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STUDYING FORESTS IN AN OPEN SCHOOLING PROJECT

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Abstract

The objective of this study is to run a pilot test on the application of Open Science Schooling (OSS) methodology in projects with secondary-school students to know the impact it can have on their learning and their perception of it in addition to know how to develop teaching practice. As a study sample, we have selected a series of countries that are participating in an Erasmus+ project; to ensure a more exhaustive study, we are working with one of the participating schools located in Catalonia, near to our research group. In our study, we will consider the application of the Open Science Schooling methods in several secondary-school projects with the goal of comparing them and evaluating the method's versatility. We used questionnaires designed specifically for this project. The goal of OSS is to encourage schools to promote community well-being in cooperation with other stakeholders. It is very important the interplay of local, regional and global contexts and dynamics in shaping education and development. In one of the secondary schools students study the key role forests play in the fight against climate change, and the relationship of this natural resource with several Sustainable Development Goals (SDGs).

Keywords – Open science schooling, SDG, Forest, Education for sustainable development, International education.

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1. Introduction

Today's society is extremely technical. As the world grows more complex, people require broader knowledge and more skills to solve the problems they encounter. As a result, our youth need to develop the skills to analyse information critically, make decisions and resolve the challenges faced by the industrial sector, the technology sector and society as a whole. This means that education plays a key role in the development of society: since we will need plenty of individuals who can take on new science and engineering jobs by 2025, we also need strategies that can help make young people passionate about these fields. Societies need to offer their young people an education in and about science –and that this needs to be an education that will develop an understanding of the major explanatory themes that science has to offer and contribute to their ability to engage critically with science in their future lives (Osborne & Dillon, 2008).

Learning can increasingly be carried out in three environments: formal, non-formal and informal, where different areas of society collaborate beyond strictly educational settings. According to the study by

Masino & Niño-Zarazúa (2016), there are three drivers of change that improve student achievement performance and learning: the first is related to supply-side elements of education systems, through the provision of additional material and human resources; the second driver of change is associated with supply-side and demand-side factors that influence behaviours, and intertemporal choices of teachers, students, and households; the third driver of change is channelled through bottom-up and top-down participatory and community management strategies, via decentralisation reforms, and with the involvement of communities in the school system management. Open schooling seeks to include all these educational levels in science and technology classes, while also involving different parts of the local community in making science education accessible to all: administrators, organizations, businesses, families, political authorities...

The open schooling methodology was firstly used in public primary schools in Britain after World War II (Cuban, 2004). The process experienced significant international growth and was a forgotten practice in the 1980s. In the 21st century it regained strength and in 2014 the European Commission issued a report called: Science Education for Responsible Citizenship, which offers a 21st century vision of science for society within the broader European agenda.

According to this report, in open schooling, schools help to promote community wellbeing in cooperation with other stakeholders Families are urged to play an active role in educational activities and school life, while representatives from companies and society in general help to bring projects from real life into the classroom (Hazelkorn, Ryan, Beernaert, Constantinou, Deca, Grangeat, et al., 2015). The participating schools will be supported to set forward an innovation agenda that will help schools to promote the collaboration with non-formal and informal education providers, enterprises, parents and local communities; become an agent of community well-being; promote partnerships that foster expertise, networking, sharing and applying science and technology research findings and thus bringing real-life projects to the classroom and focus on Effective Parental Engagement (European Union, 2020).

Open Science Schooling (OSS) encourages students to find real science in their surroundings with practical activities outside of school. These activities allow them to put into practice the knowledge acquired into the classroom. That way, students get a better understanding of how science is applied in real life (Suero, Baranowski & Gejel, 2019). OSS is a clear application about the importance of appreciating the interplay of local, region al and global contexts and dynamics in shaping education and development.

After completing a comparative study (Mulero-Jiménez, Torra-Bitlloch & Grau-Vilalta, 2019), we can state that OSS goes beyond the four methods outlined therein (learning by doing, the Montessori method, constructivism and constructionism). It could even be said that it encompasses some of the theoretical and practical views of these methods. OSS focuses on getting the different sectors of society that surround students involved in developing and realizing activities. These participating sectors are called "stakeholders". We can relate this approach to the participation of the individual in social consciousness, a starting point for John Dewey's definition of education (Dewey, 1897). The essential ideas from his thoughts on "learning by doing" are reflected in OSS and the proposed activities. Also, the environment for the development of each student defined by Montessori (Standing, 1897) can be reconciled with OSS, as can teachers' role as guides in personal development, not just as transmitters of knowledge. A rather optimistic statement is that students with an ability to think hypothetically have an advantage in doing certain kinds of school work: by definition, they require relatively few "props" to solve problems (Wikibooks Contributors).

It is important to emphasize that OSS presents an important "new" point: the fight against gender inequality (Sotiriou & Cherouvis, 2017). An essential component needed in order to facilitate the transformation of schools to open schooling environments is addressing the issue of gender inclusion. Open Schooling for Open Societies (OSOS) project will address gender inclusion in the school environment through the following levels: cultural (country level), institutional (school level), interactional (student-teacher and student-student level) and individual level (towards each student) (European Union, 2020).

At the very least, we attempt to develop a theoretical-practical vision that addresses this social problem. Once again, education can serve as a tool for promoting social change. The application of the methodology OSS is a process that will facilitate the transformation of schools to innovative ecosystems, acting as shared sites of science learning for which leaders, teachers, students and the local community share responsibility, over which they share authority, and from which they all benefit through the increase of their communities' science capital and the development of responsible citizenship (European Union, 2020).

The objective of this study is to run a pilot test on the application of Open Science Schooling methods in projects with secondary-school students, as this is the first time we do so. The paper is structured as follows: methodology, where the study sample, the data-gathering instruments and the case study are explained; the results; the conclusions and some recommendations.

2. Methodology

In this study, as a sample, we have selected a series of countries that are participating in an Erasmus+ project; to ensure a more exhaustive study, we are working with one of the participating schools located here in Catalonia, near to our research group. In our study, we will consider the application of the Open Science Schooling methods in several secondary-school projects with the goal of comparing them and evaluating the method's versatility.

Over the course of one school year, we collected experimental information from five schools in different countries that applied OSS. The purpose of the study was to find the best strategies for integrating OSS into the curriculum, and to compare the topics chosen and the results from different schools with those of a secondary school in Catalonia; our proximity to the Catalan school allowed for a more complete study.

This project was divided into two phases. The first is a general study of the participating countries. We first evaluated the implementation of OSS in each of the participating countries by having students and teachers answer a questionnaire at the beginning and the end of the experiment. Below we compare the results from different countries without including Catalonia. In the second phase of the study, we follow the development of the project designed and implemented by the secondary school in Catalonia.

Governmental and European founders expect the positive effects of the projects and funds provided to schools in order to develop and prepare young citizens to modern world (Baranowski, 2017).

2.1. Study Sample

We chose five schools in different countries (Catalunya, Greece, Lithuania, Poland, Portugal) with different projects (practice partners, with secondary education) connected to knowledge partners from five different European countries were included in the study. Knowledge partners are universities. This included the university's EXPLORATORI program. One secondary school was also chosen as a practice partner in Catalonia; this provided a case for study that was nearer geographically, allowing us to work more closely with the students. Although we represent higher education, we believe it is essential to motivate secondary school students and to help them find their calling as they will soon become the next generation of university students. With our work, we seek to transfer knowledge of sustainability to secondary school students.

Students from each school worked in a co-creation process with their teachers to choose a subject from their surroundings that was of interest to their community and that would allow them to learn experimental science through OSS. By working with families, the community, businesses and the administration, schools were able to contribute to the well-being of the community.

Our research used two samples: the students and the teachers that participated in the Erasmus+ project over the course of a school year. A total of 75 students participated in the project, of which 57 filled out questionnaires. Meanwhile, a total of 16 teachers participated in the project, of which 10 filled out questionnaires.

Figure 1 shows the distribution of students by countries and by gender. Country A (Greece) is quite balanced; Catalonia and country D (Portugal) have a majority of boys, while countries B (Lithuania) and C (Poland) have a majority of girls.

Table 1 presents the missions selected in each country.

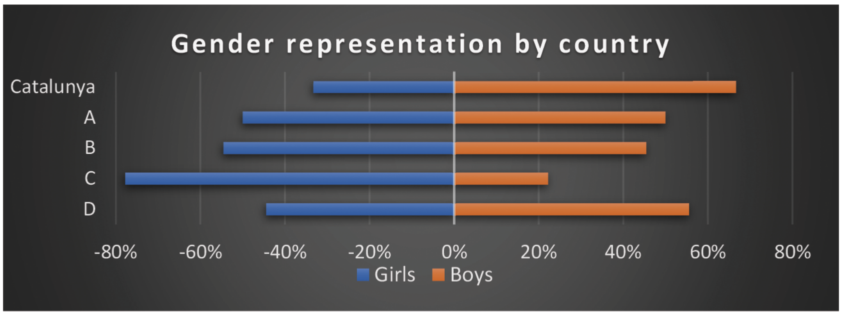

Figure 1. Participating students by gender

Country	Mission
Catalonia	The forest and its relationship with different sectors of society
Country A	Studying wine production
Country B	Recycling and use of resources
Country C	Research into regional biodiversity
Country D	Study of renewable energies that could be used at school

Table 1. Relationship between countries and missions

The project carried out in Catalonia was based on the UN's (United Nations) 2030 Sustainable Development Goals (SDG). It studied how each of the SDGs is connected to the activities to be completed and to the use of forests by the UN's (United Nations) Food and Agriculture Organization (FAO). Using different questionnaires, students analysed the relationship between forest activities and different sectors of society. By studying the SDG and the relationship between those sectors and the forest, the objective was to look at topics in all manner of different fields from a scientific-technical point of view–even social projects. This allowed students to make connections between scientific-technical knowledge and the problems affecting society.

More specifically, our study focused on the relationship between OSS and the promotion of community well-being (that of families, companies and society) through the development of different projects from participating schools. In our study case from Catalonia, some specific examples are the involvement of students' families through a study on domestic energy consumption. Local representatives of the private sector (such as representatives from forestry companies and a centre for medicinal and aromatics plants) also participated through visits. The devices that allowed for studies of domestic energy consumption at students' homes were installed with the help of the municipal authorities. The community was also involved by having them participate in the presentation of the final results by students.

2.2. Data-gathering Instruments

Two different instruments were used to evaluate the development of the Erasmus+ project: pre-test and post-test questionnaires for students, and pre-test and post-test questionnaires for teachers. The purpose of using these two instruments is to know the impact of the experience on the participating teachers and students comparing the previous opinions with the final perceptions. To analyse the results of the questionnaires anonymously, each individual was assigned a code. The first number indicated the country, the letters S and T indicated whether the individual was a student or a teacher, and a two-digit number from 00 to 49 was used for students while a two-digit number from 00 to 09 was used for teachers.

Surveys for students were based on existing questionnaires: the Constructivist Learning Environment Survey (CLES), the What Is Happening In this Class? survey (WIHIC), the Constructivist-Oriented Learning Environment Survey (COLES), the Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI), and the Science Motivation Questionnaire II (SMQ-II).

The initial version of CLES not only extends the field of learning environment research by making available a new assessment tool, but it permits a confluence of the work of researchers who investigate constructivist teaching/learning approaches with the work of learning environment researchers (Taylor & Fraser, 1991). It consisted of 21 items classified into different areas (such as autonomy, prior knowledge, student negotiation and focus). This survey was reviewed, and an additional area was added due to the survey's lack of a perspective on critical theory. The result was a questionnaire with 30 themes and five areas: personal relevance, uncertainty, critical voice, shared control and student negotiation (Taylor, Fraser & Fisher 1997). School subjects that are traditionally perceived as distinct, such as the sciences, are particularly difficult to internalize and to apply in meaningful ways across variable situations (Nix, Fraser & Ledbetter, 2005).

The WIHIC (Fraser, 1998) questionnaire provides a look at the classroom surroundings by combining modified versions of the most notable areas in a wide range of existing questionnaires with additional areas that adapt to current educational concerns such as equity or constructivism. The original version included nine levels of ninety questions each, while the definitive version of the WIHIC contains seven levels (student cohesion, teacher support, research, task orientation, cooperation, equity and participation) with eight questions each. The final version of COLES includes eleven areas with eight questions each. Students answer each of the 88 questions using the following frequency scale: almost always, often, sometimes, rarely and almost never (Aldridge, Fraser, Bell & Dorman, 2012). The eleven areas can be grouped into three categories: relationships (student cohesion, teacher support, equity and ethos of young adults), evaluation (clarity of criteria for evaluation and educational evaluation) and dedication (guidance activities, cooperation, personal relevance and participation). TROFLEI, with 80 items, evaluates ten elements from the classroom setting: student cohesion, teacher support, involvement, research, task orientation, cooperation, equity, differentiation, computer use and young adult ethos (Koul, Fisher & Shaw, 2011). The three effectiveness scales used in the study are: attitude towards the project, attitude towards computers and academic effectiveness. This questionnaire is designed to evaluate students' perception of their learning environment when a results-oriented curriculum with a great deal of technological wealth is used. SMQ-II has proven to be a trustworthy tool that allows for the evaluation of the following five components regarding students' motivation to learn science in American university courses: intrinsic motivation, self-determination, self-efficacy, career motivation and grade motivation (Salta & Koulougliotis, 2015).

Using the existing questionnaires, we created one of our own. It includes 17 areas with 5 questions each. In other words, the questionnaire is made up of a total of 85 questions. The different areas were classified into four categories: class, science (intrinsic motivation, self-determination, level of motivation), course (personal relevance, academic efficiency and attitude towards the course) and project (attractiveness of the scenario, contact with and knowledge of the scenario, abilities regarding the scenario). The "course" category includes two sub-categories: relationships (student cohesion, support from teachers, equity, young adult ethos) and dedication (implication, orientation activities, differentiation and cooperation). The "course" category consists of 40 questions, while the "science", "course" and "project" categories consist of 15 each. Students respond to each of the questions according to two different scenarios: what they know and what they expect to happen during the project. These responses use a frequency scale with the following four levels: almost always, often, sometimes, rarely and almost never. This instrument enabled students to provide information about the learning environment that was present in the classroom (the actual environment) as well as information about the learning environment that they would like (their preferred environment) (Bell & Aldridge, 2014). Based on the side-by-side format used in the COLES, the format shown in Table 2 has been used in this study.

Table 3 provides a clearer look at the structure, the origin of the scales used and their goals.

	Actual				**Preferred**			
Student cohesiveness	**Almost Never**	**Seldom**	**Often**	**Almost Always**	**Almost Never**	**Seldom**	**Often**	**Almost Always**
Members of this class are my friends.	1	2	3	4	1	2	3	4

Table 2. Side-by-side response format for actual and preferred responses used in this study

Questionnaire	Scale	Description
COLES; WIHIC; CLES	**CLASS**	
	Relationships	
	Student cohesiveness	The extent to which students know, help and are supportive of one another.
	Teacher suport	The extent to which the teacher helps, befriends, trusts and is interested in students.
	Equity	The extent to which students are treated equally by the teacher.
	Young Adult Ethos	The extent to which teachers give students responsibility and treat them as young adults.
	Delivery	
	Involvement	The extent to which students have attentive interest, participate in discussions, ask questions and share ideas.
	Task orientation	The extent to which it is important to complete activities planned and to stay on the subject matter.
	Differentiation	The extent to which teachers cater for students differently on the basis of ability, rates of learning and interests.
	Cooperation	The extent to which students cooperate with one another on learning tasks.
SMQ-II	**Science**	
	Intrinsic Motivation	The extent to which student are doing an activity for the inherent satisfaction of the activity itself.
	Self-Determination	The extent to which students have autonomy, competence and relatedness.
	Grade Motivation	The extent to which students are motivated to obtain good grades.
	Subject	
COLES; WIHIC; CLES	Personal relevance	The extent to which subject is relevant to students' everyday out-of-school experiences.
TROFLEI	Academic efficacy	
TROFLEI	Attitude to subject	The extent to which students are interested in, enjoy and look forward to lessons in that subject.
OWN	**Project**	
	Scenario's attraction	The extent to which students have interest in the scenario and enjoy the project activities.
	Scenario contact and knowledge	The extent which students have some relation with de scenario and if know something about it.
	Scenario abilities	Students' judgements of their capabilities to develop the project' activities.

Table 3. Description of the 17 areas in the student questionnaire

Below are the questions related to the class, science, the subject or subjects and the course or courses in which the project was implemented and the questions related to the project in particular.

Scenario's attraction	I know people who have a strength relation with our scenario.
I like the scenario we work.	I want to know more about our scenario.
I think that the scenario is interesting.	I want to have more personal relation with our scenario.
I will read a lot about our scenario.	**Scenario abilities**
I will enjoy the activities over our scenario.	I am good working about our scenario.
I think that I can learn a lot about our scenario.	I find easy to understand how our scenario works.
Scenario contact and knowledge	I help my friends in the activities developed.
I know our scenario.	I find easy do activities about our scenario.
The scenario is familiar to me.	I feel that I will achieve good results in this project.

Table 4. Pre-test and post-test questions for students regarding the project

CLASS	**Cooperation**
Student cohesiveness	When I work in groups in this class, there is teamwork.
Members of this class are my friends.	I work with other students on assignments in this class.
I know other students in this class.	I share my books and resources with other students when doing class work.
I make new friends among students in this class.	I cooperate with other students on class activities.
I am friendly to members of this class.	I learn from other students in this class.
I work well with other class members.	**SCIENCE**
Teacher Support	**Intrinsic Motivation**
The teacher considers my feelings.	The science I learn is relevant to my life.
The teacher helps me when I have trouble with the work.	Learning science is interesting.
The teacher talks with me.	Learning science makes my life more meaningful.
The teacher takes an interest in my progress.	I am curious about discoveries in science.
The teacher's questions help me to understand.	I enjoy learning science.
Equity	**Self-Determination**
The teacher gives as much attention to my question as to other students' questions.	I put enough effort into learning science.
I get the same amount of help from the teacher as do other students.	I use strategies to learn science well.
I have the same amount of say in this class as other students.	I spend a lot of time learning science.
I receive the same encouragement from the teacher as other students do.	I prepare well for science tests and labs.
I get the same opportunity to contribute to class discussions as other students.	I study hard to learn science.
Young Adult Ethos	**Grade Motivation**
I am given responsibility.	I like to do better than other students on science tests.
I am expected to think for myself.	Getting a good science grade is important to me.
I am regarded as reliable.	It is important that I get an "A" in science.
I am considered mature.	I think about the grade I will get in science.
I am encouraged to take control of my learning	Scoring high on science test and labs matters to me.
Involvement	**SUBJECT**
I give my opinions during class discussions.	**Personal Relevance**
My ideas and suggestions are used during classroom discussions.	I relate what I learn in this class to my life outside of school.
The teacher asks me questions.	What I learn in this class is relevant to my day to day life.
I explain my ideas to other students.	I apply my everyday experiences in this class.
I am asked to explain how I solve problems.	This class is relevant to my life outside of school.

Task Orientation	In this class, I get an understanding of life outside of school.
I am ready to start this class on time.	**Attitude to Subject**
I set my own goals for this class.	Lessons in this subject are fun.
I pay attention during this class.	Lessons in this subject interest me.
I try to understand the work in this class.	There should be more lessons in this subject.
I know how much work I have to do.	I enjoy the activities that we do in this subject.
Differentiation	These lessons have increased my interest in this subject.
I am able to work at the speed which suits my ability.	**Academic Efficacy**
Students who work faster than others are able to move on to the next topic.	I am good at this subject.
I can choose topic I wish to study.	I find easy to get good grades in this subject.
Tasks are suited to my interests.	I outdo most of my classmates in this subject.
Tasks are suited to my ability.	I feel that I will achieve a good result in this subject.
	I help my friends with their class work in this subject.

Table 5. Pre-test and post-test questions for students on class, science and course

Questions for teachers are related to their professional role and their experience working with OSS. Two questionnaires were designed to better evaluate the project's impact on this working group: one pre-test and one post-test. Each questionnaire consists of ten interrelated questions; the pre-test and post-test versions are also interrelated. This allows for a comparison between the initial circumstances and the final results of the project, and provides a look at how it can be better applied in the future.

Teachers pre-test	Teachers post-test
1. Can you say the three most important personal motivations to use the Methodology Open Schooling?	1. Has this experience increased your motivation to use the Methodology Open Science Schooling?
2. Can you say the most important think that keep up your interest?	2. Can you say what has kept up your interest or, contrary, has disappointed you?
3. Do you spend specific hours to the OSS project, or you include it in each subject?	3. After your experience, what is better: spending specific hours to the OSS project or including it in each subject?
4. How many hours a week do you and the group of pupils spend to the OSS Project?	4. Would you change the number of hours a week that you and your group of pupils have spent to the OSS Project? Could you give us an amount?
5. How do you want to implement the methodology OSS in the curriculum? With…	5. How would you implement the methodology OSS in the curriculum after your experience?
6. Which percentage of formal and No formal schooling are there?	6. Which percentage of formal and No formal schooling do you think that is the best, after your experience?
7. Do you think that working as OSS teacher is more difficult than with the classic methodology?	7. After this experience, do you think that working as OSS teacher is more difficult than with the classic methodology?
8. For who is more difficult to work with OSS, students or teachers?	8. After this experience, for who is more difficult to work with OSS, students or teachers?
9. In which of these areas do you think that will be more difficult to work with OSS?	9. In which of these areas have you had more difficulties to work with OSS?
10-Can you say three objectives that you think you will have achieved when the project ends?	10. Have you achieved your initial objectives?
Country	
Years of experience in teaching	
Gender	
Subject	

Table 6. Pre-test and post-test questionnaire for teachers

2.3. Case Study in Catalonia

As part of this study, OSS methods were applied at a secondary school in Catalonia. During the first twelve months (last school year), students studied the environment and looked for ways of saving energy. They visited several businesses to learn more about their local community. Students' families played a key role in ensuring that the project was well-structured. This school year, the selected topic was "The forest: exploitation and contribution to sustainability". It was chosen because the local area provides 70% of Catalonia's timber. This subject included a range of local organizations such as research centres and public administrations (the regional council, municipal governments, the department of education, etc.) the food sector (companies selling honey, herbs, mushrooms, etc.) or forestry companies (a biomass plant, sawmills, etc.). The study of forests included two very different facets: their environmental importance and the raw materials they can provide.

The initial phase focused on the role woodlands play in conserving energy. Through its EXPLORATORI research program on natural resources, the University encouraged students to take part in an initiative entitled SAVEnergy. Students who participated in the project had a device measuring electricity consumption installed in their homes; these made families more aware of the energy they use. Next, students extrapolated the results of individual steps taken to save energy and calculated the resulting drop in CO_2 emissions; they also used statistical tools to complete a report on emissions in Spain from 2007-2017. Besides saving energy and analysing the global effects of those savings, students also studied a source of sustainable energy provided by forests: biomass. Finally, students were able to apply the knowledge they had acquired by building a prototype of a biomass boiler.

This study was related to the significant existing concern for climate change, which provided an opportunity to teach students about the 2030 Agenda. The 2030 Agenda for Sustainable Development is an action plan for people, the planet and prosperity. All countries and stakeholders are working together to implement this plan. Its 17 Sustainable Development Goals (SDGs) and 169 targets seek to promote universal human rights, achieve gender equality and empower woman and girls. The 2030 Agenda for Sustainable Development includes universal objectives that effect the planet as a whole and that take into account all three aspects of sustainable development: the environment, society and the economy (UNESCO 2015). The Agenda was approved by all nations, and all are subject to it; it factors in their capacities, circumstances and level of development while respecting their individual priorities and policies. Furthermore, the 2030 Agenda emphasizes the importance of an effective educational response. SDG 4 specifically includes education as a goal in and of itself; however, education is also essential to achieving the remaining SDGs (UNESCO 2017).

As a whole, this project is based on SDG 4 (quality education) and SDG 13 (climate action). The activities it includes also involve SDG 7 (affordable, clean energy) and SDG 12 (responsible consumption and production). As many students may not see woodlands as a part of their daily lives, we chose to focus on an ecosystem closer to them: urban forests. Coincidentally, this also has to do with SDG 3: good health and well-being. It is now common knowledge that trees in urban areas can have a positive role on the welfare of local residents; besides their aesthetic value, trees improve the quality of the air and contribute to both neighbours' mental and physical health. Therefore, we need learn to see planting trees as a way of contributing to the public health system. For this topic, students studied wooded areas in two cities of Catalonia with different size: Berga and Barcelona. This task is related to SDG 11: sustainable cities and communities. Students were asked to connect SDG with the project. We suggested starting with SDGs 1, 3, 4, 6, 7, 8, 9, 11, 12 13 and 15.

Below are the questions posed to Catalan students to evaluate their knowledge of the SDGs and their connection to the Erasmus+ project. The questionnaire connects the project to the SDGs. All students participating in the Erasmus+ project were asked the fourth question.

Working group:

1. What did you do with your working group?
2. SDGs: how have you contributed?
3. Are there any other SDGs you contributed to that you think we should add? Why?
4. Rank the SDGs that are most important to you from 1-5.

3. Results

Below are the results of our evaluation of the use of OSS in the Erasmus+ program, as well as the results of the pilot test of associating students' knowledge of the SDG with their study of the forests of Catalonia.

3.1. Analysis of Questionnaires

Teachers' responses to our questionnaires showed that all educators found OSS to be more challenging for teachers than for students.

Figure 2 shows that the preparation of the curriculum was the most challenging activity for teachers. Approximately 70% of teachers found that communication was an added difficulty. 15% believed that involving students and evaluating their process posed a significant challenge.

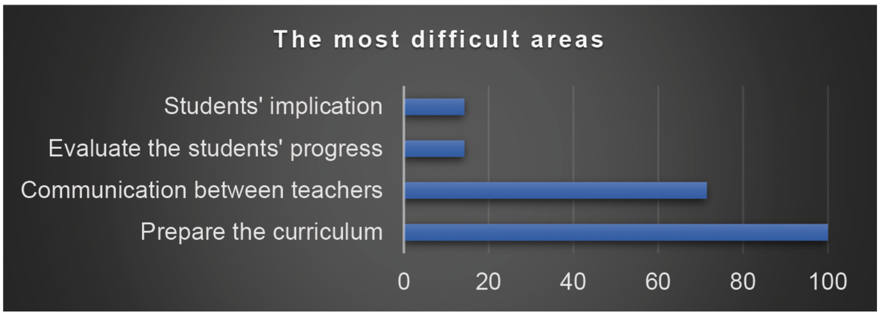

Figure 2. Distribution of activities by level of difficulty according to teachers' responses

Although this project can be used directly within the curriculum through formal education, many teachers took part in the project in extracurricular hours through activities like workshops, visits, conferences, interviews or debates. As a result, this can be considered non-formal education. The following graph shows the proportion of hours of formal and non-formal education. Figure 3 shows that over 40% of teachers invested 60% of the hours they dedicated to the project in non-formal education. Over 40% dedicated 70% of their project hours to non-formal education, while approximately 15% managed to dedicate 90% of their project hours to non-formal activities.

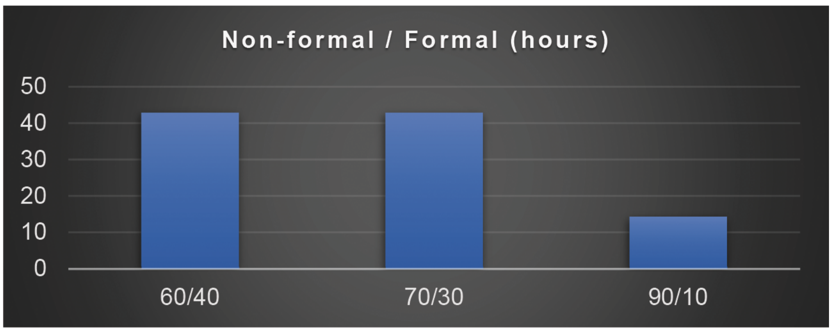

Figure 3. Relationship of hours invested in non-formal and formal education

All teachers managed to teach a range of subjects through the project (transversal), while approximately 30% also managed to teach specific courses (Figure 4). Responses to the questionnaire make it clear that 3-5 teachers took part in each project at all participating schools, including one English teacher. For example, in cases where 5 teachers took part, the courses involved were: mathematics, chemistry, technology, biology and English. This shows the multidisciplinary nature of the project.

Student questionnaires were used to conduct a general analysis; no distinctions were made by country of origin, although gender was taken into account. Figure 5 shows responses to the questions "how have students' perceptions changed? In what ways have they improved, in what ways have they become worse, and in what ways have they stayed the same?" Differences between the reality in the classroom at the end of the project (Actual final, or Af) and the initial situation (Actual initial, or Ai) are noted for each section of the questionnaire, with gender taken into account. The question "by the end of the project, did students achieve the intended objective?" was answered using the same method: differences were noted between the "Actual final (Af)" and the intended outcome, "Preferred initial (Pi)" (Figure 6). Finally, we studied the evolution of students' expectations for the project (Figure 7), taking into account the desired outcome from a hypothetical projection (Preferred final, or Pf) and the intended situation at the start of the project (Preferred initial, or Pi).

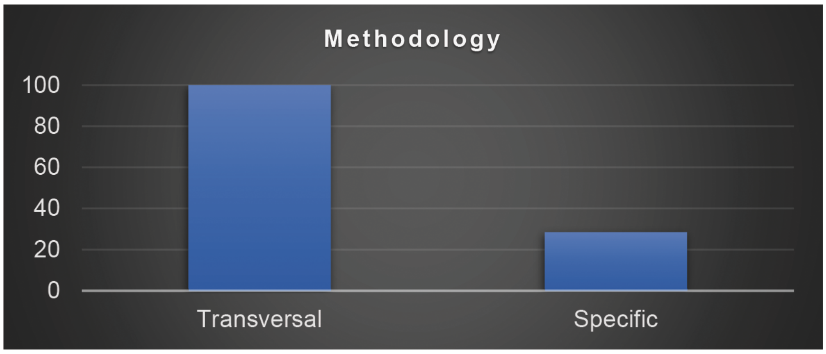

Figure 4. The methodology followed in the implementation of the project

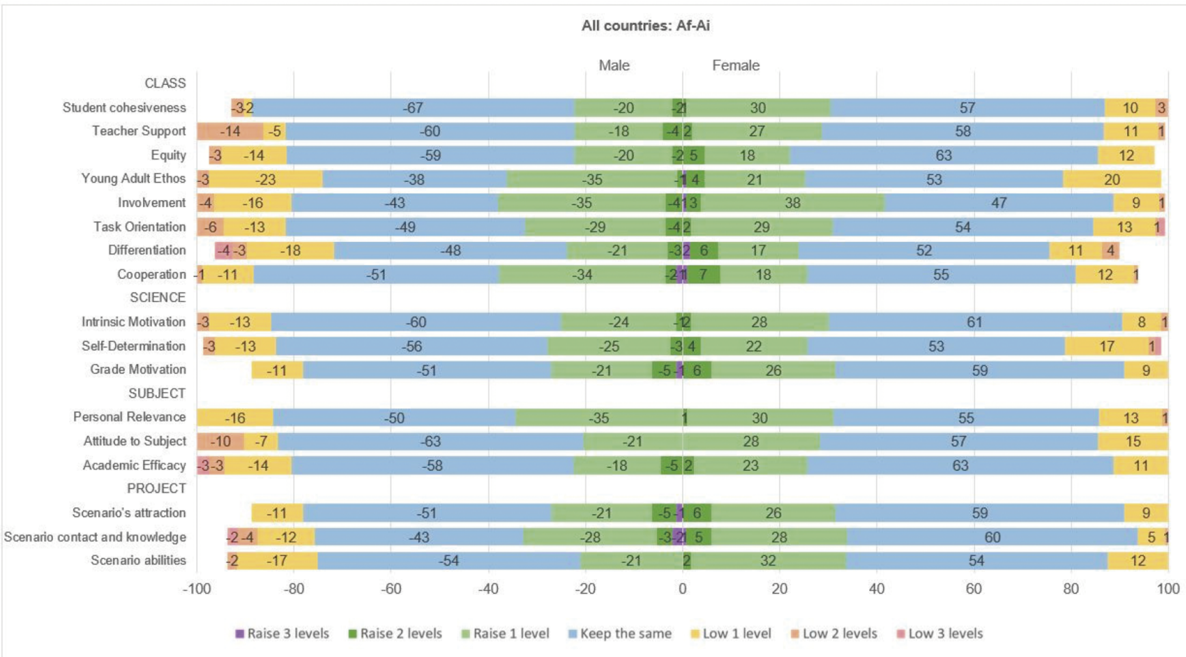

Figure 5. Differences between the reality at the end of the implementation of the project in the classroom (Af) and the initial situation (Ai) of all participating students

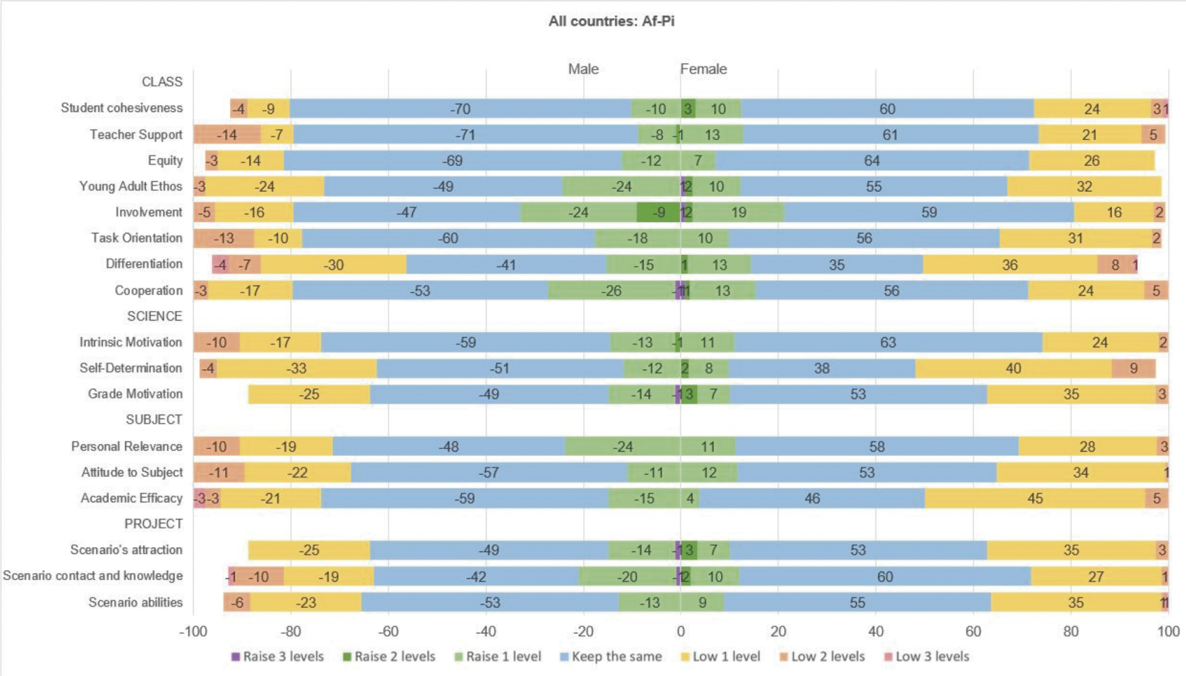

Figure 6. Differences between the actual final situation (Af) and the intended result at the start of the project (Pi) for all participating students

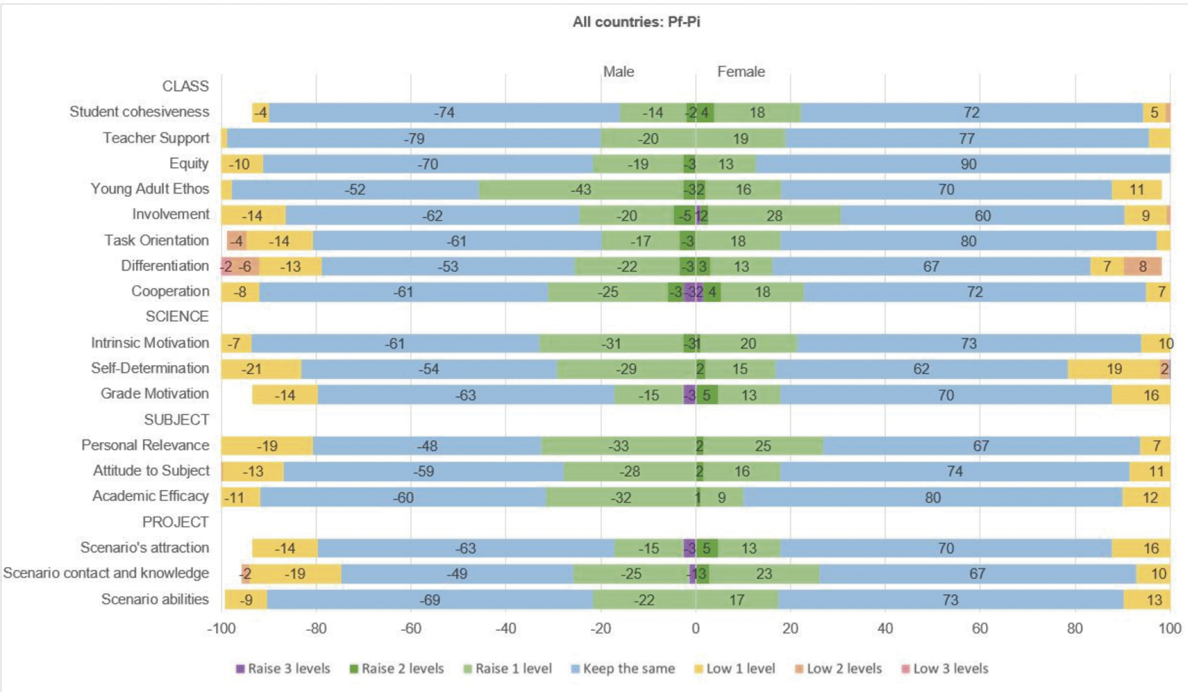

Figure 7. Difference between the desired situation at the end of the project in a hypothetical projection (Pf) and the desired situation at the start of the project (Pi) for all participating students

The three analyses do not show much difference between genders, although it should be noted that girls participated more actively in the surveys. About 50% of students –both boys and girls– maintained their initial perception at the end of the project, while around 25% ended up with a more positive perception. One difference we did note is that girls had a slightly more positive point of view than boys. If we analyse the responses to different parts of the questionnaire within the "class" category, it is worth noting that 14% of boys felt that they received less support from teachers, as opposed to only 1% of girls. In the area of "science", girls showed lower levels of self-determination while boys gained motivation during the project. Within the "project" category, responses were quite positive: almost 80% of boys and over 90% of girls maintained or improved their situation, showing both an increased interest in the chosen project and greater knowledge. As for students' aspirations, the results were more varied. We cannot make significant distinctions between genders, but boys' results were more diverse, with positive gains in cooperation within the "class" category, gains in motivation in the "science" category, and gains in interest for the chosen project, contact and growth within the "project" category. Meanwhile, girls were more critical; about 35% did not feel that their expectations had been fulfilled. If we look at the results of the analysis of future expectations, we find a distribution that is similar to the achievement of real aspirations, but from a more optimistic perspective. About 60% of boys and 70% of girls maintained their expectations. There was a notable increase in personal growth in young adult ethos for boys, and in cooperation in the classroom for girls.

3.2. Analysis of the Forest Study Pilot Test

As is shown in Figure 8, the two conductive threads in the application of OSS to a study of forests are "use of resources" and "sustainable development". In the first, we focus on raw materials, principally wood and biomass: content C1a (building materials) and content C1b (fuel and energy). We also focus on secondary products: content C2 (mushrooms and aromatic plants), and content C3 (cooperative creation). Meanwhile, we worked on two areas regarding sustainability: content C4 (the forest, water, air and well-being) and content C5 (forest biodiversity).

These subjects were integrated into in a series of secondary-school classes, including social sciences, English, maths, technology, experimental sciences and entrepreneurship.

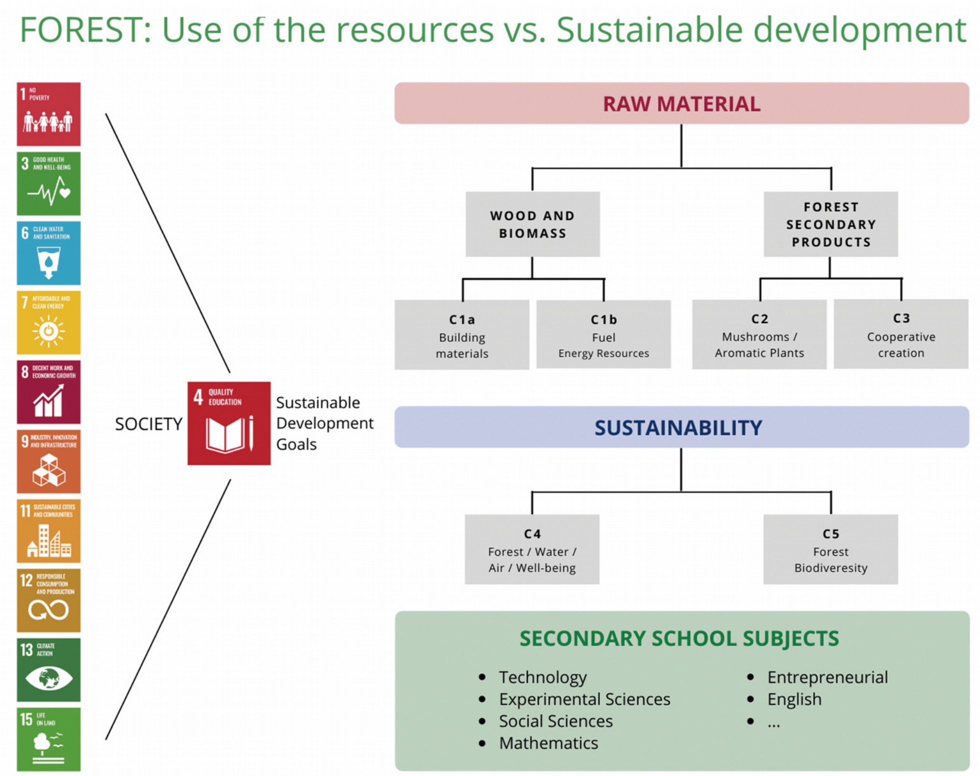

Figure 8. Diagram for applying OSS to forest studies. Original creation

Figure 9 shows the connections students make between forest-related activities and the SDGs throughout the project. This figure was based on the work of (The Nature Conservancy, 2021), in which it is showed as several actions contribute to the SDG.

Figure 9. Relationship between forests and the SDG. Original creation

Figure 10 shows the priority given to the SDG by students participating in the Erasmus+ project and the students from the school in Catalonia (responses to question 4 of the questionnaire that associates the activities from different projects with the SDGs).

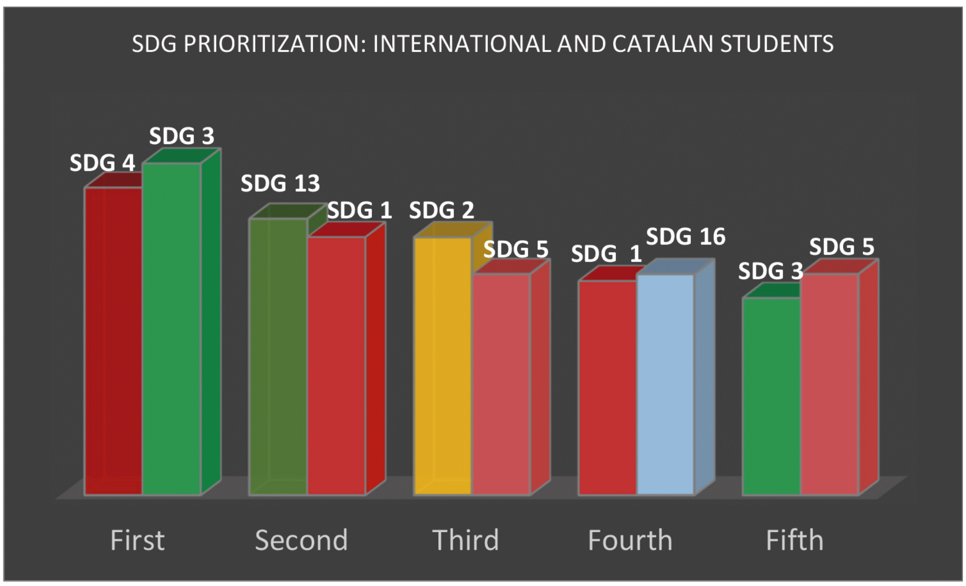

Figure 10. Priority given to the 5 SDGs selected by participating students

Figure 11 shows a series of photographs of students taking part in activities associated with the project.

Figure 11. Some images from learning experiences

4. Conclusions

With this experience we have learned that the methodology Open Schooling, we can greatly broaden students' perspectives. Besides giving students a chance to address problems from real life, a series of individuals from different parts of society are given a role in the education of our youth. Its educational curriculum also anticipates the skills developed by students in different areas. Its main drawback is that most schools divide their curriculum by subjects, each with their own structure and contents. With OSS, we introduce connections between the local environment, the community, and solutions to real-life problems; it goes without saying that in real life, issues are not divided into subjects. For us, the most difficult part of introducing new educational methods to secondary schools is doing away with the strict, traditional confines of different classes in order to address different issues in a more realistic, overarching way; lining up course contents with available time also proves difficult. Getting other sectors of society involved in young people's education will be another important challenge.

This study allowed us to prove that although implementation of the OSS method is particularly challenging for teachers, they are willing to learn from it and improve their students' education. Meanwhile, this project has helped to increase students' interest in science; they also enjoyed the co-creation process and the autonomy it gave them. They are more engaged with science when they can solve real life problems.

As for the study case from Catalonia involving a project connecting the forest with sustainability and the Sustainable Development Goals, it showed that most students were not aware of the SDGs; the project also helped to expand their knowledge of the usefulness of woodlands. This provided them with a systemic view and showed them how to relate resources from the forest with scientific-technological solutions to our current needs related to a big global challenge: climate change.

Energy conservation is a priority for 21st-century society. With the OSS and the Forest Project, we can work to make our communities aware of this by driving our youth to save energy and serve as catalysts for change. The most innovative part of this project is its work with secondary schools, since it empowers both teachers and local families while developing and using a new virtual platform. Above all, however, students serve as the main actors of the project. Giving them tools that measure and help moderate the energy consumption at their schools and homes encourages them to be responsible and makes the initiative much more effective.

5. Recommendations

Regarding the use of the OSS methodology, it is important for teachers who want to implement the project, especially if the curriculum is very strict, to have an interdisciplinary group of teachers. If the teachers can work as a team and divide the project into different disciplines, the process is much more agile. Another possibility is to take advantage of the weekly tutoring hours and distribute the project throughout an academic year. Finally, it is also possible to concentrate on end-of-year periods and work is done by groups of students on specific topics.

In the particular case of the experience carried out with students from Catalonia, it has been verified that from the initiatives focused on the SDGs and woodlands can be related to Education for Sustainable Development (ESD). ESD helps to drive the fulfilment of the SDGs by promoting the skills needed to deal with a wide range of challenges to sustainability and by promoting links between the different SDGs. Finally, ESD provides students with the socio-emotional, behavioural and cognitive abilities they need to address the challenges that go with each of the SDGs (UNESCO 2017). It is therefore recommended to use the forest as a resource to work on the different SDGs, as it allows young people to be involved in issues related to climate change.

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