is meant to be used in our daily life and to help us developing as a person, not only at school when students are in science class.

It is also useful to say that in the evaluation of this competence we can find that some of the students with poor results may not have a poor result due to their lack of their scientific knowledge, but due to their problems in their other competences, as the reading competence or the mathematical competence.

Another thing we may need to know is how the does OCDE evaluate the scientific competence.

In the PISA tests the scientific competence is evaluated in three different dimensions: The scientific processes, the scientific contents and the context in which the scientific knowledge is applied. Inside the scientific process we can find five different items. I would like to highlight the ones I will later use in my project and those are: to show their knowledge about scientific concepts, extract conclusions and communicate the conclusions.

It is also quite easy to observe that when we try to introduce the scientific competence, we, as teachers should tend to explore other possibilities rather than mere memorization or summing up texts, due to the definition of the competence.

As we intend to make the students research and act as true scientists, they use more advanced cognitive skills and strategies which can be understood in reference to the Bloom's taxonomy, a pyramid that is used to show the different levels of cognitive skills, starting with the low order cognitive skills in the base, as memorization to the high order thinking skills, as creation or evaluation in the top of the pyramid (Image 1).

1.3- Bloom's Taxonomy: Advancing in complexity to achieve a better learning

Image 1. Revised Bloom's pyramid. Source http://ww2.odu.edu/educ/roverbau/Bloom/blooms_taxonomy.htm

In the Bloom's revised taxonomy (Anderson and Krathwhol, 2001), we can find different levels. The first level is, starting from the lower levels, the "*remembering*" level. In science, an example we can find of an activity in this level may be a theory or telling to a partner the first rule of thermodynamics by heart.

The second level is the "*understanding*" level. In this point the students need to use higher cognitive skills in order to achieve their objective. An example of this level can be an activity where a student needs to write in his own words how does a caterpillar change into a butterfly.

The third level is "*applying*". In this level the student builds something from the previous knowledge he or she has. This is the level where the scientific process becomes interesting and where most of the objectives in PISA tests can be found. One example of this level can be this: The student is given a problem; for example, they are lost with a compass in the middle of a mountain. In order to solve this situation they do not only need to know where he is, he will need to know how a compass works, and how this object would be useful in their situation. Another interesting activity may be predicting the results of experiments after studying the theory, as the students may be engaged to think about it and later on it can be checked in class.

The fourth level is the "*analysis*", which is another important step talking about sciences. In this step the students will be able to contrast, compare and carry complex tasks that will allow the teachers to see the level of knowledge of the students and if they are able to complete tasks that require more than only remembering things. A good example of activity for this level may be a discussion. As sciences usually have questions that can be answered correctly in more than one way, a discussion can be useful as some students will think that one side is better and others will go to the other side, after some time to work in their arguments, the students will try to convince the opposing group of their point of view, using better arguments than they or even breaking their arguments. This point may become a really successful activity if it is carried out well. Probably for most of the topics in primary education this level may be challenging, not only for students, but also for teachers, as in most of the cases neither the teachers nor the students are used to working this way.

Approaching the top of the pyramid, the fifth level is the level called "*evaluating*". An example of this, carried out as an activity in the classroom can be done comparing with the example I showed you in the previous level. If we have had the discussion in class and both groups have exposed their arguments in a topic, the evaluation exercise will be for them to individually choose the solution they now think is better, justifying it. In this activity some of the students will have most likely changed their minds, as maybe they arguments were not strong enough or they may had not considered everything equally, meanwhile other students will be in the same position, with their strong arguments. This level includes a high component of thinking and analysis.

The last level, being a really complicated task for the students and the teachers is the "*creating*" level. In this level, the students develop something based on their experience and previous knowledge. As it is easily seen, to reach this level the student needs to go step by step, starting in the first levels of the pyramid and advancing in order to be able to create something. An example of an activity, in the area of sciences, which may be useful to reach this level, may be this: After studying different kind of birds that live in a determined ecosystem, we have determined that there are two kinds of birds that eat nuts. One of the species is endangered, and the other isn't. After analyzing the characteristics of both species, we have found out that the endangered birds have a longer beak, and using this characteristic, we are going to build some recipients that will only be accessible for this species.

So, in order to acquire the competences needed for a student needs to be able to understand science a little better, or only to improve the children's performance in the PISA exams, traditional education may not be the ideal way to accomplish such difficult objectives, as this kind of education usually focuses in the first levels of the Blooms taxonomy; namely "remembering" and "understanding".

New teaching methods, as scholar research, are used because we have realized that we need to create something meaningful for the children, something useful for them, which involve most levels in the Bloom's taxonomy. For example, a project-based approach makes possible to reach a very high point in the Bloom's taxonomy, as it involves creation, the last step in the pyramid. For example, the result objective of a project about electricity may be the creation of a series of circuits to

Meaningful learning is also usually related with some of the higher levels of the pyramid (and the lower ones too), as applying or analyzing, levels where is not enough to read and repeat the concepts that appear on the book, where students need to think, and use strategies and where teachers should try to arrive with every student.

But, reality is not so perfect and it is difficult for the teachers to create different activities. This can be due to their lack or time, the differences between students, usually considered as a flaw, as a teacher is not always able to create an activity that is suitable for every student, or even because they are not fully prepared to accept a challenge like this. And, even if teachers try to develop activities related to the scientific process, a big number of them do not have enough knowledge about sciences or the scientific method to create consistent activities, or are old and remain still in their positions as their experience makes them think that with the methods they have always used the students will be able to pass their exams. But, there also are some teachers really devoted to new methodologies that are willing to create these activities and that are trying to change the educational system in a better way, as it is visible from the high number of publications about this topic.

In this way, it would be ideal for teachers to keep studying for the rest of their life, at least to keep in touch with new methodologies, or even, it would be more interesting to have a good number of teachers specialized on science, as there are specializations in foreign languages or physical education (Paixao y Cachapuz, 1999).

In the field of didactics, it is useful for teachers to read about the different approaches, as the constructivist method, the project based method and the research based method nowadays, and to adapt their units and activities to new approaches, in order to gain confidence, to see the positive effects of these methodologies and to improve the quality of education. And in order to do this, the teachers need to know more about the best methodologies to bring to their classrooms. In order to do that, a considerable amount of specialized magazines are being published in Spain. For example, Alambique.

1.4- New methodologies in Science Class. Advancing to the practice.

Coming back to the topic, in Science class, one of the methodologies, which has been investigated and is interesting to carry to the classroom, as it introduces ideas like discovering science or giving the main role to the student, is the school research. "*This kind of learning proposed that students should be the ones that discover reality, avoiding direct exposition from the teacher. Students become "little scientists" able to learn by themselves following the steps of the scientific method, used to reach scientific knowledge*" (Cañal 2007). This method is considered obsolete, as it is unviable due to the differences between the learning process and the scientific research (Cañal 2007). It is necessary to overpass this image and start thinking in other ways to introduce investigation in the classroom.

The schoolar research nowadays is based in other ideas (Cañal, 2007), as the fact that research is viable in every stage on life. The curiosity and the capacity to see and try to solve the problems that appear is something that most of the children, if not all, have. So, it is also a bad idea to avoid introducing a research process in the classroom, even if it will be mixed with another methodology.

Despite of this, many times, a lot of arguments have been said in order to stop the ideas in favor of this approach. Among them, we can find something like: "*there are other methods that are equally valid in order to achieve the curricular objectives*" "*It is a very slow method*" "*the teachers do not have enough time to create the materials required for the classroom*" or "*the* *students may reach to a point where neither the teacher nor science has an answer*" (Cañal, 2007 pp. 10-11)

Even if these arguments are not easy to contradict, there is huge research that shows that this method is still useful and has multiple benefits. Even tough, it will be useful to have a proper definition for what we call scholar research. According to Cañal and Porlán (1987): "*Scholar research is a teaching strategy which, starting from the innate ability and tendency to investigate that every child has, the teacher orientates the class dynamic to the exploration and collective thoughts of the questions that the students ask about the components and physical phenomena characteristic of the socio-natural systems of their surroundings, choosing the problems that the students consider as that and designing different plans that can give the necessary data to a collaborative construct of solutions to the questions proposed in a way that also the desire to know and comprehend of the students, and at the same time, advance in the achievement of the priority curricular objectives*."

In this paragraph, the authors highlight very important aspects from this methodology. According to them, it is important to use the desire of investigation that every child has, and to pose problems in order to find a solution. In this way, we are also approaching the higher levels of the Bloom's pyramid, as solving a problem requires more than remembering or understanding abilities.

It is also important to say that it is more useful, in engagement terms, to use problems that are close to the students, as the students usually consider that science is something that is distant, or that cannot be used to solve problems at their levels, opening in this way a new door to reinforce and make them more comfortable about science.

Scholar research requires the introduction into the classroom of a whole variety of new activities, but, nowadays is not so hard to find activities based in this approach in books or the internet, allowing the teachers with no time to have another strategies to combine with their lessons to create a class where students use their knowledge to solve problems (Cañal, 2007)

It is also a remarkable thing that this approach does not need to be considered as a global option, disregarding the rest of good methodologies. This approach can be used partially, taking into consideration the students' life experience, or introducing problem, solving activities or even introducing some sequences based in researching.

This is also useful for the teacher, who can promote curiosity or research among students, or even develop initiatives in order to introduce this approach in his subject. Another good idea is to create researching groups, where the students will be able to deepen their knowledge in science. These initiatives should make the difference (Cañal, 2007).

But, at this moment, teachers will find themselves in a really new situation, after they have accepted this methodology as a good way to improve the students' science knowledge they need to introduce this method in the classroom, which may appear as a problem, because it will probably crash with the students' expectations, or as this method may be confusing for them as they will be used to working in other methods.

So, the question here should be the following: *How should a teacher introduce the researching process in class*?

Introducing the researching process can be done in many different ways. According to Caamaño (2012) one possible method is to elaborate a series of practical works, using the researching process in punctual points of the subject along the course. Other form to do this, in a more ambitious way, is the elaboration and use of different research sequences. And, the last option, if the curricular structure allows it, this can be done doing different works at the end of an educative step, as the ESO (Spanish Secondary Education) or High School.

Therefore, the resolution of the proposed problem may require looking for information in different means, not necessarily experimental or it can be based in the resolution of an experimentation realized in the laboratory or outside the school. For example, in my practical work, which I will explain later, the students needed to find some data related to the problem that I had proposed to them, and the main source they used was their text book, although it was not experimental.

Historically speaking, there have been two different ways to put this practical method into practice (Caamaño, 2012):

- The first approach is an analytical conception that defends the use of practical exercises, specially designed to improve the learning process of each and every abilities of science (Observation, classification, hypothesis creation, experimentation, interpretation of data…) before starting the realization of research.
- The second approach is an integrated or holistic conception, which considers that the students should start investigating since the very beginning, learning in the process the abilities they are going to need and use in the scientific activity.

With both conceptions, the student will start investigating, but, as it is easy to observe, using the first approach the student will enter gradually to the investigation, trying to solve little by little the problems that appear in the classroom, and with the holistic conception, the student will need to discover what to do and will try to apply that in further investigations. Depending on the characteristics of the class a teacher should decide anyway which kind of approach will fit better the classroom and apply it.

Also, when the teacher is using this methodology, they will probably need to structure the research in order to make things easier for the students. This should be done following determined steps, in order to plan an investigation in advance.

One of the most recommendable structures states this (Caamaño, 2012):

1- Problem proposal: In this step, the teacher shows and puts in context the problem that the students will need to solve.
2- Initial plan: The students will read the problem, check if they have understood it, and will possibly need to rewrite it.
3- Planning: to plan the resolution of the problem. In this step the students will need to solve some questions, as:
    a. Which variables should I take into account?
    b. How should I solve the problem?
    c. What materials should I use?
        i. And so on...
4- Realization: In this step the students will solve the problem. It may involve taking the measurements, carrying an experiment or involving mathematical operations depending on the problem that has been chosen.
5- Analysis: This step may be done comparing the results with the other groups or with their bibliography. This step is called Evaluation.
6- Communication: It implies to put into paper the steps they have followed and their conclusions and then, if it is possible, the communication of the results to their partners, usually orally.

As we are talking about primary education, most of the problems that we propose will be simple and will not need very big experiments or very complex until the student has reached higher states in their cognitive development. The problems grow in complexity in the secondary education or High school.

So, what are the primary education children able to do? Is it useful to use a researching sequence or activity in the classroom?

1.5- Developmental steps of the children. Flaws and possibilities of the children to solve practical situations

It is indeed interesting to carry activities like this in primary education, as the children tend to explore and deduce things since they are little children, and therefore, curious about their environment and able to adapt to new circumstances. According to the Piaget's cognitive, (McLeod, 2009), the children from 6-12 years old are between the *concrete operational stage* and the *formal operational*. If we take a look into the littlest children in primary (5-6 year old) we may even find children that are in the finishing stage of the preoperational stage.

The *preoperational stage* may be a little bit soon to use a lot of researching sequences as the children still are only able to focus in only one aspect of a problem, giving the teachers limited problems to propose. For example, conservation (the ability to understand that the quantity of something does not vary even if you change its appearance) problems may make difficult for the children to gather data or to think of a solution if the problem is not well posed.

The children in the *concrete operational stage*, who are not able to think in an abstract or a hypothetical way, have developed the conservation notions and are able to solve problems in a logical way, so, maybe utilizing situations that are close to them or not very complex problems, based on reality will be more than enough to introduce this methodology to the classroom. Abstract problems are not recommendable, as the students may have problems to solve them if they have not developed yet the hypothetical thinking (Ginsburg and Opper, 1979).

If we are talking of older students, as the students in the last course of primary education, we may find that some of the students are in the *formal operational stage*, what will allow us to introduce new situations and more complex problems to the classroom.

The *formal operational stage* is characterized by the capacity of abstract thinking and the capacity for high order reasoning. In this stage of their lives the students do not depend on manipulation in order to realize the tasks, allowing the teachers to introduce abstract problems in their classrooms, although it is not useless to use problems related to their daily lives, including in these problems abstract elements, or problems where the students are able to manipulate the objects and do experiments, as manipulation and real based problems are a source of engagement the students and make them gain interest about science and the researching problems. (Ginsburg and Opper, 1979).

After saying this, I think that research and experiments should be part of the science practice in class, as it is something that children can perfectly do, although it should be used in different ways, depending in the characteristics of the class. If we consider the practical field, starting with simple problems that can be solved with the manipulation of simple objects and advancing to more complicated and abstract situations while the students grow and learn how to do their research in more efficient ways is one of the best options that science teachers, interested in this methodology may have.

Taking into account the nature of the problem we can find two kinds of problems that will help our students to reach the scientific competence(Caamaño, 2012):

1- Practical problems: They are problems of general interest, usually contextualized in the daily life of the students. This kind of research is not specially directed to the acquisition of theoretical knowledge. They are usually related with the aspects that relate science, technology and society in the curriculum. This involves questions that emphasize the comprehension of science in a practical way, in the planning and the realization of research; however, in order to solve these problems a conceptual level is required.
2- Theoretical problems: They are problems of interest in the frame of a concrete theory. The problem to solve may come from a hypothesis or a prediction that appeared in the development in the development of an experiment or maybe from the need to know some properties or characteristics of some of the entities of a model. The results may lead the children to discover an algorithm to solve similar problems in the same frame.

As I have said before, both kinds of problems are useful to develop the scientific competence and to improve the general understanding of science of the students, but according to their ages it is necessary to start with practical problems, that are near to them, as abstract problems will still be out of the students reach according to Piaget, until they acquire the skills necessary to carry a research properly, as the abstract thinking or the ability to gather and analyze data or the ability to hypothesize.

Theoretical problems are out of hand for students of the lowest grades in primary education, as they will probably neither have enough level of the rest of the competences to carry a research. The student will not be able to read the texts that they will need to use in order to provide a base to their research or they will not be able to do some simple mathematic operations (as multiplication or division) because they will not have learnt them yet. Also, the thinking skills that they may need to elaborate the hypothesis and to think about the variation of the characteristics that may appear inside the experiment.

On the other hand, in practical problems the motivation is not a problem, as the students will be able to solve a problem probably connected to their lives, if the teacher has chosen correctly the problem, and the students will work with their partners, what will be challenging for them, creating a learning situation where the students will not require the books in order to learn, they will speak from their own experience and will argue the different ways to solve the problem, allowing them to argue if some of the ways are better than the others or if they have chosen the best solution. The theoretical problems will be also engaging, but they are not suited for primary education.

1.6- Scientific argumentation: Combining science with language and defending our results.

Following these problems, the teachers may also find something new to follow with the sequence in order to make it better for the students. One example of this is to introduce the scientific argumentation in the sequences.

Argumentation is other of the things that this methodology may introduce in the classroom. As this methodology includes the resolution of problems, talking specially about practical problems at this point, and in most of the cases, they will have more than a correct solution, which allow the students to decide which of their solutions they would like to show to their partners as the best solution, after the different groups have reached different outcomes from their experiments, leaving a space in the classroom for fact discussion and argumentation.

These cross-curricular contents, argumentation and experiments, would also give another approach to the class, as it will mix contents from language and science, making easier for the students to utilize these contents, learnt for the researching purpose in the language class, in order to develop properly an argumentative text when they are asked to. It also opens the possibility to work, whether in Language or Science, to use this and work with the scientific text, using the evidence and the argumentation as a base.

But, will argumentation be a good resource for science class? Or even, will a science teacher be able to carry activities based in language and communication rather than science itself? Even if this teacher teaches both subjects, it may be a little difficult to mix the contents.

Cross-curricular lessons are not as rare as they were 10 years ago, and nowadays, with the appearing of CLIL (Contents and Language Integrated Learning), an English teacher may also become a Science teacher. And now, more than ever, it is useful to collaborate with the teachers from other areas, as language in this case. Creating these activities may be quite challenging in the first moment, but after a few tries adjusting the contents of language and science won't be more complicated than creating a usual sequence of activities.

Before discussing argumentation in this kind of sequences, let's ask ourselves a question: What is argumentation? According to the Cambridge dictionary (Cambridge, 2014 http://dictionary.cambridge.org/) argumentation is a set of arguments used to explain something or to persuade people, and this is usually used in every field of sciences, as scientist do not only need to prove that their theory is correct, but also to demonstrate that it is better than the theories provided by the rest of the scientists.

An example of this can be seen using for example the theories of Darwin and Lamarck, in some cases Lamarck's theory seems to fit well, as in the giraffes, but it is easy to see a flaw in his theory using other kinds of animals, as platypuses, which are animals whose characteristics are difficult to explain Lamarck's point of view. However, Darwin's theory is universal and can be used with every animal or plant, making the Lamarck's theory to fade. The argumentation here will be in order to prove or disprove the Lamarck's theory.

An argument is the result of coordinating a conclusion with the evidence that supports it, and that it is formed by three essential elements: the conclusion, the evidence and the justification. It may also include the basic knowledge, the moral qualifiers and the conditions of refutation. (Puig, 2011)

These are the parts that for an argument (Jimenez, 2010):

1- Conclusion: The statement of the knowledge that is pretended to prove or refute. This may include the causal explanation of phenomena. We call hypothesis to the statements that are in a process of test.
2- Test: Fact, observation or experiment used to evaluate a statement. Sometimes data is used as a synonym, but its meaning present some differences due to the context. We call data to the information, magnitudes, quantities or testimonies, qualitative or quantitative in order to reach to the test of a statement. We use evidence to show that a statement is true or false. It is its role in the situation, integrated in a causal explanation what makes us consider it as evidence.
3- Justification: links conclusion and evidence. Its role is to show how we can reach the evidence from the data. Even if for a teacher it may appear obvious how to join the data with the evidence, sometimes the students will have problems with it.

Also in the primary education curriculum, in the physical world's knowledge and interaction competence in the basic competences area we find that this text states that this competence "also implies the application of some notions, scientific concepts and scientific theories previously comprehended. Which includes the progressive ability to put into practice the processes and attitudes from the systematic analysis and research: identify and plan relevant problems, make observations… Plan and contrast different solutions…" (DF 27/2004) or later in the same point "obtain, assimilate, evaluate and communicate conclusions in different contexts". In this way, we may find that this is a hole in which we can use argumentation.

We can use scientific argumentation in order to (Jimenez, 2011):

1- Evaluate, as the students should be able to defend their explanations, they should see what their strengths are and what their flaws are and act according to it. If they are working in groups, this kind of evaluation can make the difference between the students that were really interested in the investigation and the ones who were not.
2- Emphasize the context, as a different solution may be plausible for the same context, the students should use the evidence left in the context to improve their arguments.
3- Increase students' motivation. This activity implies talking, comparing, contrasting, moving, it can even be done between different groups with different solution in the same problem.

And, therefore, scientific argumentation is also one of the possible resources that a teacher can use to improve the scientific competence of their students as in the OCDE definition, which was quoted before in this document (OCDE, 2006).

In this way, argumentation can be considered as a way to improve the students' scientific competence because, as in the scientific method, you need to prove and argument that the solution is useful. Also, this will help the students to imply themselves in ideas related to sciences, as they will need to read and understand the scientific facts in order to provide a correct argumentation.

In addition, according to Jimenez, and Puig (2011) argumentation can be a factor that contributes to the development of the critical thought capacity, the development of independent opinions, which is very useful nowadays, as we live in a society filled with advertising, to make easier for students to express their thoughts, which usually remain in their heads. This also will allow them to see that in order to express scientific knowledge they will need to provide evidence that supports it.

But, there are still some problems for the teachers, as they are not used to this kind of methodology, and the first problem that they may find is the following: "*How can we make a group of young students to argument?*"

Students, at least in primary education are curious, and they are able to give their opinions. After an activity, as an experiment, the students will be most likely interested to talk with their partners. We can use that as a resource, asking the students, in order to start the argumentation as a discussion.

Argumentation is not a simple process that can be done once and then be forgotten. Argumentation, as a most of the abilities that are taught at school need repetition, and in this case, as sciences have a very wide variety of topics, this should be done in various situations (Puig, 2011).

Different situations can lead to very different points of view, and a wider knowledge, even promoting discussion. In this way, argumentation will be a good activity if it is continued through time and not forgotten and used only once (Puig, 2011).

This will also be good for students because they will take the main role and participate actively in the acquisition of their knowledge, as they will need to think about their arguments for example, which criteria make an argument better than other? Or, what constitutes a valid piece of evidence? This learning depends more in the student than in the teaching of the different components of an argument. However, knowing these elements can be helpful for the students which will need to analyze the evidence that supports a conclusion and for the teachers in order to create the activities (Puig, 2011).

So, summing up, in this document I have tried to show how a practical methodology in class would help to reach the development of the student's scientific competence within their stance at school.

Also, I wanted to state how research based teaching helps students to get a higher level in the scientific competence that the OCDE considers as one of the competences that should be taught at school, and this sequences will fit at school, making easier for the students to imply themselves in sciences and reaching higher levels of learning in the Bloom's revised taxonomy and analyzing some of the activities adequate to this methodology that can be useful for the development of the scientific competence. Some examples of this are the practical cases and the scientific argumentation.

And, in order to justify all this I have shown that primary students are also capable to solve scientific problems and are able to participate in this kind of activities without cognitive impediment analyzing the characteristics that can be used in this problems from the Piaget's stages of development in primary education, and, from all this, these are my conclusions:

1- The science subject in Spain has never been considered as an important, based on my experience, and the formation that students receive at school, and even the teaching degree students at university is not enough to develop the scientific competence and allow the students to be independent and able to investigate and imply themselves in science, as some students in teacher degree consider it as useless for their job.

2- A researching based sequence, inspired in the learning by discovery approach can lead to a better understanding of science, encouraging children to research, find conclusions and feel that science is something that is not so abstract.
3- A practical methodology can lead to the use of higher thinking skills and to a better learning as the student will need to use higher cognitive strategies (Understanding, applying and analyzing) than memorization.
4- Students from primary education have the cognitive level necessary to carry out research and the teachers should choose appropriate problems for the children according to their characteristics and cognitive level.
5- Argumentation exercises can be a useful exercise for the class, as it includes high cognitive strategies, is an important part in sciences and allows the students to make the defense of the solutions they have found for their problems, improving not only their scientific knowledge and strategies, but also their language acquisition.

So, we should expect that implementing active methodologies in the teaching Sciences would improve the results of students towards the acquisition of the scientific competence and their general knowledge and interest about sciences.

To test this, I will teach two subjects using two contrasting methodologies (transmissive, active) and compare the outcome, in terms of content retention and cognitive level reached.

2 - Practical work:

Based on the theoretical framework and the ideas of the experts in science didactics, I have created a series of activities. These are my objectives

Objectives:

- Demonstrate that a research based methodology can lead to better results in the tests of scientific competence proposed by the OCDE. This will be proven using tests that will measure the scientific competence in a similar way than the OCD.
- Compare the resultsof a practical and a theoretical methodology in a test which measures the first four levels of the Bloom's taxonomy.

2.1 - Contextualization:

In this practical work, three different groups of students have participated. Let's see their characteristics.

2.1.1 - The students

They are three different groups of students from the 6^{th} grade of primary, what is to say that they are between 11 and 13 years old. As the course started in September and we are now in April, most of the students are 12 years old.

Their age and results in class allows us to jump to the conclusion that they are between two different stages of development, the concrete operations stage and the formal operations stage (McLeod, 2009), so it is possible that in most of the cases we find a mixture of the characteristics of both stages of development. As the problems they are going to solve are connected with reality, the students which present characteristics from the concrete operations stage will not have many problems, cognitively speaking, to solve these problems.

2.1.2 -The school

This part of the project will be held in the school “Santa María la Real – Maristas” of Pamplona. Among the characteristics of the school, it is interesting to say that this school is a state-founded school and that the families that want their children to go here have to pay a quantity of money each month, so in the vast majority of the cases the children that go to this school do not have to worry about the food or their basic needs.

This school has has been in Pamplona for more than a century, and also, in many cases the parents of the students were students of this school in the past. It is also a school that is worried about languages and that with the time is adapting its methodologies according to newer tendencies, as projects, digital support for some of the contents of their subjects or subjects in other languages, as science, arts and crafts or Physical Education.

However, in some of the subjects, and maybe due to the age of the teachers and their way to impart the lesson, we can still find some traditional teaching in the classroom. This is the case of science in Spanish class, which is very different from the science in English class, where the lessons include a practical approach, often experiments made by the teacher, experiments made by the students and a practical problem, usually related with real life situations.

In Science in Spanish class, we often find that the lesson is imparted in a more traditional way, where the teachers explain the lesson to the students, the students take notes and in the end of every topic there is an exam where the students try to show their knowledge in the area.

2.2 – Practice in action

2.2.1 - The units:

In the third term this school had programmed the Science class to study the social sciences, making tougher to elaborate practical exercises, as social sciences do not have so more many problems that the students can solve easily using only the social sciences.

The climate, mountains and rivers from Spain: in this topic the students learned the main mountain ranges, rivers and climates that appear in Spain. In this topic the main focus was in learning maps, as the Spanish geographical map. Everything in this topic could be represented in a map. Then, talking about factors, the factor that had a little more weight was the climate.

After this topic, the next one was *the climate, mountains and rivers in Europe.* As in the previous topic, the students had to learn the main mountain ranges, rivers and the different climates that appear in Europe, but in this topic the children also had to learn about political geography, as they had to locate in a map the 28 countries in the European Union. So, in these two topics I would have had problems in order to introduce a practical problem due to the difficulty to create an adequate problem.

However, a while after starting these topics the students of 6th of primary were on an excursion to the biomass power factory in Sangüesa, Navarre, which allowed me to find a context to introduce again the topic of *renewable energies*, topic that appears in the curriculum and allowed me plan some practical exercises. This topic had been studied by this class before in the first evaluation, so it was a topic known by the students, but it was convenient to revise it.

As they were studying the climates and geography of Europe, the problem about renewable energies should be linked to that topic in order to make them think and not disconnect from it. So, the easiest way to achieve this was to create some problems where the students were given different situations based in different parts of the European geography and they had to decide which kind of renewable energy should they use in that place.

Before planning these situations, I had to see what kinds of renewable energies they knew, and after asking their teacher, he told me that the students of 6th of primary had studied the solar energy, the hydraulic energy, the tidal energy, the biomass and the wind energy.

As the students were going to go to visit a biomass plant, I decided to go with them to see how this kind of energy was explained to them and in order to know a little bit more about the fundaments of this energy. In the biomass plant the guide explained them that the rests of the harvesting arrived there in trucks, and then they were dried and burnt in the same factory in order to produce energy. Then the guide explained them the importance of using renewable energies instead the non-renewable energies.

2.2.2 Methodology:

In the contents related to the European climates, the students will receive a theoretical formation. The teacher will explain the topic to the students basing everything he says in their textbook. The exercises and the questions that the students will do will be the ones in the textbook.

The part of the renewable energies will be a series of practical problems. These problems will be divided in two activities:

In the first activity, the students will solve a problem related to the renewable energies topic and then they will use arguments to defend their answers.

To be evaluated, the students will need to complete a test, divided in different levels according to the Bloom's taxonomy (Anderson and Krathwhol, 2001). In this activity, the students will be evaluated of two topics: European climates and renewable energies. The results will be divided in the levels of the Blooms taxonomy.

After Easter break, the children took part in this second test. I wanted the children to have forgotten the lessons with their teachers and confront this test with what they had already learned, without studying or looking at the book, as the main reason I did this test was in order to know how the students think, what have the students learned and if the results in the renewable energies part were slightly better and a correlation could be found between them and a practical methodology.

2.2.3- The problems:

In order to create appropriate problems that would be able to engage the students and make them think, joining the things they knew about energy and European geography, I had to choose some places in Europe, and give the students some data, which then they would need to use as evidence in order to argument which was the best kind of energy for the inhabitants in the area, so, for example, they would need to discard the tidal energy if their situation was located in the center of Poland, as there is no see there.

Also, as I have stated in the theoretical introduction in the problems, as in most practical problems, there was not an only solution, they were open questions, if the students gave correct arguments they could choose from a range of solutions. Obviously, there were some kinds of energy that could be easily discarded in some of the problems, as the example in the previous paragraph, but in most of the cases there were arguments to choose from more than one of the kinds of energies that they knew.

In the beginning of the problem class I started activating their previous knowledge, making them remember in order to know what they remembered from the topic of energies and renewable energies, which they had finished a long time ago. This was obvious during the review of their previous knowledge.

In order to do that, I asked the students to raise their hands to the questions I made. I asked them if they remembered what the energy was, what we use energy for and the types of renewable and non-renewable energy. In this point I made sure to write in the blackboard the types of renewable energy, as after this, they were going to need to know them to choose the appropriate kind of energy for their problem, and in some of the groups they may not remember all the kinds of energy.

The objective of these activities was to solve the problems developing in this way the higher order cognitive skills, practicing for the biggest test that would include contents of energies and climate. Other objective was for them to remember the contents about energies. In order to do that, the students would need to solve a problem related to renewable energies and climate.

Also, before starting with the activity, I explained them how they needed to solve the problem providing arguments, as they were not use to this kind of exercises, and that after the groups finished with the activities, one by one, they were going to come in front of the class and explain the problem they had to solve, the solution they had chosen to the problem, and the arguments that supported that solution.

The students were divided in groups of four or five people after that and they soon started to work and read the problems. In some of the groups it was a delightful experience to see how they thought about different solutions and started arguing which one was better, usually calling me for help. In those cases, I told them to search for data in the text, look at the maps in their science books or to think it in group and then vote which one was better.

This exercise was prepared thinking in an answer for each situation. However, in these problems there were some other possible answers, so, the questions were open. The solutions were considered correct depending on the arguments the students provides.

It was also interesting to compare how the students from the different groups gave arguments. In most of the groups the argumentation was based in the use of the data in order to provide a solution, but, in some of the groups, the students gave arguments against the other kinds of anenergy, discarding them as a solution, which is another way to argument. After this part, we will focus in the arguments that the students provided. Making the students think about arguments was a really interesting experience. It is clear that argumentation and science are two topics that can be linked together (Jimenez and Puig 2011).

After the time to solve the problems, the groups had to come, one by one, to the front of the class to read their problem and to provide a solution while the rest of the class listened. After that, the rest of the groups provided a feedback.

In some of the cases, the feedback they provided was that they agreed completely, but, in other occasions there were people that said “I would have chosen another type of energy” providing their arguments after that.

It was really interesting to see how this kind of feedback was provided, as the students from the rest of the groups had not had time to think about the problem that the other group had and their solution was based in quick thinking. Almost every student in the three classes made comments to their partners, as they have worked in groups more than once, and most of the time the students showed respect to their partners. This may be because the students were engaged, and, as it was stated before, motivation is one of the elements that a teacher wants to incorporate using these problems (Cañal, 2007).

In some of the groups, the students used different techniques to give a solution to the problem and communicate it to the rest of their partners. Most of the groups just stood and read their solutions to the rest of their partners. Other groups, made drawings in the blackboard to show their partners how they imagined the scenario that was provided to them in order to contextualize it a little bit their problem to their partners. Another of the groups, as the problems were structured as a letter to the classroom wrote a letter in reply to tell the person that had written the letter which the option they considered more adequate and even was asking this person if there was something else they could do in order to help.

In the end, I consider that with this exercise the students really got involved in the process and enjoyed to do different activities than they are used to doing. Also, I have observed that the groups were very hard working and interested in the activity, as they participated and did it really good although they were not used to doing practical activities like this. I think it would be useful to introduce more activities like these in class.

I proposed six practical situations, which will be analyzed in the following section (results).

2.2.4 – Evaluation:

The students will need to complete a test (Anexo 1), divided in different levels according to the revised Bloom's taxonomy (Anderson and Krathwhol, 2001). In this activity, the students will be evaluated of two topics: European climates and renewable energies.

Table 1. Evaluation criteria. Levels refer to the revised Bloom's taxonomy.

	European climates	Renewable energies
Level 1 - remembering	The student is able to answer correctly to at least one question related to the topic	
Level 2 - understanding	The student is able to provide more than a reason to like a climate.	The student is able to provide arguments for the renewable energies or against the non-renewable energies.
Level 3 -applying	The student is able to understand climate factors to provide reasons for a person to stay or abandon an area for its climate.	The student is able to provide reasons for the use of one concrete kind of renewable energies in a concrete territory.
Level 4 - annalyzing	The student is able to deduce the climate in one area taking into account data of the area and is able to explain his choice.	The student is able to decide which kind of renewable energy is better in a situation taking into account the characteristics of the place and providing arguments for that.

2.3 – Results

2.3.1 – Situations

These were the situations realized in class:

Situación 1

Me llamo Kjell, tengo 10 años y me interesan las energías renovables, vivo en el norte de Noruega, cerca de las montañas, dónde no hay mucho sol y los inviernos son muy duros. Normalmente, más de la mitad de los días del año tenemos en casa una estufa que funciona con leña. Me gusta mucho sentarme cerca de ella y leer en los días más fríos.

Mi pueblo es pequeño y por él transcurre un río corto. Me lo paso muy bien en invierno patinando con mis amigos.

Mi padre es leñador, y trabaja cortando madera en los bosques cercanos a nuestro pueblo, pero últimamente está preocupado porque los bosques empiezan a desaparecer debido a la tala indiscriminada.

Ayer el alcalde de nuestro pueblo inició una campaña para recoger fondos con el objetivo de abrir una planta energética, dejando a los adultos votar sobre el tipo de planta a construir. Sin embargo, hay aún muchas dudas sobre el tipo de planta que debería construirse.

¿Qué tipo de planta energética creéis que deberíamos construir? ¿Por qué habéis elegido esa planta?

Respuestas:

6ºA

Respuesta: Eólica

-Eólica porque vive en las montañas. Los inviernos son duros y hace poco sol

- La mareomotriz no se puede porque está lejos del mar

- La solar no se puede porque no hay mucho sol

- La biomasa no porque recolectan poca leña

- Hidráulica no porque se congelan los ríos y no son de mucha altura.

6ºB

Elegimos el viento porque hay una corriente fuerte de viento. Además no hay mucho sol, los bosques escasean, están en la montaña y están lejos del mar, la biomasa es escasa y el agua del río se congela.

6ºC

Biomasa: Porque la biomasa produce calor y allá se quejan de que se están acabando los bosques de tanto talar porque como allá hace mucho frío necesitan una estufa que funciona con leña.

Hemos elegido la biomasa porque aunque allá no haya cultivos puede producirse biomasa sólo con restos vegetales, así ya no tendrían que utilizar más leña gracias a que la biomasa produce calor.

Situación 2

Hola a todos, me llamo Joanna, y vivo en Polonia. Polonia es una tierra que se encuentra dentro de la gran llanura europea, así que no hay muchas montañas cerca de donde vivimos.

Mi familia se ha dedicado desde hace mucho tiempo al cultivo del cereal, por lo que en estos momentos tenemos una porción muy grande de terreno donde cultivamos ciertas plantas como trigo, centeno o cebada, las cuales vendemos en el mercado. Muchos de nuestros vecinos también trabajan con el cereal y la mayor parte de nuestro país es terreno rural utilizado para el cultivo.

Por nuestros terrenos, no pasa ningún gran río, salvo el Orava, afluente del Danubio, que no lleva un gran caudal de agua. Este río a veces se congela durante los inviernos.

Este año, desde el gobierno del país se ha entregado una subvención a aquellos municipios que deseen construir una planta energética, siempre y cuando esta sea de energía renovable, y se ha abierto una comisión con los vecinos para intentar decidir qué tipo de planta debería construirse aquí. ¿Podríais prestarnos vuestra ayuda? Tened en cuenta que es importante razonar por qué elegiríamos este tipo de energía.

6ºA

Energía: Solar

¿Por qué? Porque donde vive no hay muchas montañas para ser eólica, no hay ríos con caudal para ser hidráulica y no hay mares para ser mareomotriz. Tampoco es biomasa porque no hay restos orgánicos.

6ºB

Hola Joanna:

Somos un grupo de un colegio de España. Vamos a intentar ayudaros para que podáis con la paja tener electricidad y abono para las plantas para poder tener una vida mejor.

Queremos mandaros dinero para que podáis construir una planta de biomasa y tener una vida mejor. Entonces, esperamos que os sirva de ayuda lo que hemos mandado para que podáis hacer una vida como nosotros. Tenéis que construir una planta de biomasa en vez de una hidráulica porque tenéis mucho cultivo y el río que tenéis cerca se congela.

Un saludo, Los alumnos de 6ºB.

6ºC

Respuesta: Biomasa por ser una zona rural donde se utiliza mucho y hay muchos deshechos que se pueden reutilizar para otras cosas.

No:

1- Solar: no, porque no hace mucho calor debido a su clima
2- Eólica: porque no hace mucho aire
3- Mareomotriz: por estar en el centro del continente
4- Hidráulica: por sólo tener un río que además es de muy poco caudal.

Situación 3

Hola amigos, dejad que me presente, mi nombre es Román, y procedo de Eslovaquia. Vivo en una ciudad cercana a Bratislava, la capital, desde la que puedo apreciar el Danubio en todo su esplendor.

Mucha gente dice que el Danubio es el río más caudaloso de Europa, pero eso no nos impide a mi padre y a mí ir a pescar al curso alto del río. Si tenemos suerte pescamos algún salmón o algún que otro siluro, pero es algo muy difícil de hacer, ya que, aunque no lo parezca, los peces son muy fuertes. Me encanta ver el Danubio en primavera cuando más agua lleva. A veces causa un estruendo mayor que el de los coches.

Aunque en nuestra ciudad no veamos mucho el sol, ya que aunque sea verano o invierno es muy fácil ver que está lloviendo y las precipitaciones son abundantes. Además, al estar bastante alejados de la cordillera más cercana, los Alpes, nunca hay grandes vendavales.

Este año, se ha llevado a cabo una campaña de concienciación entre todos los habitantes de esta ciudad y los pueblos de alrededor, y hemos visto que dependemos demasiado de las energías no renovables, como el gas que viene de Rusia, por lo que hemos tomado la iniciativa y decidido que debemos construir una planta de energías renovables. Sin embargo, todavía no tenemos muy claro qué tipo de planta podríamos construir. ¿Tendríais alguna idea para ayudarnos? También me ayudaría que me dierais razones para ello, ya que me ayudaría a convencer a mis vecinos.

Respuesta:

6ºA:

Hemos pensado que la mejor planta de energía renovable en Eslovaquia es la planta hidráulica porque el Danubio es el río más caudaloso de toda Europa y contiene mucha agua y sobre todo hay muchas precipitaciones en forma de lluvia.

Hemos pensado que la solar no es la idónea, porque en el papel pone que en Eslovaquia no se ve el sol. La eólica porque no hay muchos vendavales. Mareomotriz porque en Eslovaquia no hay mares. La biomasa porque la hidráulica tiene todas las condiciones para producir mucha energía.

6ºB

Presas y embalses:

Porque llueve mucho y está cerca del río más caudaloso de Europa (Danubio).

Desventajas: Hay muchos peces que se pueden ver afectados por las presas y los embalses.

También podemos hacer una planta hidroeléctrica para producir energía y una planta mareomotriz para aprovechar el movimiento de las masas de agua que se da cuando sube y baja la marea y así se aprovecha para generar energía y las presas y embalses que se almacena el agua que luego se dejará caer desde una altura determinada para aprovechar su movimiento.

6ºC

Planta hidroeléctrica

Porque el Danubio es muy caudaloso y llueve mucho, por lo que el agua corre muy rápido y al haber precipitaciones el caudal aumenta de una forma irregular.

Situación 4

Hola a todos, Me llamo Cornelia, y vivo en Rotterdam, una de las ciudades más grandes de Holanda. Como muchos habréis oído, en Holanda se trabaja mucho con el cultivo de tulipanes, que es la flor típica de nuestro país y la mayoría de la gente realiza sus desplazamientos en bicicletas, aprovechando el poco relieve que tiene esta zona. Podemos decir que estamos muy concienciados en ayudar a mejorar el medio ambiente.

En nuestro país no encontramos caudalosos ríos o altas montañas y nuestro clima es bastante húmedo, pero podríamos destacar la cercanía al mar. Casi todo el país está a muy pocos metros sobre el nivel del mar, y además hay zonas que incluso se encuentran algo por debajo del nivel del mar. Es algo muy curioso. Por lo tanto, debido a la cercanía al mar y la baja altitud de nuestro terreno, es muy fácil sentir la brisa marina, que llega a convertirse en un viento bastante fuerte.

Este año, dentro del programa de energías renovables, hemos decidido que sería conveniente construir una planta que generara energía limpia, ya que de este modo nuestro impacto ambiental sería mucho menor, pero no tenemos muy claro qué tipo de central deberíamos construir, ya que existen muchos tipos.

Vuestra ayuda nos sería de gran utilidad para llevar a cabo este proyecto, así que me gustaría pediros vuestra opinión: ¿Qué tipo de central creéis que vendría bien construir? Y ¿en qué os basáis para decir esto?

Respuestas:

6ºA

Mareomotriz debido a la cercanía del mar

Biomasa debido al cultivo de tulipanes (de combustión)

Eólica debido a los fuertes vientos que se producen, serían capaces de mover las grandes aspas de los aerogeneradores y algunos terrenos se encuentran por debajo del nivel del mar.

La mejor es la Biomasa porque como hacen grandes plantaciones de tulipanes. Aquellos que se estropeen pueden utilizarse en una planta de biomasa.

6ºB

Creemos que es mejor utilizar las plantas mareomotrices, de hecho, es buena porque hay una gran cercanía al mar. ¿En que nos basamos para esta opinión? Es que, con la energía mareomotriz usando las olas y la marea aprovechamos la disponibilidad que tenemos del mar.

6ºC

Creemos que las mejores opciones son la eólica y la mareomotriz.

Debido al relieve de este país:

Eólica: En este país las corrientes de aire procedentes del mar generan vientos muy fuertes con los que se podría aprovechar y mover las aspas de los aerogeneradores. Con todo el movimiento de las aspas se podría generar mucha energía limpia.

Mareomotriz: Los países bajos tienen una larga costa cara al mar del Norte. Las corrientes marinas de este mar son abundantes y fuertes generando olas. Con esta energía podemos aprovechar mucha energía limpia.

Situación 5

Hola chicos, me llamo Antxon, y vivo en un pueblo cerca de San Sebastián, en el País Vasco. Desde mi casa puedo contemplar el mar además de los Montes Vascos, y más de una vez al mes voy con mi familia a San Sebastián a pasar el día. Más de una vez hemos disfrutado viendo a los surfistas que vienen al Cantábrico a disfrutar con las grandes olas que hay en él.

Lo único malo que puede tener vivir aquí es que muy a menudo llueve, aunque eso nos permita ver una gran cantidad de bosques por la zona. De vacaciones solemos ir algunos veranos hacia la zona de Valencia, ya que es una zona muy calurosa en la que la mayoría de los días son soleados.

Últimamente en nuestro pueblo se está hablando de construir una planta de energías renovables. El alcalde ha planteado que seamos los propios ciudadanos los que decidamos qué tipo de planta deberíamos construir. Hay que tener en cuenta que vivimos muy cerca del mar y que tampoco hay mucho espacio para construir.

¿Podríais ayudarme a pensar qué tipo de planta deberíamos construir? Y ¿Qué razones deberíamos mandar al alcalde?

Respuestas:

6ºA

Planta eólica

Porque los Montes Vascos son altos y hace mucho viento, así los aerogeneradores funcionan. Además cuesta menos dinero y tiempo que hacer una planta mareomotriz.

Una planta mareomotriz también es una buena idea, pero cuesta mucho construirla y durante las obras matan a muchos peces.

Hidráulica no, no vamos a construir un embalse en el mar.

Los aerogeneradores tienen su parte mala porque matan aves.

6ºB

Estimado alcalde:

Hemos leído su carta y creemos que sería conveniente poner una mareomotriz. Ya que está cerca del mar. Vamos a darle algunas razones por las que deberías poner una mareomotriz:

Porque en esta zona hay bastantes olas, para que los ciudadanos puedan tener empleo, para no tener que coger energía desde muy lejos, para poder ahorrar dinero.

Nos despedimos con un cordial saludo.

6ºC

Mareomotriz, como el pueblo está muy cerca del mar, y no hay mucho espacio para construir.

Solar no, porque llueve mucho.

Eólica no, porque si lo ponemos en los montes no llegaría muy bien la señal.

Biomasa no, porque no hay mucho sitio para construir.

Hidráulica no, porque no hay mucho sitio.

Situación 6

Saludos amigos. Mi nombre es Erini, y vivo en la llanura de Mesará, en la isla de Creta. Esta llanura es una llanura histórica, ya que la civilización griega vivió en este lugar mucho antes de que yo naciera. Creta es una isla maravillosa, rodeada completamente por el mar Mediterráneo. El verano es muy soleado, y mis hermanos y yo disfrutamos en las costas de Creta.

La mayor parte de la llanura se utiliza para el cultivo de secano, es decir, plantas que no utilizan mucha agua, como cereales, la vid o el olivo. Esto es así porque no hay suficiente agua para plantar otro tipo de cultivos. Es más, en esta isla muchas personas se dedican a la agricultura, pero si pensamos que la isla no está muy poblada y es bastante pequeña, nos encontramos que no hay tanta gente trabajando en ello. También hay varias zonas de la llanura que son infértiles, y por lo tanto no podemos cultivar nada.

Al ser una isla poco poblada, con menos de un millón de habitantes, entre todos hemos pensado que podríamos vivir utilizando únicamente energías renovables, pero todavía no tenemos muy claro qué tipo de energía sería mejor utilizar. ¿Qué opináis vosotros? Sería mejor si me dierais alguna razón.

Respuestas

6ºA

Planta solar (paneles solares)

En las zonas infértiles de la llanura de Creta dependiendo de los kilómetros cuadrados infértiles podríamos poner un número indeterminado de paneles. Ya que hace mucho sol se podría absorber mucha energía. Tampoco habría que poner muchos porque la población de creta no llega al millón y un gran presupuesto no sería necesario.

6ºB

Sol: Nosotros elegimos el sol, porque han dicho que los veranos en Creta son muy soleados y podemos conseguir muchísima energía con los paneles solares, que los haríamos con materiales reciclables que conseguiríamos en un punto limpio.

Los pondríamos en los campos infértiles para no estropear los cultivos. Los haríamos tan grandes como el ancho de esta clase.

6ºC

Hemos elegido las plantas solares:

Porque está en el mediterráneo y el clima de ese lugar es muy cálido durante todo el año. La planta de biomasa no porque se necesita suelo fértil y casi no hay.

2.3.2 - Analysis

In this activity, the children needed to use high order thinking skills from the fourth level of the Bloom's taxonomy. In the written arguments there are some good reasons to support in determined cases the solar energy, or in the rest of the cases the kind of energy they have chosen. But also, there are some arguments that are not reflected here as they appeared orally in the classroom, and where not recorded in the paper here are some examples:

In situation 5, a group of students decided that tidal energy was not a suitable source of energy because they knew another variable that I had not taken into account when I was preparing the activity. As the teacher explained them in autumn when they were talking about energy, Spanish shoreline is not suitable for tidal power plants, as they are not deep enough and it will be difficult to build them and make them profitable. I did not know that, when I was preparing these situations and the groups that had this situation in the other two classes did not know it either. It was a surprising fact for me, as I had prepared that situation specifically for them to choose the tidal energy, without taking into account that variable, so this was completely unexpected for me.

Another example of this happened with a group of students that were working with situation 3. They decided to use the biomass energy, although the Danube was a suitable place to put a power plant, they said that they did not want to put there a hydraulic power plant because that would mean to destroy the natural beauty of the countryside, and that they would choose a biomass plant although they would need to dry the rests of the crops.

It was also interesting in some of the groups, which repeatedly asked me if they could choose two of the solutions as they saw many possibilities and both kinds of energy were considered suitable by them, question that allowed me to tell the groups that in this activity there was not a fully correct solution and that depending on their argumentation they could find different solutions. Even with the last group of students I could tell them that in the previous classes there were different solutions to the same problem and that both solutions could be considered correct as the argumentation their partners gave was correct.

Also, another really interesting fact was that the students were really engaged from the first moment and they even wanted to consider more variables. For example, one of the students asked me: “if they have an agriculture based economy, would they be able to afford to construct a solar plant?” or, another student asking me “which is more efficient, a biomass plant or a hydroelectric plant?” in these questions, the students showed a lot more interest that in the average science class that I had been seeing for weeks, and even when they were working in groups, most of the students had a different opinion, inside the groups.

In some of the cases there, there was a big argument inside of the group, where half of the people thought that one kind of energy was the best for that situation, while in other groups, I was able to see how with only one of the children defending an opinion, he convinced the rest of the people ion his group about his decision, telling them about the evidence he found inside the data, to show their group that he had reasons to choose that kind of energy, in the end being able to convince the rest of his partners. In fact, this exercise will be also useful in the language area as well, as the students were also practicing aspects from the language.

2.3.3. EVALUATION

As it was stated before, the evaluation was in form of a test.

This test, as it is easy to deduce, is not a normal test, as the ones they have been doing in the rest of the subjects. In this tests there are questions of both of the topics they have been studying, European geography and climate, and renewable energies. And the questions were in very different levels.

Taking into account the bloom’s taxonomy, I wanted to see how the students were able to perform in the first four levels of the Bloom’s taxonomy.

So, as the students were able to reach at least the fourth level pf the Bloom’s taxonomy in the moment they had studied about energy, now it was the time to check if they continued being able to reach again that level. And, in order to compare the methodologies, it should be useful to check how far in the Bloom’s taxonomy the students are able to reach without help. As it was stated in the theoretical part, a practical methodology, which included problem solving activities, would be useful to achieve this.

In theory, at this point the students should have a better performance at the topic of renewable energies, as they have studied it in a more meaningful way than European geography, having problem solving activities, argumentations and even a visit to a power plant, which provided a good context for learning. This will be proved or disproved after analyzing the results of the test.

So, the expected solutions for this exam are that most of the students will reach good levels of performance in both topics on the first two levels of the Bloom’s taxonomy in order to reach those levels the students do not need of a lot of specialized practical activities or extra work at school, they need to study, memorize and understand. But also, there should be a group of students that will reach a level three or four in the Bloom’s taxonomy in the part of the renewable energies, as the students have not only studied the characteristics of the renewable energies, but also practice and use their knowledge about them in order to solve a real life problem.

There will be also some students that will reach the higher levels in the Bloom’s taxonomy in the topic of Europe’s geography and climate, as some of the students may be more interested in these kind of topics than in the other one, or because they have some kind of special motivation to study this topic, for example, if a student is going to go to spend Easter in a cruise ship around Europe, they may have been interested in learning this topic in order to know what to expect in their journey. It is useful to remember at this point that these are factors that contribute a meaningful learning. Relevance, motivation and significance can lead to a meaningful learning.

But, in theory, there should be more students that reach the higher levels of knowledge in the Bloom’s taxonomy in the energies part than in the geography part.

Other of the factors that may take a role in the results can be the awareness of the test by the students. In the first classroom it is sure that between the students no one will know anything about the test , but in the second or third class, as it will be impossible to do the test in the three classes at the same time, some of the students of the first class may have said the students of the other classes that there was going to be a test and some of the people of the other classrooms may study in order to reach a better qualification, although, talking in practical skills this will only affect the result in the first two levels of the Bloom's taxonomy.

In the last part of the test, I added a table in order to tick the levels the student had achieved. This was in order to show them their tests and explain their results.In this test, most of the questions of the test had more than a possible answer, as in most of the scientific problems. Nevertheless, in some of the questions, regarding especially those from level one only had one possible answer.

These were the criteria in order to achieve the levels in the test:

In the European climates part:

1. 1st level: The students should answer correctly to at least to one of the questions.
    1.1. In the first question, in order to have it considered as correct, the students needed to have at least perfectly one of the parts of the exercise, and in the other part they could have a mistake only
    1.2. In the second question, to answer it correctly, the students needed to have at least two of the three most important ideas (deciduous trees, meadow and shrubbery) and examples
2. 2nd level: In order to achieve the second level, the students had to give at least two correct reasons to the question of the second level.
3. 3rd level: in order to get the third level, the students needed to provide to two valid answers to the question of the third level, in this question, as I had explained to the students, I only accepted the reasons related to climate, not the reasons related to culture, geography or economics.
4. 4th level: to achieve this level, the students needed to guess correctly the climate, providing at least one reason to justify why they think their answer was the correct answer and at least one reason in order to justify that the climate exposed in the problem was not the polar climate.

In the Renewable energies part

1st level: in order to achieve the first level, the students had to answer correctly to at least one of the questions for this level

In the first question, the students needed to say at least eight kinds of energy, from the ten kinds of energy that they had studied in to be considered correct

In the second question, the students needed to write at least five of the nine main ideas for the three kinds of energy. These ideas were, renewable energy, solar panels and comes from the sun for the solar energy, renewable energy, comes from the tides or movements of big masses of water, and tidal plant or non-renewable energy, comes from minerals like uranium or plutonium, nuclear central for nuclear energy.

2nd level: To get this level, the students needed to provide at least three good arguments for the use of renewable energies, or against the use of the non-renewable energies.

3rd level: in order to achieve this level, the students had to give at least two reasons, based on the territory, in this question, that was very related with the activity done a month before, the students had to give reasons as this: "as in Navarre there are a lot of forests or crops, there will be a lot of primary resources that the plant will be able to use.

4th level: To achieve this level the students needed to, provide a correct kind of renewable energy for the territory in the problem and provide at least two different reasons supporting the kind of energy they had chosen or against the ones they had not chosen.

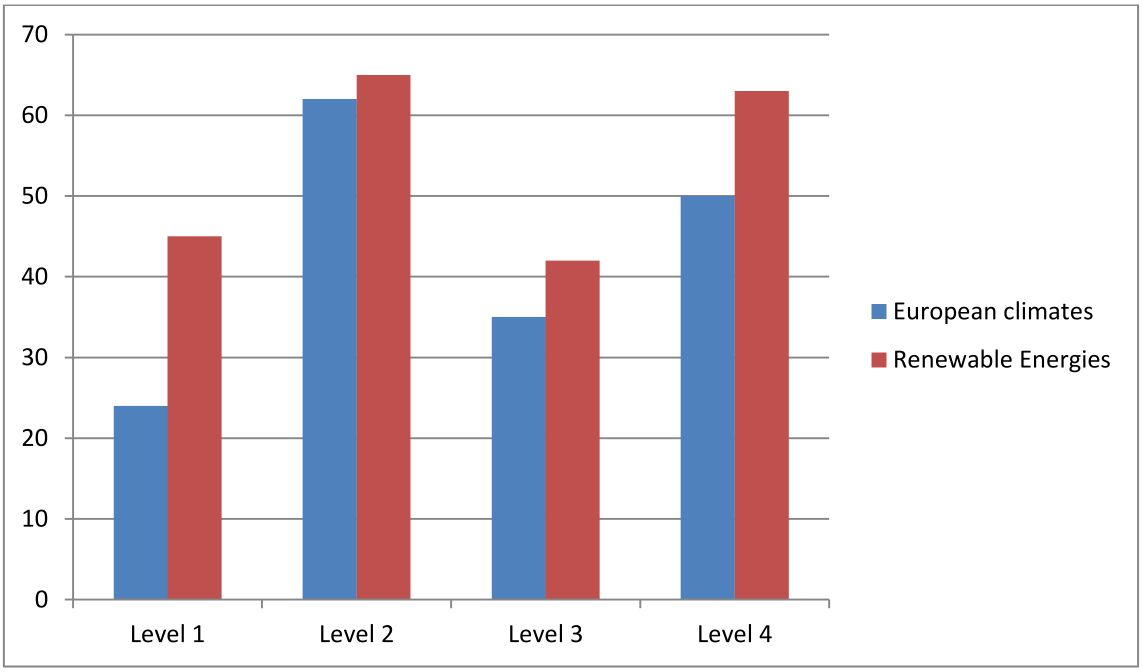
2.3.3.1 Results

A total of 78 students took the test, and these were the general results: (Table 2 and Graphic 1)

Table 2: Number of students that achieved each level

	European Climates	Renewable energies
Level 1	24	45
Level 2	62	65
Level 3	35	42
Level 4	50	63

Graphic 1: Number of students that achieved each level

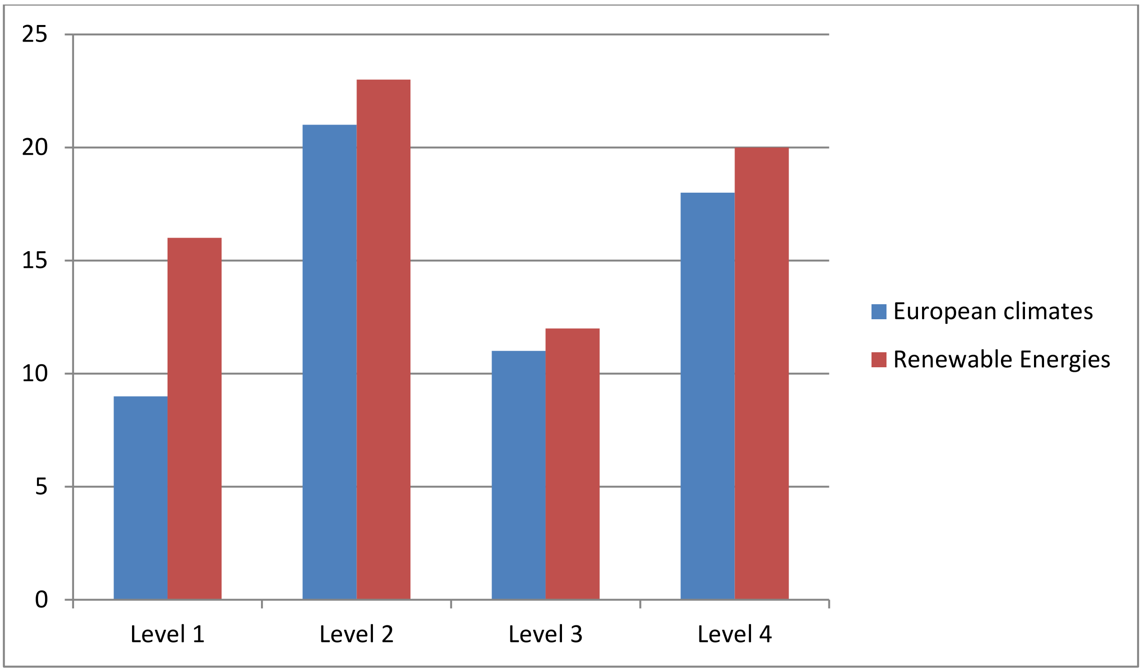


6th A

Table 3: Number of students which achieved each level in 6th A

	European Climates	Renewable energies
Level 1	9	16
Level 2	21	23
Level 3	11	12
Level 4	18	20

Graphic 2: Number of students that achieved each level in 6th A

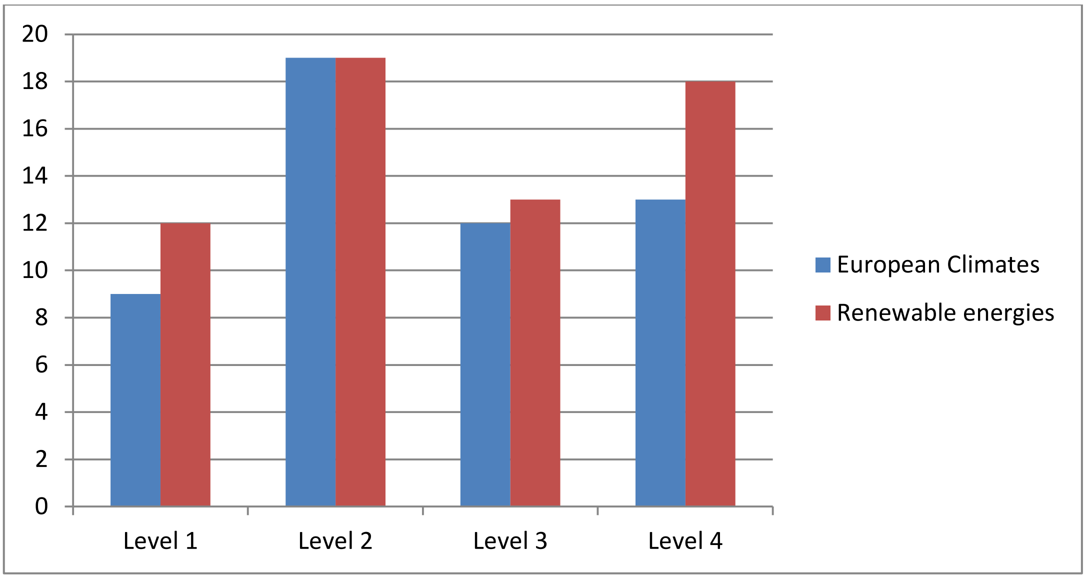


6th B

Table 4: Number of students that achieved each level in 6th B

	European Climates	Renewable Energies
Level 1	9	12
Level 2	19	19
Level3	12	13
Level 4	13	18

Graphic 3: Number of students that achieved each level in 6th B

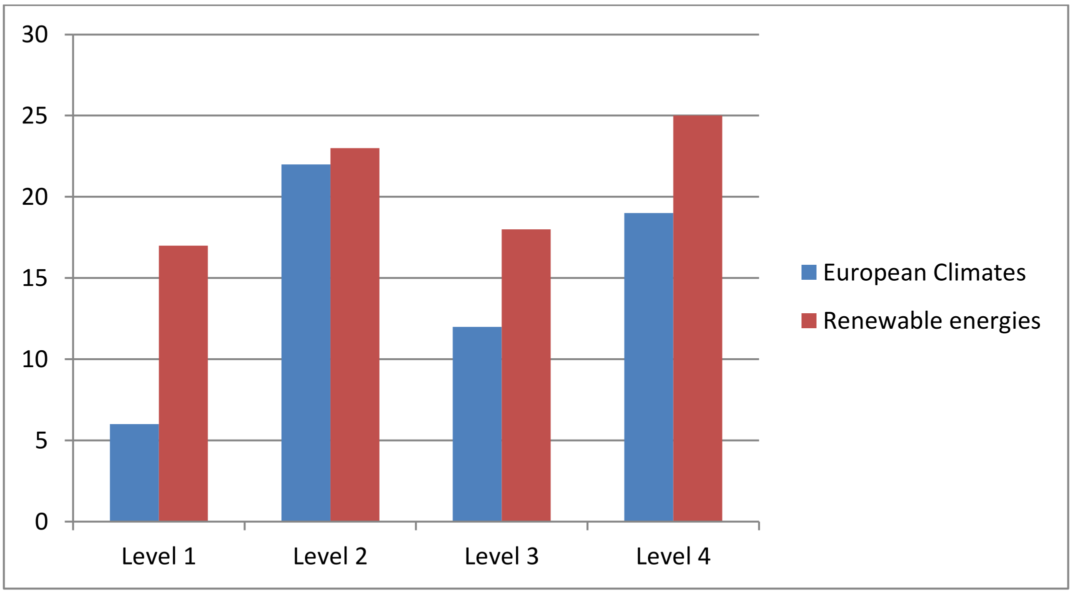


6th C

Table 5: Number of students that achieved each level in 6th C

	European Climates	Renewable Energies
Level 1	6	17
Level 2	22	23
Level 3	12	18
Level 4	19	25

Graphic 4: Number of students that achieved each level in 6th C



3. DISCUSIÓN

3.1 general discusion

Generally speaking the general data show us that the vast majority of the students did not remember concrete data about the topic of the European climates (transmissive), and that in the topic of renewable energies (active) more than half of the students answered correctly to at least one of the questions about the topic. There is a huge difference in the first level between these two topics, but regarding the activities carried, it may have been that the students needed to think about the data they needed to study (the kinds of energy, what sources of energy can we use…) so, one of the factors that have been different in the teaching of both topics has been the use of practical activities.

Another possibility is that the European climates topic was less engaging for the students, or even considered as more difficult for them, but considering the results in every other aspects we can conclude that, talking about both topics, we can see that in each and every level, the students have had better results in the topic of renewable energies.

It is also interesting considering how these students have answered better the questions in the second level frame. In order to achieve the second level, the students needed to understand both topics. Considering the topics, they were topics that were really not so hard to understand, and considering what the students need to know in order to answer to those questions, we find that the students do not need to recall specific information. They need to understand the general ideas and, as it can be concluded from this test, after some time, the students are better at recalling this kind of information than recalling specific data from the textbook.

Regarding the results of the third level, I can state that applying is more difficult for the students than understanding or remembering. In this case, the students needed to remember some information and to change it a little bit, these questions did not have such an open answer as the ones in the second level. In this case, more than half of the students were able to answer correctly to the question about renewable energies, and some less to the one about the European climates.

If something has been surprising for me in this test, it has been the results in the fourth level. First of all, both questions have been answered correctly by more than half of the students. This may have been because the students had already practiced this kind of activities when I had the chance to do the practical activity, a few weeks before and, as it was a practical activity and they had to spend a lot of time thinking and discussing it with their partners, the students will possibly have acquired the strategies necessary to answer to a similar question. And, as it was an exceptional activity the students, they may have been even more interested. It is also worth considering that in this level I also tried to create a very similar activity for both topics, in order to avoid confusing the students.

In this part of my final project, I consider that it is useful to see how these results have varied in the three classes where I was able to carry this test. This is because each classroom is different and also in order to avoid the typical excuse that some people use to avoid creating activities of this kind. This excuse states this: “those activities may have worked in your class, but my class is completely different, and there is no chance for them to work for my students.”

Now, let’s see the results focusing in the three classes:

3.1.1 - 6th A

As in the general results, we can see that in this class the students did the part about the renewable energies better. In every level there is at least one more correct answer in the Renewable energies than in the European climates.

This class had its good points, as some of the considered best students were here, and those students did make a good exam, but it had also one big drawback. In this class of the 26 students that took part in the test, there were five students that had some kind of special needs.

Even tough, considering these students, it is surprising to see that two of them achieved the fourth level question in the energies part. I think that this may be because these activities are not the school-alike activities that can be very discouraging for them. These students participated also in the previous activities, and, as they were presented as a game, where multiple answers were possible, they do not need to think in absolutes, as it occurs in other subjects like Math.

This was also the first class to do the test, which allowed me to see the most frequent questions in order to answer them in the rest of the classes. In this way, this class appeared more as an experiment, with me trying to get what to improve for the other classes.

3.1.2 - 6th B

In this class, we can also see better results of the students in the part of the renewable energies, although it is not as clear as in the previous class. It is quite surprising how in both levels the numbers are almost the same except in the level 4, where there is a difference of five people with correct answers between the two topics.

The difference with this class was the time. With the other two classes, I had the chance to use one of the hours in the morning in order to do this test. However, in this classroom I was not so lucky. As the activity took place in the afternoon, the students were tired and they did not pay as much attention as they should have paid.

Also, as in the other classes, there were some people with some special educative needs, but in this class I did not receive such a great surprise as I did in A.

From my point of view and comparing the three classes, this is the class with the strangest results. I think that the most decisive factor for the results that are reflected here was the time in which the test was done, and that those results would have probably been better in the morning.

But, in any way, it is also a fact that the students did better the renewable energies part than the European climates part. And the big difference in the number of people with correct answers in the fourth level may have been due to the practical exercise that was carried out before.

3.1.3 – 6th C

In this class we can find almost every kind of students, and that has been reflected on their results. As it is observable, this group has had some big differences with the other groups. For instance, if we focus our attention in first level we will see that there is an enormous difference in the number of correct answers from one topic to another. Comparing it with the other two classes we can see that in this class there was a difference of 11 people while in the A class there was a difference of 7 people and in B a difference of 3 people. Why does this happen?

Taking into consideration the characteristics of the students we find that in this class there is a huge contrast between students. We find that in this group there are a small group of people who thinks that studying is funny and study every day and, in opposition to this group, we also find another group of students that will try to avoid studying as much as they can.

That is the group of students I am going to focus on in this moment. As far as I am concerned, motivation takes a big role in the process of learning, and, if the students are not engaged with the lessons and the contents they need to study, they will tend to forget them quickly. In this class, there are some students that may have a lack of motivation in some of the topics. This explains the big difference we can find between the number of correct answers in level one in both topics.

3.2 valoration

I decided to use practical problems instead of theoretical problems because there was not a hypothesis that came from the previous exercises and because practical problems are related to the students' everyday life, and they already had a conceptual base (Caamaño, 2012). These facts allowed me to think that a practical problem was more adequate.

As I was surprised with how the students worked in this activity, being very good for an activity they are not used to do, I decided to investigate a little bit about the other subjects at school, in order to discover some similarities in activities proposed by other teachers to this activity. The only resemblances I could find between the other subjects and the activity of problems that I proposed was in science (in English) subject.

In the subject of science in English, the teacher usually started the daily routine showing the students an odd fact or even a little problem related to the topic they were studying in the first ten minutes of class, making the students choose from three possible solutions for the odd fact, or to work a little time in groups for the problem solving. Then, after the first term, she told the students to find the odd facts and problems themselves and every day, she asks one of the children to write in the blackboard his problem or odd fact (with the three different options) for their partners.

This is another way to introduce practical problems in the classroom, as every few days the children will be resolving a little problem related to sciences, and in the best scenario, related to the topic they are studying, without the need to change a lot the class methodology and routines.

These was useful to me due to the resemblance with my activity, and as they worked sometimes like that in science, they did not need a complete explanation of everything they needed to do in the problem or the way they have to behave when there is a practical problem to solve, saving me time and energy.

In the end, this kind of activities are useful in order to motivate the children and make them work in real life circumstances, and most of the times, this activities can be done following the constructivist method, as the student becomes the center of the learning process, being able to do things, instead of memorizing them and using higher cognitive skills, but, in the classroom, how beneficial can it be for the teachers and students to follow this methodology? Or even, is it useful for the students to solve problems and use sciences in practical situations for their learning, or, is it just another way to spend the science class?

In the theoretical introduction, I have shown the postures of various authors that have provided their arguments in order to defend this methodology, but, for most teachers, these postures are only ink in the paper, and may think that that methodology is a waste of time and resources (Cañal, 2007).

In order to prove this wrong, I have decided to see how does these things work in a class where the students are used to a more receptive approach, starting with the development of the previous activity in order to compare how do the students remember the thing they have learnt by using them against the ones that they have only studied.

This has been done like this because, due to a series of reasons this was possible. These were the reasons:

1- The teacher is a teacher that is used to teach in a more receptive way and he was teaching a topic using this kind of methodology (passive/receptive)
2- There was an event that allowed me to introduce a new topic that required some work from the students and was suitable to introduce a problem solving activity or activities based on a practical approach. In this case, it was the excursion to the biomass plant the event that allowed me to use a problem solving activity talking about energy
3- The students in the three classes where I applied the activities were used to work in groups and to interact with the others.

As the students had been studying two different topics at the same time, with two different methodologies I thought that it will be useful to use this in order to compare the results in the topic with the active methodology and the topic with the passive one. In this case the topics were like this:

In one hand, the topic stipulated by the teachers for that period of time, Europe's climate and geography, explained by the teacher using the book, with no context or special reason to study that topic instead of another one in the situation except for its location in the book.

On the other hand, due to an excursion that the school had programmed with the biomass plant of Sangüesa the students needed to study again the topic of energies and renewable energies providing a good context and motivation for the children. Therefore, there was an excursion where the students learned a little more about energy, in a more practical way than at school, as they saw the way a biomass plant worked.

With this context, it was really more useful to introduce a problem solving to the topic of energies, as the topic was used as a preparation to an excursion an was studied not to pass the exam, but to learn a little more about energy. That was the point of the previous activity

But, this also leads us to the next question: 'Why did the students answered correctly to the first level question in the renewable energies part?' From my point of view, the practical activity that was done the month before has something to do with this. First of all, the practical activity that was carried out required collaboration within the students, so in most of the cases there was at least one person that liked studying in the group. This could have led to the revision of the contents they had studied about renewable energies. Also, as the students needed to provide arguments in order to find a solution they needed to investigate, trying to solve the problem.

These activities are always considered more engaging than the mere act of studying, as the students need to be actively thinking about the solutions they can find and reasons to prove their solution as the best one. Also, another of the factors that made this activity engaging was that their partners were going to tell if they thought that there was a better solution, leading this part of the activity to active listening and a discussion after exposing the group's answer.

In this way, this activity may have lead the children to a more meaningful learning, ass the children learned with a context, solving a problem and using higher order thinking skills. Therefore, these students achieved better results in the renewable energies topic with a very visible difference.

In conclusion, considering this class and its wide range of students, practical activities may be useful in order to engage students, which will lead to a better understanding of the topic and better results. Also, as I have stated since the first page of this project, sciences are always practical in the real life, in this way, students have at least achieved higher level of performance in both topics than the one that they are used to.

Conclusion

In this project, I started showing the beneficial possibilities of the practical methodologies in the sciences area at school, and in the second part I did some practical activities and analyzed the results of a big group of children and these are my conclusions:

First of all, the practical methodology works. As I have showed in the practical part of this work, taking to account the results of the students in a topic where the students have had only theoretical explanations and an exam where the students only needed to study, and not to think and a topic where the students have done some practical exercises, where they needed to think more than to know, we can see that in the topic where they needed to think the students have assimilated more information than in the one they only needed to study and understand the topic.

A second logical conclusion that can be extracted from the first one is that learning in a theoretical way and then repeating in in an exam does not work. Considering the differences in the number of correct answers in the first level of both topics we can see that in a time lapse of a month, a big number of students have forgotten the topics they have studied. Meanwhile, after the same time lapse, the students are able to remember in a better way the contents in which they had to think, as in this case the kinds of energies.

Another of my conclusions is that a practical methodology is more suitable if the objective of learning is the acquisition of a competence. In this case, if the objective of the science class is to achieve the scientific competence, the students will need to practice. Practice is at least one of the factors that may lead to the development of the scientific competence. A competence requires a set of abilities, and not only to memorize and repeat. Therefore, in order to gain these abilities, the children need to think, to put their knowledge into practice, to choose incorrect solutions and to think what they have done in order to improve. And, a practical methodology allows the students to do that. The student becomes the main character in his learning, and with their partners, they solve problems, using the concepts they will only need to remember in a theoretical methodology.

It is also important to highlight that a practical methodology also requires studying and memorizing. In a practical methodology, the concepts are put into practice; however, in order to put a concept into practice, a student needs to know it, to study and to understand it. In a logical sequence, it is possible to start with a theoretical explanation that will later lead to a series of practical exercises (Cañal, 2007). In this way, the teacher will start with activities which will need the low order thinking skills (LOTS) to activities that will need the use of the high order thinking skills (HOTS).

Also, from my experience using this kind of activities, the most important conclusion that I have reached is that this methodology can make the students to fall in love with science. In the first part of the project, I stated that science is a subject that in some times is forgotten. For the students, this subject implies to study and to learn difficult and sometimes illogical contents, without understanding them in most of the times. In this way, a practical methodology may lead the students to discover the truth of science, the need to think, the need to discard the ideas that do not work or the need to try and continue trying until you reach a logical conclusion. This is something that can only be done in the practice, and it is something that most of the teachers forget.

About this point, it was delightful to see how almost every student, even the ones that were not talkative, participated. These activities brought joy to the classroom. And the students even asked me to do more activities of this kind in the classroom.

The problems and practical situations made me rethink the role of the science teacher. In most of the cases, the problems that are used at school have an only possible solution that is correct, but in science problems, as in most of the everyday problems, there is usually more than one. And so, a science teacher may have thought about the solution that would be useful for the problem, but if the data supports it, the children may find another solution, maybe even better than the one provided by the teacher, so, a science teacher should be open-minded, as different solutions to a problem may be correct. This change in the role of the teacher has also been stated by some experts, as it is said in the theoretical part (Cañal, 2007). And, this change of roles will also make the teacher to think, to be interested in the students' response and to keep an open mind.

Conclusión

En este proyecto he empezado mostrando los beneficios de las metodologías prácticas en el área de ciencias en el colegio y en la segunda parte realicé varias actividades prácticas, analicé los resultados de un gran grupo de niños y estas son mis conclusiones:

Lo primero es que una metodología práctica funciona. Como he mostrado en la parte práctica de este trabajo, teniendo en cuenta los resultados de los estudiantes en un tema en el que sólo han tenido explicaciones teóricas y un examen donde los alumnos únicamente necesitan estudiar sin necesidad de reflexionar y un tema en el que los alumnos han realizado una serie de ejercicios en los que necesitaban pensar en mayor medida que conocer, podemos observar que en el tema en el que necesitaban pensar los estudiantes han asimilado más información que en el que únicamente necesitaban estudiar y entender.

Una segunda conclusión lógica que podemos extraer de la primera es que aprender la teoría para luego repetirla en el examen no funciona. Considerando las diferencias en el número de respuestas correctas en el primer nivel de la taxonomía de Bloom en ambos temas podemos observar que en un lapso de tiempo de un mes, un gran número de estudiantes ha olvidado el tema que estudió en ese momento. Sin embargo, después del mismo periodo de tiempo, los estudiantes eran capaces de recordar mejor los contenidos en los que tuvieron que pensar, como es el caso de las energías renovables.

Otra de mis conclusiones es que una metodología práctica es más adecuada si el objetivo del aprendizaje es la adquisición de una competencia. En este caso, si el objetivo de la clase de ciencias es la adquisición de la competencia científica, los estudiantes necesitarán practicar. La práctica es al menos uno de los factores que puede llevar al alumno al desarrollo de la competencia científica. Una competencia requiere un grupo de habilidades, y no únicamente memorizar y repetir. De este modo, para adquirir estas habilidades, el estudiante necesita pensar, poner su conocimiento en práctica, elegir soluciones incorrectas u pensar qué es lo que ha hecho para mejorar. Para lograr esto, una metodología práctica permite a los estudiantes lograr esto. El estudiante se convierte en el protagonista de su aprendizaje, y con sus compañeros resuelve problemas, usando los conceptos que sólo necesitaría recordar en una metodología teórica.

También es importante remarcar que una metodología práctica también requiere estudio y memorización. En una metodología práctica, los conceptos se ponen en práctica, sin embargo, para poner un concepto en práctica, el estudiante necesita conocerlo, estudiarlo y entenderlo. En una secuencia lógica, es posible empezar con una explicación teórica que más adelate llevará a una serie de ejercicios prácticos (Cañal, 2007). De este modo, el profesor comenzará con actividades en las que los alumnos necesitarán utilizar los procesos de pensamiento de orden bajo (LOTS) para llegar a actividades en las que los alumnos utilicen procesos de pensamiento de orden alto (HOTS).

También, de mi experiencia utilizando este tipo de actividades, la conclusión más importante que he alcanzado es que esta metodología puede hacer que los estudiantes se enamoren de la ciencia. En la primera parte del proyecto, enuncié que la ciencia es una asignatura que muchas veces se deja olvidada. Para los estudiantes, esta asignatura implica estudiar y aprender contenidos difíciles, algunas veces ilógicos, sin llegar a entenderlos en la mayoría de casos. Es así que una metodología práctica puede llevar a los alumnos a descubrir la verdad de la ciencia, la necesidad de pensar, la necesidad de descartar ideas que no terminan de funcionar o la necesidad de intentar y continuar intentándolo hasta que se llega a una conclusión lógica. Esto es algo que solo se puede aprender por la práctica, y también es algo que la mayoría de los profesores olvidan.

Sobre este punto, fue alentador ver como casi todos los estudiantes, incluyendo aquellos que no eran especialmente habladores participaron. Estas actividades trajeron alegría a la clase y los estudiantes incluso pidieron realizar más actividades de este tipo.

Los problemas de las situaciones prácticas me hicieron también repensar el papel del profesor de ciencias. En la mayoría de los casos, los problemas que se utilizan en el colegio sólo tienen una respuesta correcta, pero en los problemas científicos, como en la mayoría de problemas de la vida real, hay más de una respuesta. También, aunque el profesor haya pensado en una solución que puede ser útil para el problema, si los datos la avalan, el estudiante puede ser capaz de encontrar una solución incluso mejor que la que ha elegido el profesor. Por esto, un profesor de ciencias debe tener siempre la mente abierta ya que distintas soluciones pueden ser correctas para el mismo problema. Este cambio en el rol del profesor también ha sido previsto por expertos, como está dicho en la parte teórica (Cañal, 2007). Y, este cambio de roles también hará pensar al profesor, estar interesado en las respuestas de los alumnos y mantener una mente abierta.

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Anexo 1: Prueba final

Nombre: __________________________

Clase 6º__   Fecha_____________________

Climas de Europa

Nivel 1

1 Temperaturas y precipitaciones del clima continental:

Temperaturas	Precipitaciones

2 La vegetación del clima oceánico:

____
____
____
____
____

Nivel 2

Explica con tus propias palabras en qué lugar de Europa (por su clima) te gustaría vivir y por qué.

____
____
____
____
____
____

Nivel 3

Algunas personas que habitan en la zona norte de Europa, tras su jubilación vienen a vivir al sur de Europa. Puedes dar razones de por qué pasa esto.

1____

2____

3____

4____

Nivel 4

Adivina el clima:

Hoy es 21 de enero, y hace 18 grados en la calle.

Hoy es 31 de julio y estamos a 25 grados en la calle

Este año decidimos contar en la escuela los días en los que ha llovido desde principio de curso hasta el último día de curso. El resultado final han sido 15 días.

Cerca de mi casa encuentro plantas como palmeras o plantas que no necesitan mucha agua, sin embargo, si vamos a las montañas podemos ver plantas como la laurisilva o el pino.

¿Qué clima crees que es? _________________

¿Por qué lo crees?

____
____
____
____

¿Por qué no es clima polar?

____
____
____

Dónde crees que vivirá esta persona: ____

Energías Renovables

Nivel 1:

1 Nombra los tipos de energías renovables y no renovables.

Energías Renovables	Energías no renovables

2 Define los siguientes tipos de energía: Solar, Mareomotriz y Nuclear

Energía Solar:

____

____

Energía Mareomotriz:

____

____

Energía Nuclear:

____

____

Nivel 2

Explica con tus palabras por qué deberíamos utilizar energías renovables en vez de energías no renovables.

____
____
____
____
____
____
____
____

Nivel 3

Conociendo la planta de biomasa de Sangüesa, explica por qué crees que se eligió ese tipo de planta energética para construir en Navarra

____
____
____
____
____

Nivel 4

Hola amigos, me llamo Amira, y vivo en Turquía, dentro de la zona asiática. Vivo cerca del mar, en un pueblo cercano a la ciudad de Izmir, una ciudad que es muy importante en la historia porque, según dicen, el poeta llamado homero, autor de la Odisea y la Ilíada nació en esa ciudad.

Bueno, mi familia lleva mucho tiempo viviendo por esta zona, pero hasta finales del siglo XIX, los miembros de mi familia eran principalmente mercaderes nómadas, porque en esta tierra no ha habido nunca mucha facilidad para cultivar. Sin embargo, desde hace unos pocos años, debido sobre todo al estudio de las semillas y del suelo hemos conseguido que al menos una parte del terreno de la zona sea cultivable, lo que ha llevado a que ya no queden nómadas por la zona.

El clima que tenemos en esta zona es el clima mediterráneo, muy típico en sitios como España, Grecia o el sur de Italia, por lo que es muy sencillo que muchos días del año veamos el sol. Además, es una de las razones por las que muchos turistas visitan esta zona en verano.

Estando tan cerca del mar, es muy fácil ver que la mayoría de nuestros platos típicos se hagan a base de pescado, y además como el mar está casi siempre tranquilo, los barcos suelen salir casi todos los días a pescar.

Es impresionante ver como todos los días avanzan por el mar los petroleros que vienen desde el estrecho del Bósforo, que llevan el petróleo desde Rusia y el oeste de Asia hacia Europa, y por lo visto ninguno de los habitantes de este pueblo quiere depender de una cosa así, por la forma en la que está la situación actualmente.

Por lo tanto, entre todos, hemos reunido suficiente dinero para construir una planta energética, y queremos que sea de energías renovables. ¿Podrías ayudarnos a decidir qué tipo de energía renovable vendría mejor utilizar?

Creo que el mejor tipo de energía renovable para esta situación es:______________________

Porque:

1- ____
____

2- ____
____

3- ____
____

	Climas de Europa	Energías Renovables
Nivel 1		
Nivel 2		
Nivel 3		
Nivel 4		