sustainability

MDPI

Article

Sustainable Civil Engineering: Incorporating Sustainable Development Goals in Higher Education Curricula

Irantzu Álvarez [1], Paulo Etxeberria [1], Elisabete Alberdi [2,*], Heriberto Pérez-Acebo [3], Isabel Eguia [2] and María José García [1]

[1] Department of Graphical Expression and Engineering Projects, University of the Basque Country UPV/EHU, P° Rafael Moreno Pitxitxi, 2, 48013 Bilbao, Spain; irantzu.alvarez@ehu.eus (I.Á.); paulo.etxeberria@ehu.eus (P.E.); mariajose.garcialopez@ehu.eus (M.J.G.)
[2] Department of Applied Mathematics, University of the Basque Country UPV/EHU, P° Rafael Moreno Pitxitxi, 2, 48013 Bilbao, Spain; isabel.eguia@ehu.eus
[3] Mechanical Engineering Department, University of the Basque Country UPV/EHU, P° Rafael Moreno Pitxitxi, 2, 48013 Bilbao, Spain; heriberto.perez@ehu.eus
* Correspondence: elisabete.alberdi@ehu.eus; Tel.: +34-946-017-790

Abstract: In the current climate emergency context, many national and international organizations have adopted measures to integrate sustainability and Sustainable Development Goals (SDGs) in all their fields of action. Within education, steps have been taken to incorporate the perspective of sustainability at all levels. This process has also started at the university since it plays a fundamental role in the strategy for the implementation of specific policies to promote sustainability. However, sometimes it is difficult to include this type of knowledge in the curriculum, due to the lack of flexibility of the university structure or the lack of time to cover the syllabus. In this scenario, civil engineering plays a main role as a fundamental activity in the creation of services and infrastructures with a high environmental impact. The objective of this study is to show a multidisciplinary approach to working on sustainability in a transversal way in the civil engineering degree and to analyze the impact that this type of initiative can have from the learning point of view. The study shows a curricular trajectory supported by problem-based learning and project-based learning designed to promote sustainability in the practice of civil engineering. The good results obtained in the evaluation of the project and the growing incorporation of the SDGs in the final degree projects suggest that this methodology can be implemented by other university degrees.

Keywords: civil engineering; university; project-based learning (PBL); Sustainable Development Goals (SDGs)

Citation: Álvarez, I.; Etxeberria, P.; Alberdi, E.; Pérez-Acebo, H.; Eguia, I.; García, M.J. Sustainable Civil Engineering: Incorporating Sustainable Development Goals in Higher Education Curricula. *Sustainability* **2021**, *13*, 8967. https://doi.org/10.3390/su13168967

Academic Editor: Kay Stables

Received: 11 June 2021
Accepted: 7 August 2021
Published: 11 August 2021

1. Introduction

Since the beginning of the 21st century, the increasingly pressing climatic and environmental emergency in which we live has conditioned the agenda of the different national and international organizations, making the challenge of a more sustainable society the center of all development strategies. After having established the Millennium Goals in 2000, at the United Nations Conference on Sustainable Development held in Rio de Janeiro in 2012, the development of the road map to face the environmental, economic, and political challenge began, through the establishment of the Sustainable Development Goals (SDG) [1]. These were the bases for the subsequent adoption of the 2030 Agenda for Sustainable Development, approved in September 2015 by the General Assembly of the United Nations [2], which was implemented as a reference guide for the work of the international community until 2030. The SDGs coincided with another historic agreement reached in 2015, the Paris Agreement, approved at the Conference on Climate Change, with the aim of limiting global warming to below 2 °C per year, preferably 1.5 °C, compared to pre-industrial levels [3]. All these agreements confirm the pillars on which the work of the current scientific and educational community is based.

The 2030 Agenda establishes 17 goals to be achieved by the year 2030. Within these SDGs, specific goals are established in the face of global challenges such as the climate emergency and environmental degradation, the elimination of poverty and inequality (which are growing), and social and environmental justice.

After five years of validity, and despite the progress made, the objectives are still far from being achieved [4]. Ten years before the deadline, the outbreak of the pandemic caused by COVID-19 has had a strong impact on the agenda and the achievement of the objectives. If, in the short term, the priority of the states is to control the spread of the virus, in the medium and long term, the Agenda can provide an adequate framework to guide the recovery from the crisis caused by the pandemic. Therefore, far from abandoning the road map, it is more urgent than ever to accelerate its achievement. In this sense, education in general, and higher education in particular, can serve as a vehicle to train the society that will have to face these global challenges and investigate the tools that will be needed to accomplish the targets.

1.1. A New Agenda for Higher Education: 2030 Goals

Facing all these challenges requires the involvement of the entire society, and, hence, it is necessary to provide knowledge, skills, and values to society as a whole, for which education is essential [5]. In this sense, universities, with their role of teaching, research, and knowledge transfer, are essential actors to address the challenges posed by the agenda and achieve the SDGs, even affirming that "it is probable that none of the SDGs can be fulfilled without the implication of this sector" [6]. It is, therefore, an opportunity for universities to establish a new strategy for higher education and try to incorporate certain values and practices related to sustainability in their mission and fundamental values [7].

National and international organizations have promoted the inclusion of Education for Sustainable Development in educational programs, and many universities have begun to integrate sustainability into their studies, but this integration is still far from being an obligation, so the systematic application from a global approach and the evaluation of progress and results remains a challenge [8]. The organizational and managerial structure of the university and the national accreditation processes make the implementation of new content a difficult or at least slow task. For this reason, the inclusion of concepts and activities related to sustainability within the curriculum depends, in many cases, on the involvement of the teaching staff, who, mostly, have not received specific training either.

In this framework, in which it is difficult to modify the content of the subjects, the activities focused on the acquisition of transversal competences are a good way to work on the strategy of introducing sustainability in the different university degrees. Other more global changes in the educational process have to be borne in mind, taking into account aspects such as:

- replacing the static and fragmented vision of reality with a complex and dynamic vision;
- reinforcing interdisciplinarity to promote holistic and relational thinking; and
- improving the functionality and contextualization of teaching, incorporating the study and treatment of local and global problems.

For the establishment of training activities, it is important, therefore, to have multidisciplinary teams, since they increase the capacity to understand the complex challenges that the world currently faces [9]. Therefore, in this work, a set of training activities has been created in different subjects of the same grade, aimed at integrating sustainability into the curriculum while improving the understanding of problems from different approaches and, therefore, the application of solutions to current challenges from different disciplines is encouraged.

1.2. Sustainability in Civil Engineering Degrees

Civil engineering is the branch of engineering in charge of the design, building, and maintenance of all infrastructures related to transport, water, and energy supply

systems. It is a strategic sector when it comes to facing the challenges that have arisen so far. Transport infrastructures and the construction of buildings have a great impact on the environment, require a high consumption of energy and raw materials, and produce a large volume of waste [10]. For example, according to the European Commission, in recent years, the transport sector has represented around a quarter (25%) of Europe's greenhouse gas emissions and is one of the main sectors responsible of the air pollution in cities [11–13], especially due to the predominance of road transport in people and freight transport [14,15]. Therefore, the sustainability of this sector would be crucial to achieve the goal of reducing greenhouse gas emissions, reaching a reduction of approximately 40 or 50% in 2030 [16]. Hence, it is essential to train the professionals who will work in this sector in topics such as the reuse of materials, the manufacture of new materials, sustainable mobility, and the reduction of the environmental impact of the infrastructures that are built, promoting the reuse and global analysis of projects from the economic, environmental, and social sustainability point of view [17]. Different entities related to civil engineering (such as professional organizations and associations) have carried out different types of initiatives to incorporate this perspective in a practical way [18]. However, the lack of specific training in issues related to sustainability among future professionals in the sector is still an obstacle [10].

1.3. Research Background

The University of the Basque Country, similarly to other universities, has aligned the work of the university with the great challenges of the planet and the 2030 Agenda [7,19], adapting its strategy to be able to (1) involve the entire university community in the achievement of the SDGs, (2) include teaching-learning strategies to achieve the objectives, (3) create its own table of indicators of Sustainable Development so that development could be measured, and finally (4) intensify collaboration with local environmental entities to increase joint responsibility with respect to the SDGs.

In this global strategy, the UPV/EHU has also modified its educational model to be able to integrate sustainability in a transverse manner. This model has been materialized in the IKD i3 Project, which is an educational model in which teaching, research, and sustainability are combined [20] with the aim of matching learning and facing the common challenges.

In this project, a group of professors and lecturers who teach in the Degree in Civil Engineering proposed to design training activities to implement this educational model among students who in a short period of time will develop their professional role in activities with a high environmental impact.

The civil engineering degree offered by the UPV/EHU is a four-year degree taught in two different schools (in the Faculty of Engineering of Bilbao and in the Faculty of Engineering of Gipuzkoa). In the supporting report of the civil engineering degree of this university, it is said that "the main objective of the degree is to train civil engineering professionals capable to work in the different stages of the projects [. . .] under scientific-technical criteria and social responsibility, making a rational, efficient and sustainable use of resources" [21]. It is, therefore, a degree that, since it was implemented, has one of its basic pillars in sustainability. However, the specific training in these subjects is limited to a subject taught in the last year of the degree. For this reason, the need to incorporate training activities aimed at applying the IKD i^3 educational model to this degree was foreseen.

2. Methodology

Based on the need to work on the implementation of a global and practical approach of sustainability in civil engineering degrees, a project has been carried out that is part of a broader project led by the University of the Basque Country (UPV/EHU). This project (Figure 1), called 'Towards a Sustainable Civil Sector', has been carried out at the Bilbao School of Engineering. First, a group of subjects who have an important weight in the degree and whose competence has a high impact on the development of the Final Degree

Project, have been selected. Subsequently, the activities have been designed and all of them were conducted.

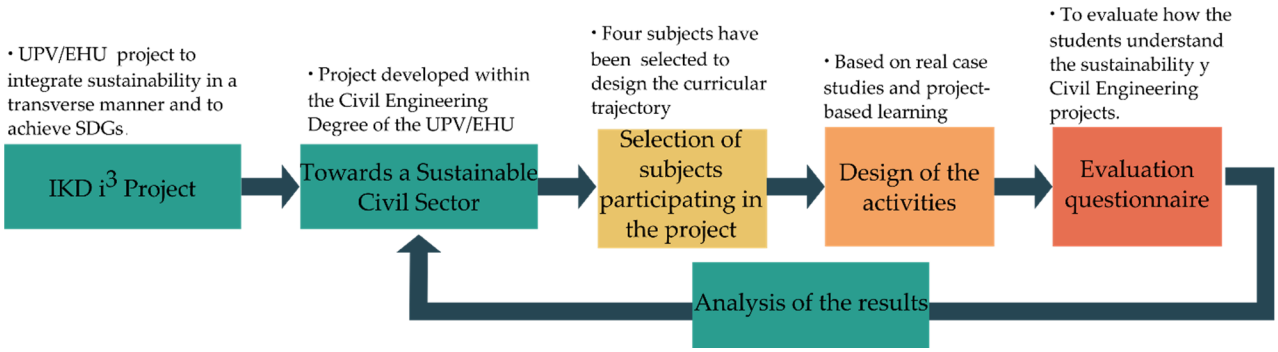

Figure 1. Flowchart of the methodology used in the project.

At the end of each activity, students have completed a broad-spectrum evaluation questionnaire. The questionnaire has been designed to cover the peculiarities of each of the subjects analyzed (between 10 and 13 items). The questions try to assess the degree of satisfaction of the students with the contributions of the evaluated activities. Some of the issues are linked to different aspects of learning in general, others refer to specific technical aspects of the contents of each subject, and finally, others try to evaluate the incorporation of concepts related to sustainability in the activities of each subject.

The civil engineering degree has, according to the policy of the University of the Basque Country, a moderate number of students, so it has not been deemed appropriate to apply a statistical analysis method. Instead, a quantitative analysis of the results of the questionnaires has been carried out. Thus, the mean value of the level of satisfaction shown by the students for each item has been calculated on a scale from 1 (fully disagree) to 5 (fully agree).

This type of analysis has been used in the evaluation of similar projects in the educational field, for example, the application of Building Information Systems in university education [22] and teaching–learning techniques such as the flipped classroom [23].

Finally, the impact of the project has been assessed by analyzing the incorporation of aspects linked to sustainability in the latest Final Degree Projects.

2.1. Implementation

Four subjects have been selected in order to design the curricular trajectory in which sustainability is going to be implemented in the civil engineering degree: one subject corresponds to the third academic year and the rest to the fourth academic year. Two of them are compulsory subjects (Transport Infrastructure and Engineering Projects) and the other two are optional (Geographic Information Systems and BIM Applications in Civil Engineering), see Figure 2. In all these subjects, the problem-based learning (PBL) and the project-based learning methodologies have been already used, and real case studies can be applied to analyze the problem of sustainability from multiple points of view.

The main objective of the project "Towards a Sustainable Civil Sector" is to launch training actions aligned with the European Environmental Strategy and the SDGs, promoting sustainability in the training of future professionals of the sector. The areas in which this work will be developed are the following:

- Urban habitat: sustainable construction (energy efficiency), resilience to the challenges of climate change, smart cities, sustainable infrastructure, and sustainable mobility.
- Project life cycle analysis: projects in the field of sustainable civil engineering must be designed and planned focusing on their usefulness, but also on their possible changes in use or the possible end of their useful life. The sustainable perspective

must, therefore, be established from a global and integrating approach in all the design stages of a project.

- Global assessment of projects: when deciding among different alternatives, civil engineering professionals must assess not only the economic impact of their proposals but also their social and environmental impact.

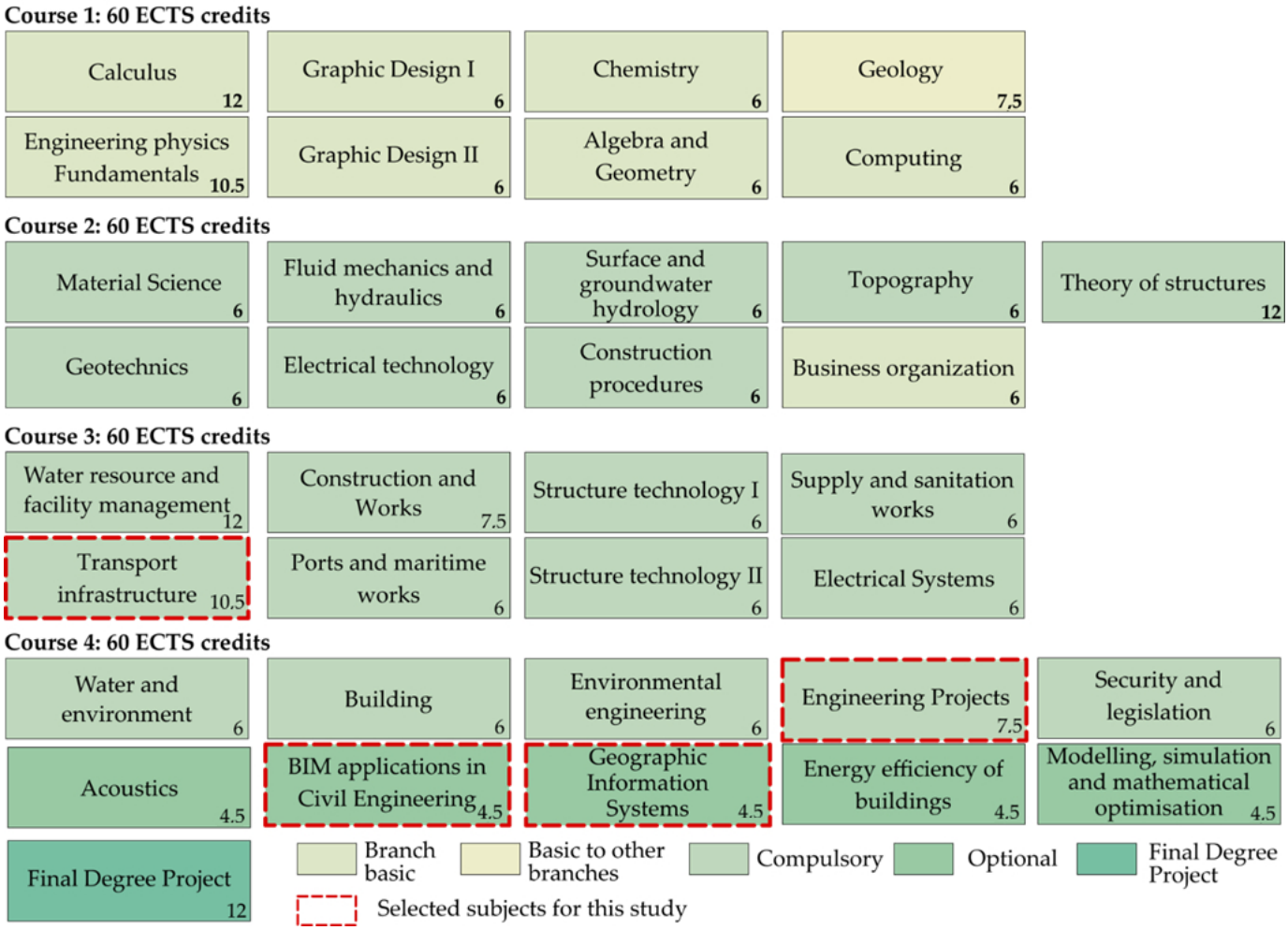

Figure 2. Subject and ECTS credits in the civil engineering degree in UPV/EHU.

The project integrates 10 of the 17 SDGs proposed by the 2030 Agenda:

1. It ensures an inclusive and equitable quality education (SDG 4).
2. It enables to achieve gender equality and empowers women and girls (SDG 5).
3. It ensures the availability and sustainable management of water and sanitation (SDG 6).
4. It ensures access to affordable, reliable, and sustainable energy (SDG 7).
5. It promotes a sustainable economic growth (SDG8).
6. It develops resilient infrastructures (SDG 9).
7. It promotes inclusive, safe, resilient, and sustainable cities (SDG 11).
8. It ensures sustainable consumption and production patterns (SDG 12).
9. It combats climate change and its effects (SDG 13).
10. It protects, restores, and promotes the sustainable use of terrestrial ecosystems (SDG 15).

The teaching–learning activities have been designed considering the current educational model of the university [24]. Therefore, activities that seek the involvement of students in their own learning process are proposed, through training that requires

autonomous learning. With this target, an analysis of case studies, teamwork, and project-based learning will be developed [25–27]. Additionally, different applications that combine different subjects will be developed to promote a global and integrative view of the problems. In this sense, links between subjects will be found so that students can create connections and interrelate concepts that are studied separately.

2.1.1. Engineering Projects

The subject called "Engineering Projects" is a compulsory fourth year subject in which the methodology to construct projects is studied in all its phases: from the initial design to the detailed construction project. In this subject, students apply all the knowledge acquired during the degree in the development of a project, and it is the prelude to the Final Degree Project. Learning is carried out through bi-weekly assignments, a preliminary project, and a final exam. Within the proposed project, a case study of a complex and actual problem has been included: the detailed analysis of a real informative study in which different alternatives for drawing a rail freight transport line were defined, evaluated, and compared, taking into account different criteria such as sustainability, economy, and society. The case study has been presented to all the students of the subject (35 students), of which 88% have completed it (31 students in total). The objective of the study has been to understand the complexity of multi-criteria evaluation in large transport infrastructure projects. In addition, emphasis was placed on decision-making in a social–political sphere that includes numerous public and private agents and other organizations, which often have opposing points of view.

Students have organized in small groups, and they have analyzed the supplied documentation within two weeks, presenting a brief report in which they have answered various questions (some of them were closed questions, others were open) and, finally, they have carried out a presentation and a roundtable in class. Once they have finished the task, the students (25 out of the 31) have answered an evaluation questionnaire on the case study.

Regarding the subject "Engineering Projects", 92% of the students consider that the methodology of the case study has clearly helped them to understand the reality of large civil engineering projects. In addition, it has been helpful to have a better understanding of how decision-making is carried out in complex environments, the usefulness of multi-criteria evaluation, and the need to consider sustainability criteria in this type of large-scale work. Consequently, this type of work seems to be useful for civil engineering students to take into consideration other criteria (sustainability, society, and economy) in projects that belong to their own field, beyond the pure application of technical and functional criteria.

2.1.2. Geographic Information Systems

The subject Geographic Information Systems (GIS) is an optional subject of the fourth year. In this subject, students learn how to use GIS technology through its application in studies and projects related to civil engineering. GIS and spatial information play a fundamental role in studies related to environmental management, infrastructure design, and urban planning [28]. The increasing availability of georeferenced data and the complexity of the territories make this technology an essential element of any comprehensive approach to a smart territory [29] and even to the achievement of the SDGs [30]. The need to integrate data sources of different types and analyze them spatially places geospatial technology at the center of the necessary tools for sustainability. Its ability to store data and relate them spatially makes it useful in a wide variety of applications, and thanks to their functionality, they are essential for making decisions related to the territory.

Within the framework of this project and within the Geographic Information Systems subject, a teaching–learning activity based on the application of multi-criteria techniques in several real cases has been designed. Multicriteria evaluation is a set of techniques aimed at assisting in decision-making processes mainly oriented to the territory [31]. In the first place, some explanations related to sustainability in the sector have been added,

and applications have been shown in class in which GIS has been the support tool that has made it possible to search for the most sustainable alternatives in various cases related to professional competencies of the students. Finally, a small questionnaire, designed with multiple-choice and short-answer questions, has been carried out in order to measure the suitability of the actions.

Several practical exercises have been conducted in which the following training activities were proposed:

- Find the best location for the creation of a new landfill in the Basque Country: the problem has been contextualized by showing news related to the collapse of a landfill in the Basque Country and the need for new landfills in the region. This is a basic multicriteria analysis task to which sustainability criteria have been added, such as the search for sites with minimal visual impact.
- Find the best location for the installation of a solar garden: the province of Gipuzkoa was used as a case study. Also in this case, in addition to the basic technical criteria for this type of facility, sustainability criteria were added, such as finding the location with the most daylight hours to increase the efficiency of the facility.
- Find the best location for a wastewater treatment plant. As in the two previous cases, looking for areas with a lower impact that could serve as many people as possible has been set as a priority.
- An exercise in which students had to analyze the impact of the sea level rise, due to climate change in the city of Bilbao, was developed. Specifically, students analyzed the buildings that would be damaged. The task has been contextualized with maps shown by different international organizations [32,33] in relation to the sea level rise.
- Mobility studies have been carried out, and the environmental impact of different alternatives has been analyzed. Different trajectories were analyzed for the transport of hazardous goods, and students were asked to find the most sustainable and safest route.

Twenty-one students participated in the activities organized in this subject. In the final questionnaire, they were asked both about the methodology used and the tool itself. They were asked about sustainability and the SDGs in general, the importance of sustainability in the field of civil engineering, the multi-criteria methodology used in the case studies, the suitability of the selected case studies, and the GIS technology itself. In all the cases, they positively valued the introduction of sustainability criteria in the different tasks to be carried out. A total of 85% of the students considered the use of specific and definite study cases to have helped them to better understand the multidisciplinary approach of sustainability, where they have also been able to incorporate knowledge from other subjects. Therefore, the application of case studies and project-based learning helped in the task of assimilating sustainability as a transversal view in all projects related to civil engineering.

2.1.3. BIM Applications in Civil Engineering

The subject BIM Applications in Civil Engineering is an optional subject of the fourth year in which BIM methodology is studied from the point of view of civil engineering. BIM methodology, an acronym for Building Information Modeling, seeks to create a digital representation of the physical and functional characteristics of a building or infrastructure in a collaborative way [34]. BIM is, therefore, a set of technologies, procedures, and policies that enable different stakeholders to collaborate in the design, construction, and operation of a facility in a virtual space. This information model becomes a single resource for all the people involved throughout the life cycle of the building or facility, and serves to resolve, inform, and communicate all decisions related to the project during the design, construction, and maintenance phases, allowing a more effective and efficient management of the entire project.

These information models make possible to carry out energy efficiency studies, simulate the behavior of buildings in a specific urban environment, optimize the use of materials, reduce waste, and, therefore, reduce project costs [35]. Thus, they are a tool that can play an

important role in ensuring sustainable development. In addition, the methodology makes the project itself more efficient, and information can be shared easily, which also results in the sustainability of the project itself [36].

In this subject, students worked with the BIM methodology in the design of infrastructures and buildings in the field of civil engineering. Students had to design a leveling and a road, and they had to install a building on this levelling. They could select the desired location and decide on the design of the building, but only within the context of this project. In all cases, they had to select the location and design according to criteria such as reducing the necessary earthworks or reusing existing roads.

Twenty-three students participated in the activities of this subject. In the final questionnaire, they were asked about the methodology used and the tool. In 92% of the cases, they positively valued the use of a specific project in which they had to select the area for the development of the project according to the aforementioned sustainability criteria. In addition, 80% of the students highly valued the BIM tools, giving a higher score to the efficiency in the creation of the documentation associated with the project and the ease of sharing and integrating the environmental data related to the construction work throughout its lifecycle.

2.1.4. Transport Infrastructure

Transport infrastructure is a compulsory annual subject taught in the third year, with 10.5 ECTS (European Credit Transfer System). In this subject, the complete procedure of the development of road and railway infrastructure is exposed. Thus, in the winter semester, themes related to roads are presented, and students learn how to manage a road, comprising all the stages: road infrastructure planning, a project of the geometric design of the road, analysis of the materials that will be employed, characteristics of the construction in situ, and maintenance and management of the infrastructure. Similarly, in the summer semester, themes related to railways are shown, including the entire process, i.e., from planning and design to construction and maintenance with the specific rail machinery [37].

Apart from the theoretical and practical lessons, the main task of the subject is the development of an "almost" real road project, which contributes to 40% of the final mark. The project follows the project-based learning (PBL) methodology. According to existing literature, PBL can be defined as complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision-making or researching activities, and give students the opportunity to work in a relatively autonomous way during longer periods, so as to culminate in realistic products [38,39]. Moreover, Thomas [40] proposed a series of criteria to help identifying PBL activities: centrality, driving question, constructive investigation, autonomy and realism. At university level, PBL and problem-based learning were perceived as the more effective ones in a comparison of seven learning methods in seven engineering disciplines [41]. Similar beneficial outcomes were observed in other disciplines in high education, such as active student participation, foster contact with reality, an increased perception of the acquisition of generic and specific skills associated with the subject, and confidence in problem-solving [42–44]. More specifically, a study conducted with civil engineers 15 years after graduation revealed that PBL-related abilities developed at the university (ability to work in groups, communication/debate skills, and leadership) were appreciated by students who followed PBL methodology and considered their learning to be more effective and with a better result-to-effort ratio than those who did not [45].

In the case of the subject Transport Infrastructure, students, gathered in groups of two, had to conduct the project of a road in a real physical area and with some determining factors. The project was presented at the beginning of the summer semester, after a partial exam about the first part of the subject (roads) is done. A real problem was introduced, from a real need detected by any administration related to the construction or improvement of the design of a highway, and students had to undertake the project. They had to find data about traffic volume and fulfill all the regulations regarding road design and pavement

design to project the road [37,46]. The two main parts of the project were the geometric design of the layout of the road and the design of the pavement structure (the layers that compose the pavement and their width), but other parts had to also be carried out: the analysis of the earthworks, the complete definition in plans, and the calculation of the estimate of the costs, in a similar way to projects developed for the administrations [47].

As a PBL project, it had multiple valid solutions, as long as the standards were fulfilled. Nonetheless, geometric designs that minimized the earthworks were preferred and were better evaluated, giving a better evaluation of the project if more sustainable layouts were designed. Moreover, following the SDGs, an additional improvement was introduced in this academic year. Apart from the standardized design of the pavement structure, some new research about more sustainable materials or construction procedures in pavements was presented, including the reutilization of previous pavements to manufacture some layers in new pavements [48–53] or the introduction of waste materials in the production of some materials [54–64]. Hence, students had to choose one of the recently investigated materials or procedures to propose a more sustainable pavement structure. Thus, an approach to existing cutting-edge research in the field was shown, and students understood the need to look for alternative materials to construct and not only focus on the classic ones.

Thirty-seven students conducted the described project of the road and 32 answered a questionnaire about the PBL methodology and the skills they developed. A total of 81% of the students agreed that the project-based learning methodology helped them to understand the reality of the engineering projects and developed their autonomous learning. Similarly, in more than 90% of the cases, undergraduates affirmed that the project was helpful for applying the standards in law in a road project. Finally, the majority of students indicated that they learned how to improve the sustainability of road infrastructure projects. As seen, apart from achieving the goals of the methodology of the PBL (constructive question, autonomy, realism, etc.), it is also a useful tool to introduce sustainable criteria at a project level in road projects in various levels such as minimization of earthworks and employment of more sustainable materials.

3. Results and Discussion

Through the training trajectory described, 10 out of 17 SDGs proposed in the 2030 Agenda were included (see Figure 3). SDG 4 and 5 are transversal to all activities. On one hand, the project ensures that students acquire the theoretical and practical knowledge necessary to promote sustainable development (SDG 4) and, on the other hand, the full and effective participation of women is ensured, as well as the use of information and communication technologies, in order to promote the empowerment of women (SDG 5).

	nº of students	Sustainable Development Goals of the 2030 Agenda									
		4	5	6	7	8	9	11	12	13	15
Engineering Projects	31	■	■			■					
Geographic Information Systems	21	■	■	■	■			■	■	■	■
BIM applications in Civil Engineering	23	■	■		■		■	■			
Transport infrastructures	37	■	■				■	■	■		

Figure 3. SDGs that have been worked on in each subject.

The objectives related to the management of resources, water (SDG 6) and energy (SDG 7), were developed in the subject of Geographic Information Systems and BIM Applications. One of the specific tasks that the students had to carry out in the first subject was finding the best location for both a treatment plant and a solar garden, having to choose in all cases the location with the lowest environmental impact. In the second case, students had to design buildings taking into account their energy efficiency.

SDG 8 was included in the Engineering Projects subject, in which different alternatives to a construction project were analyzed considering criteria beyond the purely economic ones. This subject emphasized the need to take into account the social conditions of the projects when selecting different alternatives.

The SDGs related to the creation of more resilient and efficient urban infrastructures and environments (SDGs 9 and 11, respectively) were incorporated into the subjects Transport Infrastructure, Geographic Information Systems, and BIM Applications in Civil Engineering. The creation of infrastructures is the main activity of civil engineering, and students previously carried out different activities in which they had to design roads, structures, or facilities. In this project, the Transport Infrastructure and BIM Applications subjects have introduced sustainability criteria to the methodology for creating such structures. It should be noted that roads are designed in both subjects and, therefore, criteria have been agreed to be consistent in both subjects (minimization of earthworks, use of more sustainable materials, reduction of acoustic impact, etc.).

The SDG 13 for reducing the impact of climate change was included in two subjects (GIS and Transport infrastructure). SDG 12 deals with the sustainable management of natural resources, including land, the main resource consumed by civil engineering. For this reason, in the subjects of GIS and Transport Infrastructure, the criterion of designing the works according to this criterion was introduced, seeking that the designed works make an efficient use of the land. Finally, the objective of protecting ecosystems was included in the GIS subject, in which natural and protected environments were used as conditioning factors in all projects.

Climate change is a challenge for the entire society, and the SDGs have marked a way forward. Training is a key factor, and higher education must lead the process of introducing the required changes. The inclusion of the sustainability perspective in all areas of knowledge and at all levels is a fundamental task. The university has undertaken this path, but sometimes it is difficult to incorporate new subjects or contents. Therefore, the incorporation of the SDGs and, in general, sustainability as transversal competences and through project-based learning has turned out to be a very positive way from the point of view of both professors and students.

Learning based on problems and/or projects and case studies is a tool that has proven to be useful for the incorporation of concepts related to sustainability that can hardly be apprehended only theoretically. Furthermore, emphasis should be placed on the multidisciplinary view of sustainability, encouraging interrelationships between different subjects.

A significant number of students participated in each activity (31, 21, 23, and 37 students in the four subjects, although there were students who participated in two or three activities). Bearing in mind that approximately 40 students graduate each year (41 students graduated in 2018/2019 and 48 in 2019/2020), the number of students who participated is significant. The results obtained both in the evaluation of the activity and in the qualification of the case studies are very satisfactory. In Appendix A, a table with all the results is included. From the students' point of view, in general, the developed activities were satisfactory. As can be observed in Table A1, the majority of students value positively the use of study cases used as an approach to the sustainability of civil engineering projects.

Moreover, as most of the students are in the final years of the degree, they can apply the knowledge acquired in their Final Degree Project. This has been confirmed by the significant increase in the number of projects incorporating aspects related to sustainability. In addition, all students take at least two of the subjects and most of them take three, or even four of them, and complete their Final Degree Project in the months following their

participation in these activities, so that the transfer of knowledge to the Final Degree Project and, as a consequence, to professional activity, is direct, which results in a more sustainable civil engineering sector.

4. Conclusions

The university must face the challenges that society demands and must assume an active role leading the changes needed to train the professionals of the future. The University of the Basque Country (UPV/EHU) has begun this process, promoting the incorporation of sustainability and the SDGs in the curricula of many degrees. This work shows a project in which a training path designed for students of the Degree in Civil Engineering has been designed, in which it is sought that students assimilate the importance of evaluating projects from the point of view of sustainability, beyond strictly economic criteria.

The activities are based on practical exercises about projects of the field, so these activities can be replicated and adapted in other degrees related to civil engineering, since they do not involve the transformation of the syllabus. In addition, the application of this type of activity does not imply a specific training of professors beyond that related to the SDGs and the 2030 Agenda. The SDGs cover a wide range of topics; therefore, other subjects of other degrees of a different nature can adopt this methodology by adapting the case studies and SDGs to be developed in each case.

The work has a multidisciplinary nature since four subjects from different areas of knowledge participated. Each of them used case studies and specific problems related to the subject, but in all of them, sustainability was incorporated in a transversal way. Thus, students learned to observe reality from different points of view to incorporate the view of sustainability in each and every task of the projects in the field of civil engineering. We believe that a project with these characteristics is more than the sum of its parts since when students receive the message of sustainability from different areas of knowledge and with different perspectives, synergistic connections that favor the construction of practical and applied knowledge are created.

In the future, we expect to continue working in this line and to incorporate more subjects to the project in order to work on sustainability in a transversal way in all possible subjects of the civil engineering degree. In this way, we will be contributing to turn sustainability into one of the pillars of the university.

Author Contributions: All authors have contributed equally. All authors have read and agreed to the published version of the manuscript.

Funding: This research, called "Hacia un sector civil sostenible", was funded by University of the Basque Country (UPV/EHU), Call for Innovation Projects "IKD i3" Laborategia (Call 1-2020, 2019/20).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data is contained within the article or Appendix A.

Acknowledgments: The research described in the present paper was developed within the project entitled "Towards a Sustainable Civil Sector i3 (SSi3-CIV)", and it is based on a preliminary deliverable of this project. This project is funded by the University of the Basque Country, Project No. i320-18. The authors wish to acknowledge with thanks the Vicerectorate for Innovation, Social Commitment, and Cultural Action of the University of the Basque Country (UPV/EHU) for the opportunity granted that has made possible the development of the present work.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

This Appendix includes the questions asked in the final questionnaire and the answers obtained from the students. In all cases, they are multiple choice questions in which the students had to rate the statements from 1 to 5 (1: fully disagree; 2: somewhat agree; 3: moderately agree; 4: fairly agree; 5: fully agree; Nk/Na: does not know/does not answer). In all the subjects, the questions are similar but adapted to the characteristics of each subject.

Table A1. Questions asked in the final questionnaires and their results.

	Engineering Projects	**1**	**2**	**3**	**4**	**5**	**Nk/Na**	**Mean**
1	The case study was useful for me to better understand this part of the subject.	0	1	10	11	3	0	3.64
2	The case study helped me to better understand the reality of engineering projects.	0	2	2	11	10	0	4.16
3	The case study favored my capacity for autonomous learning.	0	2	8	11	4	0	3.68
4	The case study improved my teamwork skills.	0	6	6	8	3	2	3.35
5	The case study helped me to relate different subjects of the degree.	2	6	7	6	3	1	3.08
6	The case study increased my interest in the subject.	2	4	7	9	2	0	3.21
7	The case study helped me to better understand how decision-making is carried out in large projects.	0	3	3	11	8	0	3.96
8	The case study helped me to assess the usefulness of the informative studies.	0	1	5	15	3	1	3.86
9	The case study helped me to better understand multi-criteria assessment techniques.	0	2	8	10	5	0	3.72
10	The case study helped me to better understand the entities and influential groups in large public works projects	1	1	6	11	5	0	3.75
11	The case study helped me to better understand the need to use sustainability criteria in large infrastructures.	0	4	4	13	3	1	3.63
	Geographic Information Systems	**1**	**2**	**3**	**4**	**5**	**Nk/Na**	**Mean**
1	The case studies were useful for me to better understand the subject.	0	3	7	8	3	0	3.52
2	The case studies helped me to better understand the projects related to GIS and Spatial Analysis.	0	1	4	8	8	0	4.10
3	The case studies favored my capacity for autonomous learning.	0	2	6	9	3	1	3.48
4	The case studies helped me to relate different subjects of the degree.	3	4	6	5	2	1	2.81
5	The case studies increased my interest in the subject.	1	3	6	4	7	0	3.62
6	The case studies helped me to better understand multi-site assessment techniques using GIS technology.	0	3	2	9	7	0	3.95
7	The case studies helped me to assess the usefulness of GIS tools in evaluating sustainability in civil engineering projects.	0	2	4	10	3	2	3.38
8	The case study helped me to understand the importance of the SDGs in the environmental assessment of projects related to civil engineering.	0	1	3	12	5	0	4.00
9	The case studies were useful to see the wide variety of problems related to sustainability that can be solved with multi-criteria techniques.	0	0	3	12	6	0	4.14
10	The case studies helped me to better understand the need to introduce sustainability criteria in spatial analysis projects.	1	3	2	10	4	1	3.48
	BIM applications in civil engineering	**1**	**2**	**3**	**4**	**5**	**Nk/Na**	**Mean**
1	The case study was useful for me to better understand the subject.	0	2	3	12	6	0	3.96
2	The case study helped me to better understand the complexity of projects based on BIM methodology.	0	2	1	10	8	0	4.04
3	The case study favored my capacity for autonomous learning.	0	4	6	6	7	0	3.70

Table A1. *Cont.*

4	The case study helped me to relate different subjects of the degree.	0	4	8	9	2	0	3.39
5	The case study increased my interest in the subject.	0	3	5	10	5	0	3.74
6	The case study helped me to understand the need for a correct integration of the information related to the project in a BIM model.	0	1	3	12	7	0	4.09
7	The case study helped me to understand the importance of collaborative work in the BIM methodology.	0	2	5	11	4	1	3.61
8	The case study helped me to understand the need for good interoperability between programs and formats in the BIM methodology.	1	4	7	8	3	1	3.35
9	The case study helped me to understand the BIM methodology as a tool that allows a global vision of the project and helps in the analysis of its impact and its efficiency.	1	1	8	8	5	0	3.65
10	The case study helped me to better understand the need to introduce sustainability criteria in infrastructure design.	0	3	2	14	4	0	3.83
	Transport Infrastructure	**1**	**2**	**3**	**4**	**5**	**Nk/Na**	**Mean**
1	The project (the project-based learning methodology) was useful for me to better understand this part of the subject (geometric design of roads, pavement design).	6	3	6	11	6	0	3.25
2	The project helped me to better understand the reality of engineering projects (how a project is carried out, see that it is an iterative process, etc.).	3	3	4	12	10	0	3.72
3	The project favored my capacity for autonomous learning (search of external data, application of the standards, etc.).	5	1	3	11	12	0	3.75
4	The project improved my ability to work in a team.	5	3	4	9	11	0	3.56
5	The project helped me to relate different subjects of the degree	8	6	7	7	3	1	2.71
6	The project increased my interest in the subject.	6	5	10	7	3	1	2.87
7	The project helped me to understand what the iterative decision-making process looks like on a road layout.	3	2	7	10	9	1	3.65
8	The project helped me to assess the data published by road administrations (cartography, traffic data, etc.).	2	3	11	9	7	0	3.50
9	The project helped me to interpret and use the official regulations applicable to a road project (layout regulations, pavement design standards, etc.).	2	1	5	15	9	0	3.88
10	The project helped me to know the parts of a project and understand the reasons of each of them.	3	2	11	8	7	1	3.45
11	The project helped me to know how the measurements of a project are made.	4	4	8	9	6	1	3.29
12	The project helped me to better understand the need to use sustainability criteria in large infrastructures.	5	9	6	9	2	1	2.81
13	The project helped me to know how the sustainability of the materials of a road pavement can be increased.	3	7	11	8	2	1	2.97

References

1. United Nations. Report of the United Nations Conference on Environment and Development. UN General Assembly, 3–14 June 2012 A/CONF.151./26/Rev.1 (Volume 1). 2013. Available online: https://undocs.org/en/A/CONF.151/26/Rev.1(vol.I) (accessed on 28 April 2021).
2. United Nations. Transforming Our World: The 2030 Agenda for Sustainable Development. UN General Assembly, 21 October 2015 A/RES/70/1. 2015. Available online: https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E (accessed on 28 April 2021).
3. United Nations. Paris Agreement. 2015. Available online: https://unfccc.int/sites/default/files/english_paris_agreement.pdf (accessed on 28 April 2021).
4. United Nations. Sustainable Development Goals Report. United Nations. 2020. Available online: https://unstats.un.org/sdgs/report/2020/The-Sustainable-Development-Goals-Report-2020.pdf (accessed on 28 April 2021).

5. UNESCO. Education for Sustainable Development Goals: Learning Objectives. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000247444 (accessed on 28 April 2021).
6. Sustainable Development Solutions Network Australia/Pacific. Getting Started with the SDGs in Universities: A Guide for Universities, Higher Education Institutions, and the Academic Sector. Australia, New Zealand and Pacific Edition. Sustainable Development Solutions Network—Australia/Pacific, Melbourne. 2017. Available online: http://ap-unsdsn.org/regional-initiatives/universities-sdgs/education-for-sdgs-guide/ (accessed on 20 April 2021).
7. Sáez de Cámara, E.; Fernández, I.; Castillo-Eguskitza, N. A Holistic Approach to Integrate and Evaluate Sustainable Development in Higher Education. The Case Study of the University of the Basque Country. *Sustainability* **2021**, *13*, 392. [CrossRef]
8. Cebrián, G.; Junyent, M. Competencies in Education for Sustainable Development: Exploring the Student Teachers' Views. *Sustainability* **2015**, *7*, 2768–2786. [CrossRef]
9. Annan-Diab, F.; Molinari, C. Interdisciplinarity: Practical approach to advancing education for sustainability and for the Sustainable Development Goals. *Int. J. Manag. Educ.* **2017**, *15*, 73–83. [CrossRef]
10. Akyazi, T.; Alvarez, I.; Alberdi, E.; Oyarbide-Zubillaga, A.; Goti, A.; Bayon, F. Skills Needs of the Civil Engineering Sector in the European Union Countries: Current Situation and Future Trends. *Appl. Sci.* **2020**, *10*, 7226. [CrossRef]
11. European Commission. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A European Strategy for Low-Emission Mobility. SWD(2016) 244 Final. 2016. Available online: https://eur-lex.europa.eu/resource.html?uri=cellar:e44d3c21-531e-11e6-89bd-01aa75ed71a1.0002.02/DOC_1&format=PDF (accessed on 14 July 2021).
12. Giunta, M. Assessment of the Impact of CO, NO_x and PM_{10} on Air Quality during Road Construction and Operation Phases. *Sustainability* **2020**, *12*, 10549. [CrossRef]
13. Peng, B.; Tong, X.; Cao, S.; Li, W.; Xu, G. Carbon Emission Calculation Method and Low-Carbon Technology for Use in Expressway Construction. *Sustainability* **2020**, *12*, 3219. [CrossRef]
14. Olowosulu, A.T.; Kaura, J.M.; Murana, A.A.; Adeke, P.T. Development of framework for performance of flexible road pavement in Nigeria using Fuzzy logic theory. *Int. J. Pavement Eng.* **2021**, 1–10. [CrossRef]
15. Pérez-Acebo, H.; Romo-Martín, A. Service and rest areas in toll motorways in Poland: Study of distribution and facilities. *Transport Probl.* **2019**, *14*, 155–164. [CrossRef]
16. European Commission. Communication from the Commission to the European Parliament and the Council: Strategy for the Sustainable Competitiveness of the Construction Sector and Its Enterprises (COM/2012/0433 Final). 2012. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52012DC0433 (accessed on 29 April 2021).
17. Braham, A.; Casillas, S. *Fundamentals of Sustainability in Civil Engineering*; CRC Press: Boca Raton, FL, USA, 2020.
18. Babu, G.S.; Saride, S.; Basha, B.M. *Sustainability Issues in Civil. Engineering*; Springer: New York, NY, USA, 2017.
19. UPV/EHU Agenda for Sustainable Development (EHUAgenda). Available online: https://www.ehu.eus/en/web/iraunkortasuna/ehuagenda-2030 (accessed on 11 May 2021).
20. IKD i3 Strategy of the UPV/EHU. Available online: https://www.ehu.eus/en/web/iraunkortasuna/ehuagenda-2030/ikd-i3-estrategia (accessed on 11 May 2021).
21. UPV/EHU's Supporting Report of the Civil Engineering Degree. Available online: https://www.ehu.eus/documents/6810447/6910426/Triptico_civil.pdf/8d334451-33d2-4284-93a7-88242af25717?t=1490871141000 (accessed on 11 May 2021).
22. Fakhry, M.; Kamel, I.; Abdelaal, A. CAD using preference compared to hand drafting in architectural working drawings coursework. *Ain Shams Eng. J.* **2021**. [CrossRef]
23. Hoshang, S.; Hilal, T.A.; Hilal, H.A. Investigating the acceptance of flipped classroom and suggested recommendations. *Procedia Comput. Sci.* **2021**, *184*, 411–418. [CrossRef]
24. UPV/EHU's Educational Model. Available online: https://www.ehu.eus/es/web/sae-helaz/ikd (accessed on 11 May 2021).
25. Hsieh, C.; Knight, L. Problem-Based Learning for Engineering Students: An evidence-based comparative study. *J. Acad. Librariansh.* **2008**, *34*, 25–30. [CrossRef]
26. Lacuesta, R.; Palacios, G.; Fernández, L. Active learning through problem based learning methodology in engineering education. In Proceedings of the 2009 39th IEEE Frontires in Eudation Conference, San Antonio, TX, USA, 18–21 October 2009; pp. 1–6. [CrossRef]
27. Stake, R.E. Qualitative Case Studies. In *The SAGE Handbook of Qualitative Research*; Denzin, N.K., Lincoln, Y.S., Eds.; SAGE Publications: Newbury Park, CA, USA, 2002; pp. 443–466.
28. Van Maarseveen, M.; Martínez, J.; Flacke, J. *GIS in Sustainable Urban Planning and Management: A Global Perspective*; Taylor & Francis: New York, NY, USA, 2019.
29. Wenwen, L.; Batty, M.; Goodchild, M. Real-time GIS for smart cities. *Int. J. Geogr. Inf. Sci.* **2020**, *34*, 311–324. [CrossRef]
30. Yuan, M. Geographical Information Science for the United Nations' 2030 Agenda for sustainable development. *Int. J. Geogr. Inf. Sci.* **2021**, *35*, 1–8. [CrossRef]
31. Gómez, M.; Barredo, J.I. *Sistemas de Información Geográfica Y Evaluación Multicriterio en la Ordenación del Territorio*; Ra-Ma: Madrid, Spain, 2005.
32. Climate Central. Available online: www.climatecentral.org (accessed on 10 May 2021).
33. Copernicus Climate Change Service (C3S). Available online: www.climate.copernicu.eu (accessed on 10 May 2021).
34. Ingram, J. *Understanding Bim: The Past, Present and Future*; Routledge: Abingdon, UK, 2020.

35. Barnes, P. *Bim in Principle and in Practice*, 3rd ed.; ICE Publishing: London, UK, 2019.
36. Aranda, J.Á.; Martin-Dorta, N.; Naya, F.; Conesa-Pastor, J.; Contero, M. Sustainability and interoperability: An economic study on bim implementation by a small civil engineering firm. *Sustainability* **2020**, *12*, 9581. [CrossRef]
37. Pérez-Acebo, H. Teaching geometric design of roads by means of project-based learning. In *INTED 2017, Proceedings of the 11th International Conference on Technology, Education and Development (INTED), Valencia, Spain, 6–8 March 2017*; Chova, L.G., Martinez, A.L., Torres, I.C., Eds.; IATED: Valencia, Spain, 2017; pp. 229–238.
38. Jones, B.F.; Rasmussen, C.M.; Moffit, M.C. *Real-Life Problem Solving: A Collaborative Approach to Interdisciplinary Learning*; American Psychological Association: Washington, DC, USA, 1997.
39. Thomas, J.W.; Mergendoller, J.R.; Michaelson, A. *Project-Based Learning: A Handbook for Middle and High School Teachers*; The Buck Institute for Education: Novato, CA, USA, 1999.
40. Thomas, J.W. *A Review of Research on Project-Based Learning*; The Autodesk Foundation: San Rafael, CA, USA, 2000. Available online: https://www.asec.purdue.edu/lct/HBCU/documents/AReviewofResearchofProject-BasedLearning.pdf (accessed on 2 May 2021).
41. Vidal, B.; Ribera, M.L.F.; Ribal, F.J.; Sanchis, P.; García-Ruperez, J.; Bes-Pia, M.A.; Blasco-Tamarit, E.; Noguera, P.; Muñoz-Portero, M.J.; Tortaja, L.A. Students' perception on learning methods in engineering disciplines. *J. Appl. Res. Higher Educ.* **2021**. [CrossRef]
42. Imaz, J.I. "How Has Your City Changed?" Using Project-Based Learning to Teach Sociology of Education. *Educ. Urban Soc.* **2021**. [CrossRef]
43. Ruiz-Rosa, I.; Gutiérrez-Tano, D.; García-Rodríguez, F.J. Project-Based Learning as a tool to Foster entrepereneurial competences. *Cultur. Educ.* **2021**, *33*, 316–344. [CrossRef]
44. Yoo, S.H.; Bae, S.M.; Shin, B.M.; Shin, S.J. The effect of project-based learning modules on a community dental hygiene practicum in South Korea. *J. Dental Educ.* **2020**, *84*, 418–428. [CrossRef]
45. Coronado, J.M.; Moyano, A.; Romero, V.; Ruiz, R.; Rodríguez, J. Student Long-Term Perception of Project-Based Learning in Civil Engineering Education: Na 18-Year Ex-Post Assessment. *Sustainability* **2021**, *13*, 1949. [CrossRef]
46. Pérez-Acebo, H.; Alberdi Celaya, E.; Eguia Ribero, M.I.; García López, M.J.; Álvarez González, I. Reinforcing the concept of clothoid, a key concept in geometric design of roads. In *INTED 2017, Proceedings of the 11th International Conference on Technology, Education and Development (INTED), Valencia, Spain, 6–8 March 2017*; Chova, L.G., Martinez, A.L., Torres, I.C., Eds.; IATED: Valencia, Spain, 2017; pp. 1255–1261.
47. BOE (Boletín Oficial del Estado). *Real Decreto Legislativo 3/2011, de 14 de Noviembre, Por El Que Se Aprueba El Texto Refundido de la Ley de Contratos del Sector Público*; Boletín Oficial del Estado no. 276, de 16 de noviembre de 2011; BOE (Boletín Oficial del Estado): Madrid, Spain, 2011; pp. 117729–117914.
48. Fedrigo, W.; Peres Nuñez, W.; Visser, A.T. A review of full-depth reclamation of pavements with Portlad cement: Brazil and abroad. *Constr. Build. Mat.* **2020**, *262*, 120540. [CrossRef]
49. Jallu, M.; Arulrajah, A.; Saride, S.; Evans, R. Flexural fatigue behavior of fly ash geopolymer stabilizaed-geogrid reinforced RAP bases. *Const. Build. Mat.* **2020**, *254*, 119263. [CrossRef]
50. Gonzalo-Orden, A.; Linares-Unamunzaga, H.; Pérez-Acebo, H.; Díaz-Minguela, J. Advances in the study of the behavior of full-depth reclamation (FDR) with cement. *Appl. Sci.* **2019**, *9*, 3055. [CrossRef]
51. Yu, B.; Meng, X.C.; Liu, Q. Multi-objective optimisation of hot in-place recycling of asphalt pavement considering environmental impact, cost and construction quality. *Int. J. Pavement Eng.* **2020**, *21*, 1576–1584. [CrossRef]
52. Linares-Unamunzaga, A.; Pérez-Acebo, H.; Rojo, M.; Gonzalo-Orden, H. Flexural strength prediction models for soil-cement from Uncofined Compressed Stregth at seven days. *Materials* **2019**, *12*, 387. [CrossRef] [PubMed]
53. Melese, E.; Baaj, H.; Tighe, S.; Zupko, S.; Smith, T. Characteristics of full-depth reclaimed pavement materials treated with hydraulic road binders. *Constr. Build. Mater.* **2019**, *226*, 778–792. [CrossRef]
54. Wu, S.; Montalvo, L. Repurposing waste plastics into cleaner asphalt pavement materials: A critical literature review. *J. Clean. Prod.* **2021**, *280*, 124355. [CrossRef]
55. Salas, M.A.; Pérez-Acebo, H.; Calderón, V.; Gonzalo-Orden, H. Bitumen modified with recycled polyurethane foam for employment in hot mix asphalt. *Ing. Investig.* **2018**, *38*, 60–66. [CrossRef]
56. Lachance-Tremblay, E.; Vaillancourt, M.; Perraton, D.; Di Benedetto, H. Linear viscoelastic (LVE) properties of asphalt mixtures with different glass aggregates and hydrated lime content. *Int. J. Pavement Eng.* **2020**, *21*, 1170–1179. [CrossRef]
57. Ruiz, G.; Chavez, F.; Santamaria, S.; Araujo, W.; Timana, J.; Schmitt, R. Laboratory evaluation of seashells used as fine aggregate in hot mix asphalt. *Int. J. Pavement Eng.* **2020**, *21*, 620–628. [CrossRef]
58. Pasandin, A.R.; Pérez, I. Performance of hot-mix asphalt involving recycled concrete aggregates. *Int. J. Pavement Eng.* **2020**, *21*, 1044–1056. [CrossRef]
59. Bressi, S.; Fiorentini, N.; Huang, J.D.; Losa, M. Crum rubber modifier in road asphalt pavements: State of the art and statistics. *Coatings* **2019**, *9*, 384. [CrossRef]
60. Salas, M.A.; Pérez-Acebo, H. Introduction of recycled polyurethane foam in mastic asphalt. *Gradevinar* **2018**, *70*, 403–412. [CrossRef]
61. Martinho, F.C.G.; Picado-Santos, L.G.; Capitao, S.D. Assessment of warm-mix asphalt concrete containing sub-products as part of aggregate blend. *Int. J. Pavement Eng.* **2020**, *21*, 1213–1222. [CrossRef]

62. Movilla-Quesada, D.; Raposeiras, A.C.; Silva-Klein, L.T.; Lastra-González, P.; Castro-Fresno, D. Use of plastic scrap in asphalt mixtures added by dry method as a partial substitute for bitumen. *Waste Manag.* **2019**, *87*, 751–760. [CrossRef] [PubMed]
63. Kaseer, F.; Arambula-Mercado, E.; Cucalon, L.G.; Martín, A.E. Performance of asphalt mixtures with high recycled materials content and recycling agents. *Int. J. Pavement Eng.* **2020**, *21*, 863–877. [CrossRef]
64. Yang, J.H.; Zhang, Z.Q.; Fang, Y.; Luo, Y.F. Performance characterization of waterbone epoxy resin and styrene-butadiene rubber latex composite modified asphalt emulsion (WESAE). *Coatings* **2020**, *10*, 352. [CrossRef]